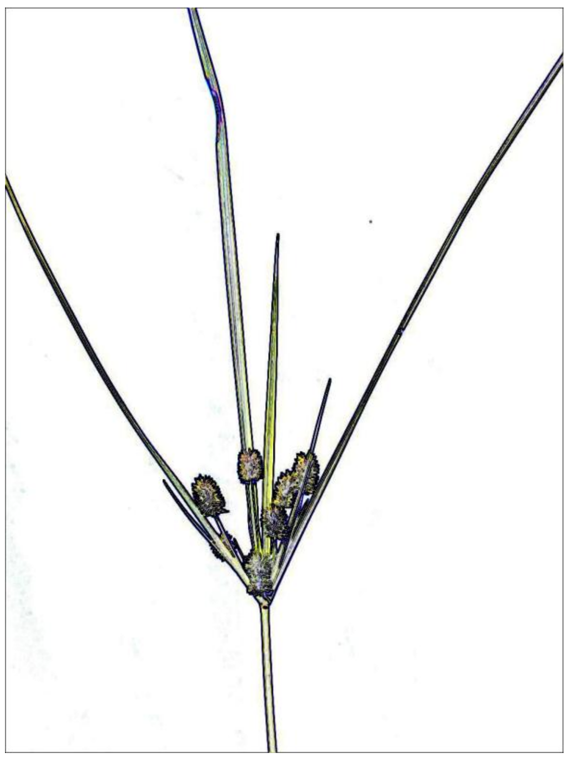
POST-TENURE REVIEW 2011

J. Richard Carter, Ph.D.

Professor of Biology



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Valdosta State University
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2011.10.13

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SELF-EVALUATION

With the close of academic year 2010-2011, I completed 27 years of service to Valdosta State University. Fresh out of a doctoral program at Vanderbilt University, I began my career fall quarter 1984 as a Temporary Instructor of Biology. Subsequently, I came up through the ranks and was promoted to Assistant Professor in 1986, Associate Professor in 1991, and Professor in 1996. When I started, Valdosta State College had about half the number of students we currently have, and the Biology Department had less than half its current faculty, was located in Nevins Hall, and had exiguous facilities. In those days, computers were not provided, so I purchased my first office computer personally: Indeed, it was a *personal computer!* The departmental secretary used a mimeograph machine to duplicate course materials, and faculty neither had direct access to office supplies nor to the photocopy machine located downstairs in the bursary. On the positive side, neither faculty nor staff was required to pay for parking privileges, and faculty had numbered, assigned parking spaces. Although substantially smaller, the departmental faculty was diverse, and our primary obligation was teaching. We sought to do that in our individual ways and were tolerant of disparate approaches and personalities, and always supportive of anyone who demonstrated a genuine commitment toward teaching.

Before moving from Nevins Hall to Bailey Science Center in January 2001, our largest lecture sections were limited to 64 students, most lecture sections had no more than 48 students, and we taught all of our students in lab as well as lecture. During the lean years of the late 1980s and early 1990s, the department at times did not have sufficient funds for basic lab supplies, and students were known to retrieve paper towels from the restrooms for use in lab. Perennially, the air-conditioning system in the non-administrative portion of Nevins Hall was shut down for several weeks between end of summer term and beginning of fall semester. Although most faculty were not on campus during the intersession, working conditions in the offices, labs, and herbarium were – to say the least – uncomfortable for those of us trying to do research. Although the department had hardly any facilities, space, or equipment for research, even then there was an increasing emphasis on professional development, and faculty were required to be productively engaged in research in order to achieve tenure and promotion.

Until 1997 we taught under the quarter system, and all courses – both with and without labs – were five credit hours. Non-lab courses, of which there were none in biology, met five hours for lecture weekly. In biology and the other sciences, introductory level courses met four hours of lecture and two hours of lab per week, and sophomore and upper level courses had three hours of lecture and four hours of lab. Teaching assignments were based on credit hours, not contact hours, which meant science faculty often taught more than 15 hours per week, and teaching loads of 18-20 hours were not uncommon, depending on the mix of courses. During my first quarter I was assigned three separate introductory biology sections for a total of 18 contact hours. Subsequently, for each of the next four quarters I had a new course preparation, and two different preparations (not counting labs!) per term, at that. By the sixth quarter, I was fairly confident I had been assigned all the courses on the books, which I might reasonably be expected to teach. To my relief, I was not assigned another new preparation the sixth quarter; however, I was given three different course preparations for a total of 20 contact hours!

My initiation to Valdosta State began in 1984, when I was interviewed the week before fall quarter began and returned to Valdosta just two days before the first day of classes. The present economic crisis is curiously reminiscent of that gloomy period when I was hired in 1984: severe recession, high unemployment, and generally bleak prospects. I considered myself fortunate indeed to have a job! Particularly attractive to me were Valdosta State's broad undergraduate curriculum in biology that included a number of field and organismal courses in the plant sciences, and its herbarium – an essential resource for any serious program in plant systematics and floristics. Initially, I was employed when Dr. Wayne Faircloth was appointed acting department head, a position he occupied for two years until the administration moved to make it permanent. Thus, my first two years were one-year temporary appointments, with any prospect for my continued employment contingent upon Dr. Faircloth's selection as permanent department head. My position was, to say the least, precarious! During my second year at VSU, the department head position was advertised, a search was completed, and Dr. Faircloth was selected and appointed permanent department head. Subsequently, Dr. Faircloth's tenure-track replacement position was advertised, and I applied. My colleagues very kindly must have figured I had *just enough* potential to be kept on and given a chance, and I was hired into a tenure track position at the beginning of my third year, and for that I am very grateful. I still consider those first two years to have been one of the most extensive job interviews on record!

Several factors have contributed to the substantial evolution of the program in biology at Valdosta State over the past three decades: university status in 1993, the shift from quarters to semesters in 1997, the occupation of the Bailey Science Center in 2001, and the rapidly increasing enrollment during the past decade. The Bailey Science Center has provided greatly improved working conditions and much more space for teaching and research. To the administration's credit, the faculty was given a substantial role in planning for this facility, which included the design of greatly expanded laboratory space for teaching and research. With the migration to the new building, increased teaching lab space and new instructional equipment (especially, additional microscopes) have allowed much greater flexibility in scheduling of courses. Also, the administration provided funds for purchasing new equipment for research when we moved (e.g., research microscope and additional specimen cabinets in the herbarium), and the lecture rooms and labs were equipped with modern presentation systems. Prior to the purchase of a research microscope for the herbarium in 2001, I used the same model of microscope for research that our students used. The recent decommissioning of the Advanced Botany Laboratory (BC 2042) and its conversion to research space has been disheartening to say the least. With that change, the space dedicated for instruction in plant science has been reduced substantially, and is now essentially what it was in Nevins Hall, prior to the 2001 occupation of Bailey Science Center.

I miss many of my former colleagues and our closely knit department. I also miss teaching the students in both lecture and laboratory, which enabled me to get to know them much better and to observe them in a variety of learning situations. This was particularly advantageous when I wrote letters of recommendation for them. Certain changes have been for the better – especially the occupation of Bailey Science Center and the increased funding for laboratory instruction and for research. Given the requirement for productive involvement in research for promotion and tenure since – and before – my employment in 1984, as one would expect, there has always been some tension with regard to the three areas of professional involvement: teaching, professional development, and service. However, concomitant with the provision of expanded and improved facilities in Bailey Science Center came the expectation and responsibility to increase the level of involvement in research. I am amazed by the scientific equipment and instrumentation purchased in the past two years through *internal* funding. This is unprecedented and indicates a major administrative shift, and I'm certain it carries even higher expectations of faculty! Following is a synopsis of my professional activities in these three areas over the past five years.

TEACHING. As summarized in Table 1, I have taught 10 different courses since my last post-tenure review, five of which have been new preparations. These courses have ranged from introductory biology, to required sophomore level botany, to advanced upper level elective courses and graduate level courses. Most all of my courses have a substantial laboratory component. They are well designed and thorough, with lecture and laboratory components complimenting one another. My expectations of students are explained at the beginning of the semester and clearly stated in the syllabus (cf. Appendix A), examinations and other assessments reflect course content and course objectives, and student performance on the examinations and assessments is the basis for assignment of the course grade. As is the case with any good college-level course, diligence and daily preparation and study are essential for success. Students differ in their backgrounds, maturity, degree or preparation, motivation to study, and in their mastery of the course content, and my grade distributions tend to reflect such differences, with students generally performing at progressively higher levels as they advance through the curriculum, from freshman- to sophomore- to senior-level courses. Not surprisingly, student opinions vary about me and my courses, with average Student Opinion of Instruction (SOI) scores generally falling about 4.0 (out of 5) or slightly below in the introductory and sophomore level courses, and ranging 4.5-5.0 in the upper-level elective courses. Not surprisingly, student comments range from the negative to the very positive. Based upon his analysis of the SOIs, my department head has consistently rated my teaching as "good." As evidence of the quality of my teaching, results of SOIs for the most recent two years of review are included in Appendix B. Following are selected comments (unedited) from courses I taught during 2010.

BIOL 2230 General Botany – Spring 2010

- Very knowledgeable about the subject content and enthusiastic.
- Knew the topics very well and intertwined lab with lecture well.
- His vast knowledge on the subject and his dedication to science.
- The teacher knew this subject like the back of his hand.
- Dr. Carter is a wonderful professor and really knows his material. He not only teaches botany very well but also teaches life lessons.
- Easy to talk to outside the classroom.
- Always has a few extra words of wisdom for life, and has a passion for the subject taught.

BIOL 4100 Morphology of Land Plants – Spring 2010

- Dr. Carter doesn't mess around, and that is meant in a good way.
- This course was presented in a problem-based format. Whereas, other courses only ask you to memorize and regurgitate information. Such courses do the student no service. In this course, we were ask to complete theorectical cladograms based on the apomorphies we learned. We were asked to classify flowers based on investigative techniques and the project taught us the scientific method, which is the essence of not only medicine, but science in general.
- Finding that there are multiple ways to interpret and analyze cladistics. There were many things learned in this course that help to better understand the relationships and reasons why extant plants are the way they are.

BIOL 4010 Dendrology – Fall 2010
What were the best features about this course?

- Course materials were best learned through field study and then reconstituted through our lecture work.
- the hands on learning made this class one of my favorites. I have never learned and retained so much information from one class. Dr. Carter was a great teacher. The class was extremely challenging, but very interesting. I'm really glad I took this course.
- Everything was pretty straight forward. Dr. Carter loves what he's teaching. It was taught how a senior level course should be taught.
- The most enjoyable and productive learning experiences of the class/lab were the field trips. Also the outdoor lab sessions were fun and productive giving students hands on experience in the field.
- We were able to go and see live specimen
- The field trips were great. The hands on approach of learning works great.
- The field quizes pushed you to learn the material, how to identify certain species, and how to relate everything learned together.
- Field trips were fun and very educational.

What were your instructor's strengths?

- His knowledge and passion for trees and plants. He was very enthusiastic about teaching us.
- His strengths were his knowledge of the subject (plants).
- He knows his material, without question, and he wants you to know the material too.
- He loved what he's teaching and knows the material as well as anyone. If he didn't know something he would be sure to know by the next class.
- Very knowledgeable
- Knowledge of the course and his abilities to make the students learn rather than memorize
- Knew material very well and is passionate about the subject
- He knew the material very well and loved talking about trees. It's nice to have a teacher who loves what he teaches. It made me want to learn everything I could about trees.

I use BlazeVIEW (formerly WebCT, Vista) in most of my courses to supplement the traditional lecture and laboratory components, especially to make various materials available on-line outside of the regularly scheduled lectures and labs. These materials include PowerPoint lectures with images from the textbook as well as original photographs and diagrams. I also find BlazeVIEW extremely useful in promoting communication with students outside of scheduled meetings and office hours, and in giving on-line assessments. Although on-going development and modification of courses through BlazeVIEW requires a considerable investment of time, I am convinced its use promotes learning especially for average to below average students by enabling more effective communication and better student access to a variety of supplementary course materials.

In an attempt to involve students in research and herbarium activities, I have made special efforts to inform students in my classes of my research activities and my responsibilities as herbarium curator. These efforts have stimulated a number of students to become involved in various aspects of my research through our Directed Study course. Also, several students have worked as herbarium volunteers after learning about the VSU Herbarium and its importance, and, currently, I am thesis advisor to one graduate student who became interested in research after volunteering as a herbarium assistant while she was enrolled in General Botany. I have mentored a number of undergraduate students in Directed Study, one of whom presented the results of his research at the Council for

Undergraduate Research annual symposium, and I am currently mentoring one M.S. student, who is scheduled to complete degree requirements Fall 2011 or Spring 2012.

Professional Development. Since my initial employment at VSU, my research interests – both in the field and in the herbarium – have been flora of the Georgia coastal plain region and systematics of the sedge family (Cyperaceae), particularly the genera *Cyperus* and *Eleocharis*. Over the years, including those recent ones under review, I have secured a number of small grants and contracts that have enabled me to work on a variety of field-based projects each involved with documenting some aspect of the Georgia coastal plain flora. Moreover, stimulated by requests for identifications of specimens by applied researchers at the University of Georgia and elsewhere (e.g., agronomists, weed scientists, horticulturists), I have become interested in the distribution and ecology of weeds. Since my last post-tenure review in 2006, I have continued active engagement in research, and I currently have a number of research projects underway in various stages of completion. During the period of review, I have had 18 journal articles published in 12 different peer-review journals (Table 2; Appendix C). Additionally, I have had nine other miscellaneous articles published (Table 2), have completed three technical reports (Table 2), and have made presentations at state, regional, and national conferences (Table 3). I have secured external funding (>$130K, cf. Table 4) from a variety of sources, supporting my research. In particular, this funding has enabled me to involve undergraduate and graduate student-assistants in the herbarium and in field research, and to further my efforts to document the flora of the Georgia coastal plain.

In 2006, I received support through Yale University to attend a workshop on herbarium cyber-infrastructure sponsored by the National Science Foundation, at the 100th Annual Meeting of the Botanical Society of America in Chico, California. In 2008, I represented the Southeastern Regional Network of Expertise and Collections (SERNEC) at a workshop "Opportunities and Challenges of Small Collections" sponsored by CollectionsWeb at Michigan State University and participated in a SERNEC-sponsored workshop on the SPECIFY database program at the University of South Carolina in 2009. In July 2010, I re-submitted a grant proposal (in collaboration with Dr. Wendy Zomlefer, University of Georgia) to the National Science Foundation to acquire funding for improving and enhancing the Valdosta State University Herbarium.

Service. Since my last post-tenure review in 2006, my service has included a variety of activities both on and off campus (Table 5). I have been invited to give public lectures locally (VSU Honors Program Fall Colloquium Address, 2006) and in Tallahassee (Magnolia Chapter, Florida Native Plant Society, 2006). I was invited to speak at the Annual Meeting of the Georgia Native Plant Society in Atlanta (2008), to present a workshop on sedge identification at the Annual Conference of the Florida Native Plant Society in Tallahassee (2010), and to teach a short course at the State Botanical Garden of Georgia (University of Georgia, Athens) for the Certificate in Native Plants Program (2010). I assisted colleagues at University of Georgia (Tifton) at the Southern Weed Science Society Field Day (2009), and I was solicited for "expert input" by the Georgia Department of Natural Resources for its Georgia Coastal Conservation Planning Process (2009).

My duties also include curating the Valdosta State University Herbarium. As herbarium curator, I have continued to add specimens to the VSU Herbarium, which currently comprises ca. 70,000 accessions. Second largest in the state, the VSU Herbarium is exceeded only by the University of Georgia Herbarium, and is about three times the size of the third largest at Georgia Southern University. As herbarium curator, I routinely provide service determinations of plant specimens for agricultural scientists at University of Georgia and others, at the rate of ca. 50 per year. Evidence of use of the herbarium and activities provided through my role as curator are detailed in Appendix D. When we moved to Bailey Science Center, the herbarium was allocated considerably more space than it occupied in Nevins Hall, as well as 12 new herbarium cabinets. The additional space and cabinets provided substantial relief from the severe over-crowding associated with cramped quarters in Nevins Hall. However, in the past decade my research efforts – especially those to document the flora of the Georgia coastal plain – have resulted in the accumulation of thousands of additional voucher specimens, creating a specimen backlog and the need for additional supplies and cabinets to store these specimens properly. During the period of review, I have submitted grant applications to the National Science Foundation (including a resubmission July 2010) seeking funds to purchase herbarium cabinets and supplies, to produce a database and high-resolution digital images of specimens making the virtual herbarium accessible through the Internet, and to employ students to assist with these efforts. The Valdosta State Herbarium has never had regular funding from the institution, and has been dependent upon sporadic support through the department, the Valdosta State University Foundation, and from small grants and contracts secured by me. An annual line for the herbarium in the university budget – even if only a nominal amount – would be greatly beneficial in allowing for the regular purchase of basic supplies needed to maintain the existing collections and to process new ones. Without such institutional support, cyclical shortages of basic materials and supplies will continue. About 10 years ago, I made a formal – albeit unsuccessful – appeal to the administration requesting such funding. I herewith respectfully renew that request and shall be happy to discuss the details further with the appropriate administrators or to submit additional documentation, as needed. Additional information about the Valdosta State Herbarium is available through the corresponding link at http://www.valdosta.edu/~rcarter/index.htm.

As shown in Table 6, my service activities have included the review of research papers submitted to a variety of journals. I have also reviewed books and have served as a peer-reviewer for United States Department of Agriculture–Agricultural Research Service, a regional reviewer for the *Flora of North America,* and a reviewer for the National Science Foundation. I have also served on the Valdosta State University Faculty Senate and chaired the university-wide Environmental Issues Committee, and I have served on a variety of other committees at various levels within the University, as well as the Valdosta Tree Commission, and the Student Travel Award Committee of the Association of Southeastern Biologists (Table 7).

SUMMARY. I have always striven to be engaged and productive in my teaching, professional development, and service, and to maintain some balance among these areas, recognizing of course that my primary obligation is toward sound teaching in support of learning. My basic philosophy – which I do recommend for consideration by fresher colleagues – has always been to work as hard as I possibly could to achieve, first, my intrinsic professional objectives and, second, those extrinsic requirements relating to tenure, promotion, and post-tenure review imposed by the institution – knowing full well there are never assurances of success. Thus, in the face of the inevitable setbacks I could at least take solace in the fact that I had fought the good fight. I find my work at Valdosta State immensely rewarding, and my work habits have not changed substantively since my initial employment in 1984. It is particularly gratifying to know my department head has found my performance "satisfactory" both overall and in the three areas, for each of the five years currently under review, and he has also consistently characterized my contributions as "outstanding" in his summary statements (cf. Appendix E). I trust my colleagues and administration will view favorably my contributions over the past five years, the essential details of which I have attempted to present in this document. Additionally, my current curriculum vitae may be found in Appendix F.

Table 1. Courses taught since my last post-tenure review (2006-2010), with new course preparations in **bold.**

1. BIOL 1010 Introduction to Biology: Evolution & Diversity of Life
2. BIOL 2230 General Botany
3. BIOL 3600 Local Flora
4. **BIOL 3650 Plant Systematics**
5. **BIOL 4010/6010 Dendrology**
6. **BIOL 4100/6100 Morphology of Land Plants**
7. BIOL 4900 Senior Seminar
8. BIOL 4950 Directed Study
9. **BIOL 7900 Graduate Seminar**
10. **PERS 2490 History & Use of Medicinal Plants**

Table 2. Peer-review publications, miscellaneous publications, and unpublished technical reports 2006-2010.

Peer-review publications –

1. Bryson, C.T., and R. Carter. 2010. Spread, growth parameters and reproductive potential for brown flatsedge (*Cyperus fuscus*). Invasive Plant Science and Management. 3: 240-245.
2. Carter, R. 2009. Rediscovery of *Platanthera chapmanii* in Georgia. Native Orchid Conference Journal 6(4): 1-3.
3. Goddard, R.H., T.M. Webster, R. Carter and T.L. Grey. 2009. Resistance of Benghal Dayflower *(Commelina benghalensis)* seeds to harsh environments and the implications for dispersal by Mourning Doves *(Zenaida macroura)* in Georgia, U.S.A. Weed Science 57: 603-612.
4. Carter, R., C.W. Allen, P. and D. Lewis. 2009. *Cyperus pilosus* Vahl (Cyperaceae) new to the flora of Texas. J. Bot. Res. Inst. Texas 3: 457-459.
5. Carter, R., W.W. Baker and M.W. Morris. 2009. Contributions to the flora of Georgia, U.S.A. Vulpia 8: 1-54.
6. Bryson, C.T., and R. Carter. 2008. The significance of Cyperaceae as weeds. Pp. 15-101 in R. F. C. Naczi and B. A. Ford (editors), *Sedges: Uses, Diversity, and Systematics of the Cyperaceae*. Monogr. Syst. Bot. Missouri Bot. Gard. 108.
7. Carter, R. 2008. Floristic highlights from Camden County. Tipularia 23: 34-42.
8. Bergstrom, B.J., and R. Carter. 2008. Host tree selection by an epiphytic orchid, *Epidendrum magnoliae* Muhl., in an inland hardwood hammock in Georgia. Southeastern Naturalist 7: 571-580.
9. Rosen, D.J., S.R. Hatch and R. Carter. 2008. Taxonomy and nomenclature of three closely related species of *Eleocharis* subg. *Limnochloa* (Cyperaceae). Blumea 53: 235-246.
10. Bryson, C.T., V.L. Maddox and R. Carter. 2008. Spread of Cuban Club-rush [*Oxycaryum cubense* (Poeppig & Kunth) Palla] in the Southeastern United States. Invasive Plant Science and Management 1: 326-329.
11. Bryson, C.T., and R. Carter. 2008. A novel design for a light weight and durable field press. J. Bot. Res. Inst. Texas 2(1): 517-520.
12. Whittier, D.P., and R. Carter. 2007. The gametophyte of *Lycopodiella prostrata*. Amer. Fern J. 97(4): 230–233.
13. Carter, R. 2007. Nomenclatural notes on *Cyperus retrorsus* Chapm. and «*Cyperus retroversus* Chapm.» (Cyperaceae). Vulpia 6: 1-3.
14. González-Elizondo, M.S., D.J. Rosen, R. Carter and P.M. Peterson. 2007. *Eleocharis reznicekii* (Cyperaceae), a new species from the Mexican High Plateau. Acta Botanica Mexicana 81: 35-43.
15. Carter, R., C.T. Bryson and S.J. Darbyshire. 2007. Preparation and use of voucher specimens for documenting research in weed science. Weed Technology 21: 1101-1108.
16. Rosen, D.J., S.R. Hatch and R. Carter. 2007. Infraspecific taxonomy and nomenclature of *Eleocharis acutangula* (Cyperaceae). J. Bot. Res. Inst. Texas 1(2): 875-888.
17. Rosen, D.J., and R. Carter. 2007. Additional noteworthy collections of *Cyperus drummondii* (Cyperaceae) from Texas and first report from Mexico. J. Bot. Res. Inst. Texas 1(1): 779-780.
18. Rosen, D.J., R. Carter and C.T. Bryson. 2006. The spread of *Cyperus entrerianus* (Cyperaceae) in the southeastern United States and its invasive potential in bottomland hardwood forests. Southeastern Naturalist 5: 333-344.

Misc. publications –

1. Jarvis, T.A., R. Carter, and R.H. Goddard. 2010. Agricultural significance of seed dispersal by migratory doves. Proceedings of the Southeastern Microscopy Society 30: 27 (abstract).
2. Goddard, R.H., T.M. Webster, R. Carter, and T. Grey. 2010. Functional morphology and seed anatomy of the invasive weed, Benghal dayflower *(Commelina benghalensis):* Implications for dispersal by mourning doves. Proceedings of the Southeastern Microscopy Society 30: 23 (abstract).
3. Carter, R. 2008. Obituary – Wayne R. Faircloth (1932-2008). Southeastern Biology 55: 501-504.
4. Bryson, C.T., and R. Carter. 2008. Brown flatsedge *(Cyperus fuscus):* A potential rice weed. Proc. South. Weed Sci. Soc. 61: 39 (abstract).
5. Carter, R., R.H. Goddard, T.M. Webster, J.T. Flanders, A.S. Culpepper and T.L. Grey. 2006. Do mourning doves disperse seeds of tropical spiderwort? Proceedings of the 38th Annual Meeting of the American Peanut Research and Education Society, Savannah, Georgia. Abstract 117.
6. Rosen, D.J., R. Carter and C.T. Bryson. 2006. The potential for spread of *Cyperus entrerianus* (Cyperaceae) into native habitats of the southeastern United States. Proc. South. Weed Sci. Soc. 59: 252 (abstract).
7. Bryson, C.T., R. Carter and D.J. Rosen. 2006. Dispersal, biology, and control of deeprooted sedge. Proc. South. Weed Sci. Soc. 59: 253 (abstract).
8. Carter, R., C.T. Bryson, and D.J. Rosen. 2006. Invasive sedges: Impending problems. Proc. South. Weed Sci. Soc. 59: 254 (abstract).
9. Stewart, K., J.R. Carter, J.A. Nienow, J. Rudloe and J.T. Baxter. 2006. Phytochemical investigations of *Thalassia testudinum.* Georgia J. Sci. 64(1): 33 (abstract).

Technical reports –

1. Carter, R. 2010. Status survey and search efforts for pondberry *(Lindera melissifolia)* and pondspice *(Litsea aestivalis)* in Georgia, with special attention to Laurel Wilt Disease – Final Report. Unpublished report submitted to Georgia Department of Natural Resources. Social Circle, Georgia. 253 pp.
2. Carter, R. 2010. Survey of trees at St. Barnabas Episcopal Church. Unpublished report submitted 10 August 2010 to St. Barnabas Episcopal Church, Valdosta, Georgia. 20 pp.
3. Carter, R., and W.W. Baker. 2009. Status survey and search efforts for *Schwalbea americana* L. (American chaffseed) in Georgia – Final report. Unpublished report submitted to Georgia Department of Natural Resources. Social Circle, Georgia. 191 pp.

Table 3. Workshops and other contributions at professional conferences 2006-2010.

1. Carter, R. Sedge Identification Workshop. 30th Annual Conference of the Florida Native Plant Society, 23 May 2010, Tallahassee, Florida.
2. Carter, R. Appreciating Native Grasses. Presented at the 2008 Symposium of the Georgia Native Plant Society, Mercer University, Atlanta, Georgia; 16 February 2008.
3. Carter, R., R.H. Goddard, T.M. Webster, J.T. Flanders, A.S. Culpepper and T.L. Grey. Do mourning doves disperse seeds of tropical spiderwort? Paper presented at *Symposium – Tropical Spiderwort: A New Troublesome Exotic-Invasive Weed in Peanut*. 38th Annual Meeting, American Peanut Research and Education Society, Savannah, Georgia; 11-14 July 2006.
4. Carter, R., C.T. Bryson, and D.J. Rosen. Invasive sedges: Impending problems. Paper presented at *Symposium – Invasive Grasses and Sedges: Deep-rooted Issues* sponsored by U.S. Fish and Wildlife Service and SWSS at 59th Annual Meeting of Southern Weed Science Society, San Antonio, Texas; 23-25 January 2006.

Table 4. External grant proposals funded or pending 2006-2010.

1. Carter, R. (PI). Collaborative Research: The GA-VSC Herbaria Collaborative: Phase I of a Statewide Consortium. National Science Foundation, **$199,336**; 2011-2013; PENDING.
2. Carter, R. (PI). Floristic Inventory and Vegetation Survey of the Banks Lake National Wildlife Refuge, Lanier County, Georgia; U.S. Fish & Wildlife Service, **$4,000**; 2009-2011; FUNDED.
3. Carter, R. (PI). Survey of known and potential populations of pondberry (*Lindera melissifolia*) and pondspice (*Litsea aestivalis*) in Georgia; contract funded by Georgia Department of Natural Resources, **$20,000**; 2008-2009; FUNDED.
4. Carter, R. (PI), J. Pascarella (Co-I). Effects of Prescribed Burning on Representative Forest Communities at Moody Air Force Base and Grand Bay Wildlife Management Area, Lowndes and Lanier counties, Georgia; cooperative agreement with Moody Air Force Base; U.S. Army Medical Research Acquisition Activity (USAMRAA); **$87,000**; 2007-2011; FUNDED.
5. Carter, R. (PI). Status Survey and Search Efforts for American Chaffseed (*Schwalbea americana*) in Georgia; contract funded by Georgia Department of Natural Resources, **$18,800**; 2007-2008; FUNDED.
6. Carter, R. (PI). Flora of Camden County, Georgia, with emphasis on Crooked River State Park; Marie Mellinger Field Botany Research Grant funded by the Georgia Botanical Society, **$1,500**; 2006; FUNDED.

Table 5. Miscellaneous service contributions 2006-2010.

1. "Learn to love the sedges" – Short-course for the Certificate in Native Plants Program, State Botanical Garden of Georgia, University of Georgia (Athens); 11 September 2010.
2. Assisted with the regional weed identification competition at the Southern Weed Science Society (SWSS) Field Day, University of Georgia (Tifton); 05 Aug 2009.
3. "A Field Botanist's Perspective on the State of the Environment" – Address to the 2006 Freshman Honors Colloquium, Valdosta State University, Valdosta, Georgia; 11 August 2006.
4. "An introduction to the sedges" – Presentation to the Florida Native Plant Society (Magnolia Chapter), Tallahassee; 08 March 2006.

Table 6. Summary of reviewing and editing activities 2006-2010.

Journals

1. Guest Editor for *Southeastern Naturalist* / 1 manuscript
2. Reviewer for *Castanea* / 4 manuscripts
3. Reviewer for *Florida Scientist* / 1 manuscript
4. Reviewer for *Harvard Papers in Botany* / 1 manuscript
5. Reviewer for *Journal of the Botanical Research Institute of Texas* / 1 manuscript
6. Reviewer for *Rhodora* / 1 manuscript
7. Reviewer for *Taxon: International Journal of Plant Taxonomy, Phylogeny and Evolution* / 3 manuscripts
8. Reviewer for *Weed Technology* / 1 manuscript

Books, web publications, and databases

9. Reviewer of *Biology of Plants* by Raven et al., W.H. Freeman Publ. (textbook)
10. Reviewer of *Field Guide to the Rare Plants of Georgia*
11. Regional reviewer for *Flora of North America* (on-going multi-volume series)
12. Reviewer of *Georgia Protected Plant List*
13. Reviewer for Global Invasive Species Database (GISD), IUCN SSC Invasive Species Specialist Group, Centre for Biosecurity and Biodiversity, Univ. of Auckland, New Zealand

Misc.

14. Reviewer for the National Science Foundation / 3 research proposals
15. Reviewer for U.S. Department of Agriculture – Agricultural Research Service / 7 manuscripts

Table 7. Summary of committee and related service 2006-2010.

Name of Committee/Organization	Role	Scope
Student Travel Award Committee of the Association of Southeastern Biologists	Member (2009-2010)	Regional
Valdosta Tree Commission	Member (2006-2007)	Municipal
Faculty Senate	Member (2006-2008)	University
Environmental Issues Committee	**Chair (2006-2007)** Member (2006-2008)	University
Campus Beautification and Stewardship Subcommittee	**Chair (2006, 2008)** Member (2006-2010)	University
University Council	Advisory Member (2006)	University
Faculty and Staff Campaign Committee	Member (2006-2007)	University
Graduate Committee	Member (2009-2010)	Departmental
Promotion and Tenure Committee	Member (2006-2010)	Departmental
Search Committee	Member (2009-2010)	Departmental
Peer Review of Teaching Committee	Member (2009-2010)	Departmental
Awards Committee	Member (2010)	Departmental

Appendix A. Representative syllabi for courses taught 2006-2010.

BIOL 1010 Introduction to Biology: Evolution & Diversity of Life

BIOL 2230 General Botany

BIOL 3600/5600 Local Flora

BIOL 3650/5650 Plant Systematics

BIOL 4010/6010 Dendrology

BIOL 4100/6100 Morphology of Land Plants

BIOL 4900 Senior Seminar

BIOL 7900 Graduate Seminar

PERS 2490 History & Use of Medicinal Plants

BIOL 1010 A — **INTRODUCTION TO BIOLOGY: THE EVOLUTION & DIVERSITY OF LIFE**

COURSE SYLLABUS — **FALL SEMESTER 2006**

Instructor: Dr. Carter Office: BC 1105 Office Hours: Mon. & Wed. 11:00-11:50 AM; Tues. & Thurs. 8:00-9:00 AM; other times by appointment Telephone: 333-5759, ext. 5763 Homepage: http://www.valdosta.edu/~rcarter/	WEEKLY LECTURE SCHEDULE Tuesday 11:00 AM–12:15 PM BC 3009 Thursday 11:00 AM–12:15 PM BC 3009

Course Description. Co-requisite: BIOL 1020L. This course cannot be taken for credit toward the major in biology. An introduction to the diversity of life on Earth with a special emphasis on ecological and evolutionary processes and relationships.

Required Textbook. Starr, C. & R. Taggart. 2006. *Biology: The Unity and Diversity of Life*. 11th Edition. Brooks/Cole – Thompson Learning, Belmont, CA.

WebCT Vista. A variety of course resources and materials will be made available through WebCT Vista, and it will also be used to administer assignments and assessments and to post announcements and grades. Students should log onto WebCT Vista daily in order to check for course announcements and to take course assessments. Also, the Mail tool in WebCT Vista provides a convenient means for students to contact one another and their instructor, and it should always be used to communicate about matters relating to the course. To access WebCT Vista, select the link near the upper right corner of the Valdosta State University homepage or go directly to the following address.

http://www.valdosta.edu/vista/

Students experiencing difficulties using WebCT Vista should seek assistance through the VSU Microcomputing & System Services HELP-Desk located in Odum Library (telephone 245-4357).

Required Materials. Several sharpened number two (No. 2) pencils should be brought to each scheduled lecture examination.

COURSE POLICIES

In order to complete BIOL 1010 successfully, one must be mindful of all policies relating to attendance, grading, etc. Before the end of the first week of classes, after reading the course syllabus and comprehending the policies presented therein, log onto WebCT and use WebCT Mail to send a brief message to your instructor informing him that you have read the course syllabus and understand all course policies. *Note this is your first course assessment; refer to the section on* Miscellaneous Assessments *below.*

Regular attendance of scheduled lecture periods, daily preparation, and review are essential for success in this course. Students should prepare for each lecture session by reading the assigned sections from the textbook. Students should bring their textbook to each scheduled lecture period, since illustrations and diagrams from the text will be used regularly during lecture. Notes should be taken regularly during lecture and should be used along with the text and materials made available through WebCT Vista in studying for examinations.

Student identification. Students should have in their possession at all times their VSU student identification card. In order to verify the identification of students officially enrolled in the course, it is the instructor's prerogative to request official student photo identification cards at any time during lecture. During examinations, students will routinely be asked to display their VSU student identification cards visibly on the desk top and to make them available for inspection by their instructor and assistants.

Attendance and punctuality. Regular attendance and punctuality are expected. The student is responsible for all material missed, regardless of the reason for absence. Students arriving late for class should enter the lecture hall quietly and take the nearest seat to avoid disruption of lecture. Attendance will be taken electronically as at the beginning of the period and then again as students exit at the end of the period. Each three cases of tardiness will be counted as one absence, and cases of tardiness will be counted as absences thusly, unless a satisfactory explanation is provided to the instructor by the student. It is the instructor's prerogative to have the explanation in writing. Any scheduling problems or other extenuating circumstances necessitating chronic tardiness should be explained to the instructor in writing and properly documented at the beginning of the semester. In order to have an absence excused, the student must provide a written explanation with proper documentation immediately upon returning to class. Provision of an explanation of absence or tardiness by the student does not insure that the absence or tardiness will be excused. The instructor shall determine the validity of all excuses. Students absent from more than 20% of the regularly scheduled lecture periods are subject to failure in the course. Refer to Absence Regulations on pages 79-80 of the 2006-2007 Undergraduate Catalog. Attendance, participation and attitude account for 5% of the final course grade.

Lecture examinations. Four unit lecture examinations and a comprehensive final examination will be given. Lecture examinations are weighted equally, with each potentially accounting for 20% of the final course grade. Exam dates are posted on the course calendar and are shown on the printed course schedule. Under no circumstances will a makeup examination be given. A student involved in an official off-campus activity necessitating an absence from a scheduled lecture examination should contact the instructor at least one week prior to the absence in order to schedule a time to take the examination before departing from campus. Note that in such cases the student will normally be allowed to take the examination before, but not after, the scheduled examination period. When requesting permission to take an examination early, the student should provide copies of official documentation to the instructor.

Collectively, lecture examinations account for 80% of the course grade. The lowest examination score (including the comprehensive final) will be dropped prior to calculating the course grade. If a student is absent from a lecture examination, a grade of zero will be entered into the grade book, and the zero will automatically become the drop grade when the final course grade is computed. This "drop" policy is designed to provide "insurance" against an unanticipated absence from a scheduled lecture examination, regardless of the reason – be it illness or death in the family. If a student is absent from more than one examination, a grade of zero will enter into the calculation of the final course grade; therefore, it would be unwise to miss a lecture examination frivolously.

Miscellaneous assessments. A number of miscellaneous course assessments will be given during the semester, which, collectively, account for 15% of the final course grade. Some assessments will be graded pass/fail, some with letter grades, and some with numerical grades. Some will be completed in class and some outside of class via WebCT Vista. In class assessments are mostly unannounced and most cannot be made up.

Grading. A 10-point scale is used (i.e., 90--100=A; 80--89=B; 70--79=C; 60--69=D; <60=F) to determine the final course grade. The final course grade will be calculated as follows.

Lecture Examinations (each exam 20%)	80%
Miscellaneous assessments	15%
Attendance, participation, and attitude	5%
Total	100%

Class conduct. Students are expected to comport themselves courteously at all times during lecture. Disruptive behavior will not be tolerated, and students behaving in a disruptive manner will be asked to relinquish their VSU student identification card and will be removed from the classroom and referred to the Dean of Students for disciplinary action. Refer to the Student Code of Conduct, Appendix A in the VSU *Student Handbook*.

http://www.valdosta.edu/stulife/handbook/2006-2007/SAF_Student_Handbook.pdf.

Consumption of food or drink (including water) and wearing of hats or caps is prohibited in the lecture room. Students should be punctual for all scheduled lecture meetings, and, except in situations of emergency, students should not depart from lecture before being dismissed. Students are to direct their full attention to lecture and are to refrain from unwarranted discourse. Behavior contrary to these guidelines is disruptive.

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is prohibited during scheduled lectures or examinations. If students bring cellular telephones or similar devices to lecture, it is their responsibility to switch them off prior to the beginning of the lecture period. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave lecture immediately.

Academic integrity. Students are encouraged to work together and to learn from one another in an appropriate manner. Cooperation between students is especially encouraged in study outside of class. However, students should bear in mind that most work ultimately must be done individually and independently.

All examinations and tests are given to students individually and are to be completed independently. Cooperation by students on tests or examinations is prohibited and constitutes cheating. Unless otherwise indicated, tests and examinations are taken strictly from memory without use of textbooks, notes, etc. Unless otherwise indicated, assignments and assessments are to be completed individually and independently. Behavior contrary to these guidelines is prohibited and constitutes cheating. Plagiarism and cheating will not be tolerated and will be prosecuted to the full extent allowed by University policy and the law.

Students with disabilities. Students requiring classroom accommodations or modifications because of documented disabilities should discuss this need with their professor at the beginning of the semester. Disabled students who are not registered with the Special Services Program should contact the Office of Special Services, Nevins Hall 1115, Telephone 245-2498.

BIOL 1010A **INTRODUCTION TO BIOLOGY: EVOLUTION & DIVERSITY OF LIFE**
COURSE SCHEDULE **FALL SEMESTER 2006**

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TUESDAY, AUGUST 15 – FIRST DAY OF CLASSES
Introduction to Course
Chapter 1 – Invitation to Biology
THURSDAY, AUGUST 17
Chapter 4 (in part) – Cell Structure & Function

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TUESDAY, AUGUST 22
Chapter 9 – How Cells Reproduce
THURSDAY, AUGUST 24
Chapter 10 – Meiosis & Sexual Reproduction

****

TUESDAY, AUGUST 29
Chapter 11 – Observing Patterns in Inherited Traits
THURSDAY, AUGUST 31
Chapter 17 – Evidence of Evolution

****

TUESDAY, SEPTEMBER 5
Chapter 18 – Microevolutionary Processes
THURSDAY, SEPTEMBER 7
Chapter 18, continued

****

TUESDAY, SEPTEMBER 12
Chapter 19 – Evolutionary Patterns, Rates & Trends
THURSDAY, SEPTEMBER 14
UNIT EXAM I – Chapters 1, 4 (in part), 9, 10, 11, 17, 18 & 19

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TUESDAY, SEPTEMBER 19
Chapter 20 – Life's Origin & Early Evolution
THURSDAY, SEPTEMBER 21
Chapter 21 – Prokaryotes & Viruses

****

TUESDAY, SEPTEMBER 26
Chapter 22 – "Protists" – The Simplest Eukaryotes
THURSDAY, SEPTEMBER 28
Chapter 23 – Plant Evolution

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TUESDAY, OCTOBER 03
UNIT EXAM II – Chapters 20, 21, 22 & 23
THURSDAY, OCTOBER 05
Chapter 24 – Fungi
FRIDAY, OCTOBER 06 – MIDTERM DATE

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TUESDAY, OCTOBER 10
Chapter 24, continued
THURSDAY, OCTOBER 12
Chapter 25 – Animal Evolution: The Invertebrates

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TUESDAY, OCTOBER 17
FALL BREAK – NO CLASSES
THURSDAY, OCTOBER 19
Chapter 25, continued

****

TUESDAY, OCTOBER 24
Chapter 26 – Animal Evolution: The Vertebrates
THURSDAY, OCTOBER 26
Chapter 26, continued

****

TUESDAY, OCTOBER 31
Chapter 27 – Biodiversity in Perspective
THURSDAY, NOVEMBER 02
UNIT EXAM III – Chapters 24, 25, 26 & 27

****

TUESDAY, NOVEMBER 7
Chapter 45 – Population Ecology
THURSDAY, NOVEMBER 9
Chapter 46 – Community Structure & Biodiversity

****

TUESDAY, NOVEMBER 14
Chapter 47 – Ecosystems
THURSDAY, NOVEMBER 16
Chapter 48 – The Biosphere

****

TUESDAY, NOVEMBER 21
Chapter 49, Behavioral Ecology
THURSDAY, NOVEMBER 23
THANKSGIVING HOLIDAY – NO CLASSES

****

TUESDAY, NOVEMBER 28
Chapter 49 – Behavioral Ecology, continued
THURSDAY, NOVEMBER 30
UNIT EXAM IV – Chapters 45, 46, 47, 48 & 49

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MONDAY, DECEMBER 04 – LAST DAY OF CLASSES
FRIDAY, DECEMBER 08
FINAL EXAM – 10:15 AM - 12:15 PM

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BIOLOGY DEPARTMENT – COLLEGE OF ARTS & SCIENCES – VALDOSTA STATE UNIVERSITY

BIOL 2230 – GENERAL BOTANY   SPRING SEMESTER 2010

Instructor: Dr. Carter
Office: BC 1105 *Telephone:* 229/333-5759, ext. 5763
e-mail: Please use the mail tool in BlazeVIEW.

Office Hours: BC 1040 or BC 1105
Tues. and Thurs., 11:00 AM – 12:00 Noon
Wed., 8:00 – 9:00 AM
Other times by appointment

Weekly Course Schedule

Tuesday	Lec	9:30 – 10:45 AM, BC 1025
Tuesday	Lab	2:00 – 4:50 PM, BC 2040
Thursday	Lec	9:30 – 10:45 AM, BC 1025

Course description. Survey of plants, emphasizing evolution, homologous variation, and reproductive cycles of the major groups and development, structure, and function as represented by the seed plants.
Prerequisite: BIOL 2010 with a grade of "C" or higher or consent of instructor.
Contact hours: 150 mins lecture & 170 mins lab per week.
Credit hours: 4 sem hrs credit.

Course objectives. The student should gain a basic understanding of life history, ecology, and evolution of the major plant groups and development, structure, function, and reproduction of the typical seed plant.

Course Outcomes linked to Biology Department Educational Outcomes (B) and Valdosta State University General Education Outcomes (V)

1. The student will demonstrate understanding of cell theory and the structure and function of the typical plant cell. [B 3; V 4, 7]
2. The student will demonstrate understanding of the organization of plants from the level of cells through tissues, tissue systems and organs. [B 3; V 4, 7]
3. The student will demonstrate understanding of developmental patterns and processes of plants. [B 4; V 4, 7]
4. The student will demonstrate understanding of the relationships between structure and function in plants. [B 4; V 4, 7]
5. The student will demonstrate understanding of the major effects and physiological mechanisms of growth regulators (hormones) in plants. [B 4; V 4, 7]
6. The student will demonstrate understanding of the mechanisms for procurement of mineral ions by plants and mineral nutrition. [B 4; V 4, 7]
7. The student will demonstrate understanding of the physiological mechanisms involved in the uptake and transport of water and the translocation of food by plants. [B 4; V 4, 7]
8. The student will demonstrate understanding of the basic principles of systematics and the inference of evolutionary patterns from data. [B 2; V 4, 7]
9. The student will demonstrate understanding of evolutionary processes and patterns in the major plant groups. [B 2; V 4, 7]
10. The student will demonstrate understanding of life histories, reproductive cycles, and ecological relationships of the major plant groups. [B 2, 5; V 4, 7]
11. The student will demonstrate understanding of the relationships between plants and humans across cultures. [V 2, 4, 7]
12. The student will demonstrate understanding of the interrelationships among plants, micro-organisms, and animals in the functioning of ecosystems. [B 5; V 4, 7]
13. The student will demonstrate understanding of the fundamental roles of plants in ecosystems, including the production of food energy, replenishment of oxygen, and water and nitrogen cycles. [B 5; V 4, 7]
14. The student will demonstrate understanding of spatial and temporal patterns of variation in plant community structure and the determinants of such patterns, including concepts of biome, community and succession. [B 5; V 4, 7]
15. The student will formulate hypotheses, collect and analyze data, and present results in the standard format of a scientific paper. [B 1; V 4, 5, 7]
16. The student will demonstrate the ability to handle and analyze plant materials in the laboratory. [B 1; V 5, 7]
17. The student will demonstrate the ability to work and use basic equipment effectively in the laboratory. [B 1; V 4, 5, 7]
18. The student will demonstrate the ability to work safely in the laboratory. [V 4, 5, 7]
19. The student will demonstrate comprehension of basic concepts and the ability to use scientific terminology accurately through effective oral and written communication. [B 1; V 4, 5, 7]
20. The student will demonstrate the ability to follow oral and written instructions effectively. [V 4, 7]
21. The student will demonstrate the ability to access course resources and complete assignments on-line using computer technology (i.e., BlazeVIEW). [V 3]
22. The student will demonstrate the ability to complete assignments and examinations ethically. [V 8]

Course materials
Required text: *Biology of Plants* by Raven, P.H., R.F. Evert & S.E. Eichhorn, 2005, 7th Ed., W. H. Freeman & Co.[1]

Required lab manual: *General Botany Laboratory Exercises* by R. Carter, 2005, provided free-of-charge through BlazeVIEW[1]

Required materials & supplies: large (3 inch spine) 3-ring binder for lecture and lab notes, 3H or 4H drawing pencil with eraser, and biology filler drawing paper.

1. Students are responsible for bringing their textbook and their lab manual to each scheduled lecture and laboratory period.

Course Requirements and Policies

Prerequisite. BIOL 2010 with a grade of "C' or higher or consent of instructor. *Inform your instructor immediately, if you have not met this prerequisite or are unsure about it.*

Use of BlazeVIEW as a course supplement. BlazeVIEW will be used to make a variety of course resources and materials available, to administer certain assignments and assessments, and to post announcements and grades. Students should log onto BlazeVIEW daily in order to check for course announcements and to take course assessments. Also, the Mail tool in BlazeVIEW provides a convenient means for students to contact one another and their instructor and is the preferred means of communicating about matters relating to the course. To access BlazeVIEW, select the BlazeVIEW link under Quick Links on the left side of the Valdosta State University homepage. Students experiencing technical difficulties using BlazeVIEW should seek assistance through the VSU Microcomputing & System Services HELP-Desk located in Odum Library (telephone 245-4357).

Academic integrity. Students are encouraged to work together and to learn from one another in an appropriate manner. Cooperation among students is especially encouraged in certain laboratory exercises and in study outside of laboratory and lecture. However, students should bear in mind that most work ultimately must be done individually and independently. All examinations and tests are given to students individually and are to be completed independently. Cooperation by students on tests or examinations is prohibited and constitutes cheating. Unless otherwise indicated, tests and examinations are taken strictly from memory without use of textbooks, laboratory manuals, notes, etc. Unless otherwise indicated, assignments are to be completed individually and independently. Behavior contrary to these guidelines is prohibited and constitutes cheating. Plagiarism and cheating will not be tolerated and will be prosecuted to the full extent allowed by University policy and the law.

Recognition of and respect for the ownership of property is one of the distinguishing features of civilization. Ideas come from individuals and are effectively owned by their originators; thus, ideas are intellectual property. In the academic sphere, we frequently deal with the ideas of others, most often in published form. As with tangible property, intellectual property is subject to ownership and protection. Moreover, publication establishes ownership of intellectual property. It is essential that we respect the ideas and writing of others and that we scrupulously cite all sources of any and all ideas that are not our own.

Random House Webster's College Dictionary (2000) defines **plagiarism** as "the unauthorized use of the language and thoughts of another author and the representation of them as one's own." There are many forms of plagiarism. Perhaps the most blatant form is copying from some other source without citing that source. Other types of plagiarism include using a paper written by another and the improper citation of references. When paraphrasing, the author of the paraphrased material must be properly cited, and, when words are taken directly from another source, their author must be properly cited and the quotation must be placed within quotation marks for short quotations or in a separate paragraph with special indentation for longer quoted passages. Plagiarism is theft of intellectual property, and the simplest way to avoid plagiarism is to give credit where credit is due! The following statement from the Writing Tutorial Services website at Indiana University is useful.

To avoid plagiarism, you must give credit whenever you use

- another person's idea, opinion, or theory;

- any facts, statistics, graphs, drawings – any pieces of information – that are not common knowledge;
- quotations of another person's actual spoken or written words; or
- paraphrase of another person's spoken or written words.

http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml; Copyright 2004; last updated 27 April 2004; last accessed 05 August 2007.

It is imperative that laboratory reports and papers be the student's own original work. Plagiarism will not be tolerated, and any student caught plagiarizing shall receive a failing grade on the report or assignment. Please be forewarned that various web search engines will be used to check for plagiarism.

Attendance, participation, and attitude. Regular attendance of all scheduled lectures and labs and punctuality are expected. The student is responsible for all material missed regardless of the reason for absence. Normally, attendance will be taken during each scheduled lecture and laboratory period.

Each three instances of unexcused tardiness will be counted as one absence. Tardiness will not be excused without a written explanation from the student and a determination by the instructor that the reason for tardiness is valid. Requests for excused tardiness must be submitted to the instructor in writing within 24 hours of the beginning of the period during which the student was late. It is the student's responsibility to initiate such requests. Any scheduling problems or other extenuating circumstances necessitating chronic tardiness should be explained to the instructor in writing and properly documented at the beginning of the semester.

In order to have an absence excused, the student must provide a written explanation with proper documentation immediately upon returning to class or laboratory. Based upon the written explanation and associated documentation, the instructor will determine whether the reason for absence is valid and will excuse absences accordingly.

Students are reminded that it might not be possible to make up certain laboratory exercises, and, whenever possible, the student should clear an absence and request permission for a make-up with the instructor prior to the actual absence. In accordance with Valdosta State University Absence Regulations on page 90 of the *2009-2010 Undergraduate Catalog*, students absent from more than 20% of the regularly scheduled lecture and laboratory periods are subject to failure in the course:

http://www.valdosta.edu/catalog/0910/ugrad/

Moveover, the final course grade may be lowered because of poor attendance, participa-tion, or attitude.

Conduct in lecture and laboratory. Students are expected to comport themselves courteously at all times during lecture and laboratory. Disruptive behavior will not be tolerated, and students behaving in a disruptive manner will be removed from the classroom and referred to the Dean of Students for disciplinary action. Refer to the Student Code of Conduct in the VSU *Student Handbook Volume III:*

http://www.valdosta.edu/studentaffairs/StudentHandbook.shtml.

Students should be punctual for scheduled lecture and laboratory meetings. Except in special situations (i.e., emergency), students should not depart from lecture before being dismissed. If a student departs from lecture early, re-entry into the lecture room during the same period will not be permitted. Students anticipating early departure from lecture should inform their instructor of this prior to the beginning lecture and seat themselves near an exit. Students are to direct their full attention to lecture and laboratory and are to refrain from unwarranted discourse. Behavior contrary to these guidelines is disruptive and may result in lowering of the final grade.

Valid identification. It is the student's responsibility to have her/his VSU identification card in his/her possession at all times during class and laboratory periods, especially during scheduled examinations. Normally, each student will be asked to present her/his valid VSU photo-identification card in order to take an examination.

Consumption of food and drink. The distraction factor aside, food and drink in laboratory pose certain health and safety risks to students and in lecture present problems for maintenance of the building. Therefore, the consumption of food or drink (including water) is absolutely prohibited during lecture and laboratory. Bear in mind that food items or drink containers on desks, tables, benches, etc. in lecture rooms and laboratories create the appearance that these items are being consumed and will be treated accordingly by your instructor.

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is not permitted during scheduled lectures, labs, or examinations. If students bring cellular telephones or similar devices to lecture, it is their responsibility to switch them off prior to the beginning of the lecture or laboratory period. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave lecture or lab immediately.

General suggestions. Regular attendance of scheduled lecture and laboratory periods and daily preparation and review are essential for success. Students should prepare for each lecture and laboratory session by reading the assigned sections from the textbook and laboratory manual and any additional supplementary material made available by the instructor. Students should bring their textbook to each scheduled lecture and laboratory period, since illustrations and diagrams from the text will be used regularly during lecture and lab. Notes should be taken regularly during lecture and lab and should be used along with the text and lab manual in studying for examinations.

General comments on laboratory. Success in the laboratory is largely dependent upon student interest, curiosity, and assumption of responsibility for independent learning. Material presented during lecture should be studied along with laboratory material in order to integrate the two learning experiences. Laboratory work emphasizes careful observations and the opportunity to repeat and confirm the work of others. It also provides for some experimentation and gathering of data. To gain the most from laboratory experiences, students should be regular and punctual in attendance, especially to receive directions and instructions given by the instructor at the beginning of each laboratory period. Students also benefit by using the textbook frequently during each laboratory session, by keeping descriptive notes on observations, by recording data accurately and systematically, and by making diagrams and drawings.

The General Botany course is designed so that lecture and laboratory complement one another. Although some asynchrony is inevitable, in most cases, major topics are covered in lecture prior to lab. It is the student's responsibility to refer to the laboratory schedule and to read the appropriate laboratory exercise(s) before each lab period. The assigned laboratory exercise(s) for each scheduled lab is(are) indicated in the Course Outline (below) and the Laboratory Schedule. In addition to the appropriate printed laboratory exercise(s) from the lab manual, students should bring textbook, notebook, and writing and drawing tools to each scheduled laboratory session.

Lecture examinations. Three equally weighted lecture exams will be given, which account for 60% of the course grade. Regular attendance of lecture and laboratory sessions, good note taking, daily study, and timely completion of assessments are essential in preparing for lecture examinations. Lecture exam dates are provided in the course outline.

Laboratory examinations. A midterm laboratory exam will be given prior to the midterm date, and a *comprehensive* final laboratory exam will be given at the end of the semester. The midterm and final laboratory examinations account for 10% and 15% of the course grade, respectively. Laboratory exam dates are provided in the course outline.

Miscellaneous assessments. A variety of miscellaneous course assessments will be given during the semester. Collectively, the miscellaneous assessments account for 10% of the course grade. Miscellaneous assessments include pop quizzes, on-line assessments through BlazeVIEW, study guides, labeled lab diagrams and drawings. Some assessments will be graded Satisfactory / Unsatisfactory, some with letter grades, and some with numerical grades. Some will be completed in class during lecture or laboratory periods and some outside of class. In-class assessments are mostly unannounced and most cannot be made up. Including on-line assessments, 20-30 miscellaneous assessments are normally given during the semester.

Grading. If a student thinks an error has been made in grading an examination, quiz, or any other assignment, s/he should communicate about this directly with the instructor *within one week* of the instructor's posting of the exam or grade in question or returning of the graded quiz or assignment. In determining the final course grade, a 10-point scale is normally used (i.e., 90–100=A; 80–89=B; 70–79=C; 60–69=D; <60=F) and the final course average calculated as follows.

Lecture exams	*60%*
Midterm lab exam	*10%*
Final lab exam	*15%*
Lab reports	*5%*
Miscellaneous assessments	*10%*
Total	*100%*

Meeting the minimum point requirement for a letter grade does not necessarily assure that the student will receive that grade. Assignment of the final grade is the prerogative of the instructor and will be based upon each individual student's overall performance, including patterns of consistency, trends toward improvement, and attitude as shown through attendance, participation, and cooperation.

Laboratory reports. Normally, two to three laboratory reports are assigned. Collectively, the laboratory reports account for 5% of the course grade. For certain laboratory exercises, students will be instructed to gather and analyze data and write laboratory reports as laboratory groups. Each student should participate in all phases of these laboratory exercises, and any departure from this requirement constitutes cheating. Obviously, if a student is absent during a laboratory period when data is gathered, then the student cannot have participated in all phases of the laboratory exercise. Students absent from a laboratory session should not participate in subsequent phases of report preparation (i.e., data analysis and report writing) without having made up the actual laboratory exercise. Under no circumstances should students be included as authors of laboratory reports in which they did not participate fully in all phases of preparation. Cases of students pressuring peers to credit them with work they did not actually do should be reported to the instructor.

Instructions for writing the laboratory report are provided in Appendix B of the lab manual. *Laboratory reports not written according to instructions will be returned without benefit of the instructor's review*. A standard cover sheet (Appendix C, lab manual) shall be affixed to each laboratory report. The cover sheet shall be signed by each group member who has fully participated in all phases of preparation of the laboratory report, and a signature on the cover sheet is an indication of full participation by each signatory. Laboratory reports are normally due one week after completion of the laboratory exercise.

Normally, laboratory reports will be collected, reviewed, redacted, marked, and tentatively graded by the instructor, then returned to the student(s) for revision, and then graded again after revision. Each laboratory report grade will be determined by averaging the initial, tentative grade and the final, post-revision grade. *Students must return the initial version of the laboratory report along with the cover sheet when revisions are submitted.*

Students are reminded that group preparation of laboratory reports is more likely the exception than the rule, and that such co-operation will likely be forbidden in other courses and thus would constitute cheating in these courses. In other words, just because it is allowed in one course does not mean it will be in another.

Access to laboratory. Students will be granted access to the General Botany Laboratory (BC 2040) after hours until 11:00 PM on weekdays and until 9:00 PM during weekends. Frequently, the outer door near the northeast corner of the Bailey Science Center is unlocked after hours; check this door first. If this and other outside doors to Bailey Science Center are locked, then students should contact the University Police Department or a university police officer and present a valid student identification card upon request in order to gain entry into the building. A numerical code will be provided by your instructor, which will enable access to the General Botany Laboratory. Access to the laboratory after hours is a privilege; it is not a right. If problems occur with regard to safety, security, neatness, or general order in the lab, then this privilege will be revoked. It is up to each student to see that materials, slides, microscopes, etc. are properly cared for and replaced for proper storage.

Students with disabilities. Students requiring classroom accommodations or modifications because of documented disabilities should discuss this need with their professor at the beginning of the semester. Disabled students who are not registered with the Access Office for Students with Disabilities should contact the Access Office, Farber Hall, telephone 229/245-2498 (V/VP) and 229/219-1348 (TTY).

TENTATIVE COURSE OUTLINE WITH ASSIGNED READINGS FROM TEXT AND LABORATORY MANUAL

Week of 11 Jan.
1.0.Introduction to Course; Syllabus
1.1.Introduction to Botany; Chap. 1, pp. 1-13
1.2.Plant Cell; Chap. 3, pp. 35-70

*Lab assignment: Introduction to Herbarium and Plant Propagation (handouts provided by instructor)

Week of 18 Jan.
1.3.Osmosis & Water Relations; Chap. 4, pp. 71-87
1.4.Early Development; Chap. 22, pp. 497-509

*Lab assignment: Laboratory Technique & the Microscope and Introduction to Vegetative Plant Body

Week of 25 Jan.
1.5.Cells & Tissues; Chap. 23, pp. 510-527

*Lab assignment: The Plant Cell & Water Relations and Early Development of Seed Plant

Week of 01 Feb.
1.6.Root Structure & Development; Chap. 24, pp. 528-546

*Lab assignment: Cells & Tissues

Week of 08 Feb.
2.1.Shoot Primary Structure & Development; Chap. 25, pp. 547-579
Unit 1 Lecture Exam *– Thurs., 11 Feb.*

*Lab assignment: The Root

Week of 15 Feb.
2.2.Secondary Growth Stems; Chap. 26, pp. 580-601

*Lab assignment: The Herbaceous Stem

Week of 22 Feb.
2.3.Plant Nutrition; Chap. 29, pp. 645-666

*Lab assignment: ***Midterm Laboratory Exam*** – Tues., 23 Feb.

Week of 01 Mar.
2.4.Movement of Water & Solutes; Chap. 30, pp. 667-686
Midterm date: Thurs., 04 Mar.

*Lab assignment: The Woody Stem

Week of 08 Mar.
2.5.Plant Hormones; Chap. 27, pp. 603-621
2.6.Plant Growth; Chap. 28, pp. 622-644

*Lab assignment: The Leaf

Week of 15 Mar.
Spring Break

Week of 22 Mar.
3.1.Plant Systematics; Chap. 12, pp. 219-237
3.2.Bryophytes; Chap. 16, pp. 345-367
Unit 2 Lecture Exam *– Thurs., 25 Mar.*

*Lab assignment: Field Trip to Lake Louise

Week of 29 Mar.
3.3.Seedless Vascular Plants; Chap. 17, pp. 368-407

*Lab assignment: The Bryophytes

Week of 05 Apr.
3.4.Gymnosperms; Chap. 18, pp. 408-433

*Lab assignment: The Seedless Vascular Plants

Week of 12 Apr.
3.5.Angiosperms I; Chap. 19, pp. 434-451

*Lab assignment: The Gymnosperms

Week of 19 Apr.
3.6.Angiosperms II; Chap. 20, pp. 452-474
3.7.Plants & People; Chap. 21, pp. 475-495

*Lab assignment: The Angiosperms I

Week of 26 Apr.
3.8.Dynamics of Communities & Ecosystems; Chap. 31, On the Web: www.whfreeman.com/raven
3.9.Global Ecology; Chap. 32, On the Web: www.whfreeman.com/raven
Unit 3 Lecture Exam – Thurs., 29 Apr.

*Lab assignment: The Angiosperms II

Week of 03 May
Final Laboratory Exam – Final Exam Period, Fri., 07 May, 9:30 – 11:30 AM

BIOL 2230 – GENERAL BOTANY
LABORATORY SCHEDULE
SPRING SEMESTER 2010

Tuesday 2:00-4:50 PM, BC 2040

Week of 11 Jan.	Introduction to Herbarium / Plant Propagation
Week of 18 Jan.	Laboratory Technique & the Microscope / Introduction to Vegetative Plant Body
Week of 25 Jan.	The Plant Cell & Water Relations / Early Development of Seed Plant
Week of 01 Feb.	Cells & Tissues
Week of 08 Feb.	The Root
Week of 15 Feb.	The Herbaceous Stem
Week of 22 Feb.	*Midterm Laboratory Exam*
Week of 01 Mar.	The Woody Stem
Week of 08 Mar.	The Leaf
Week of 15 Mar.	*Spring Break (no lab)*
Week of 22 Mar.	Field Trip to Lake Louise
Week of 29 Mar.	The Bryophytes
Week of 05 Apr.	The Seedless Vascular Plants
Week of 12 Apr.	The Gymnosperms
Week of 19 Apr.	The Angiosperms I
Week of 26 Apr.	The Angiosperms II

Note: It is the student's responsibility to print out and read the scheduled laboratory exercise(s) before each laboratory period and to bring a copy of the laboratory exercise(s) to each scheduled laboratory period.

Instructor: Dr. Carter Office: BC 1105 Office Hours: M, W, F 9:00–10:00 AM; Tu 9:30–10:30 AM; other times by appointment Telephone: 333-5759, ext. 5763 Web page: http://www.valdosta.edu/~rcarter/	WEEKLY LECTURE AND LAB SCHEDULE Monday Lec 10:00-10:50 AM, BC 1024 Lab 2:00-4:50 PM, BC 2042 Wednesday Lec 10:00-10:50 AM, BC 1024 Friday Lec 10:00-10:50 AM, BC 1024

Course Description

A field-oriented study emphasizing identification, distribution, and ecology of locally occurring seed-bearing plants. Identification using floristic manuals and sight identification of the common native woody flora will be stressed during laboratory. Pre-requisite: BIOL 2230 or permission of instructor.

Course Objectives

- The student is expected to develop a working knowledge of basic descriptive terminology relating to the identification of locally occurring vascular plants.
- The student is expected to develop sufficient proficiency with dichotomous keys in a regional floristic manual to identify unknown specimens reliably.
- The student is expected to be able to identify in the field local native and naturalized trees by family name, scientific name (binomial), and common name.
- The student is expected to know how to collect, document, and prepare herbarium specimens, including proper ethics, especially as regards rare, threatened or endangered species.
- The student is expected to be able to identify and describe the major plant communities in the Georgia coastal plain.

Required Texts

- *Plant Identification Terminology* by J.G. Harris & M.W. Harris, Spring Lake Publishing, 2001
- *Manual of the Vascular Flora of the Carolinas* by A.E. Radford, H.E Ahles & C.R. Bell, University of North Carolina Press, 1968
- *Common Trees of Central South Georgia* by W.R. Faircloth, VSC Printing Service, 1977

Supplementary References

- **The Natural Environments of Georgia* by Wharton, Georgia Department of Natural Resources, 1978
- **Protected Plants of Georgia* by Patrick, Allison & Krakow, Georgia Department of Natural Resources, 1995
- **An Introduction to Plant Taxonomy* by Lawrence, 1955
- Other references and reading assignments will be placed on reserve in Odum Library or provided electronically through WebCT.

Miscellaneous Required Items

- Pencils or pens for recording notes, etc.
- Spiral bound notebook convenient for field trips
- Separate field notebook for recording plant collection data
- 200 3X5 inch note cards for field identification quizzes
- *Hand lens with lanyard will be provided in your individual lab kit for your use in the course. It is the student's responsibility to keep up with the hand lens and to bring it on all field trips.

Additionally, the following are recommended.

- Old clothes, including long pants, and sturdy shoes or boots for field trips
- Rain gear and warm clothing, as appropriate
- Insect repellant for field trips
- *Immediately upon returning from field trips, students are urged to check their bodies thoroughly for ectoparasites (i.e. ticks) and, if possible, to shower.*
- Bottled water for field trips
- Food for all-day field trips

COURSE POLICIES & REQUIREMENTS

WebCT Vista. A variety of course resources and materials will be made available through WebCT, and it will also be used to administer assignments and assessments and to post announcements and grades. Students should log onto WebCT daily in order to check for course announcements and to complete scheduled course assignments. Also, the Mail tool in WebCT provides a convenient means for students to contact one another and their instructor, and it should always be used to communicate about matters relating to the course. To access WebCT, select the link near the upper right corner of the Valdosta State University homepage or go directly to the following address.

http://www.valdosta.edu/vista/

Students experiencing difficulties using WebCT should seek assistance through the VSU Microcomputing & System Services HELP-Desk located in Odum Library (telephone 245-4357).

General statement. In order to complete BIOL 3600 successfully, one must be mindful of all policies relating to attendance, grading, etc. Before the end of the first week of classes, after reading the course syllabus and comprehending the policies presented therein, log onto WebCT and use WebCT Mail to send a brief message to your instructor informing him that you have read the course syllabus and understand all course policies.

Regular attendance of scheduled lecture and laboratory periods, daily preparation, and review are essential for success in this course. Students should prepare for each lecture session by reading the assigned sections from the textbook and other sources as assigned under Course Content in WebCT Vista. Students should bring their textbooks (three) to each scheduled lecture and laboratory period, since they will be used regularly during lecture and lab. Notes should be taken regularly during lecture and laboratory and should be used along with the text and materials made available through WebCT in studying for examinations.

Attendance and punctuality. Attendance, participation and attitude account for 10% of the final course grade. Regular attendance and punctuality are expected. The student is responsible for all material missed, regardless of the reason for absence. Students arriving late for class should enter the lecture room or laboratory quietly and take the nearest seat to avoid disruption. Bear in mind that field trips normally require prompt departure from campus and that tardiness could easily result in a student missing transportation to the field site and absence from lab and that such absences will adversely affect the course grade. Attendance will normally be taken at the beginning of the period. Students who arrive after the roll is called are counted absent unless they inform their instructor immediately after class of their tardiness. It is the student's responsibility to inform the instructor of her/his tardiness. Each three cases of tardiness will be counted as one absence, and cases of tardiness will be counted as absences thusly, unless a satisfactory explanation is provided to the instructor by the student. It is the instructor's prerogative to have the explanation in writing. Any scheduling problems or other extenuating circumstances necessitating chronic tardiness should be explained to the instructor in writing and properly documented at the beginning of the semester. In order to have an absence excused, the student must provide a written explanation with proper documentation immediately upon returning to class. Provision of an explanation of absence or tardiness by the student does not insure that the absence or tardiness will be excused. The instructor shall determine the validity of all excuses. Students absent from more than 20% of the regularly scheduled lecture and laboratory periods are subject to failure in the course. See Absence Regulations on pages 83-84 of the *2007-2008 VSU Undergraduate Catalog*, accessible through the following Internet address.

http://valdosta.edu/catalog/0708/ugrad/index.shtml

Field trips. On-site, spontaneous identification of native and naturalized trees and keying of unknown specimens will be emphasized on field trips. Both of these components account for a substantial portion of the course grade; therefore, attendance of all scheduled field trips is absolutely critical for success in the course. In addition to insect repellant and water and other items recommended above, students should bring all three of their text books, hand lens, 3X5 note cards, and notebook on all field trips. Most field trips will be taken during the scheduled lab period. However, two all day Saturday field trips are scheduled. For these trips, students should bring water, soft drinks, and food as needed. A complete field trip schedule is provided below with the course schedule.

Lecture examinations. Several lecture exams and quizzes will be given during the semester, at least one of these prior to midterm. Collectively, these exams and quizzes account for 30% of the course grade.

Field identification quizzes. The student will be required to recognize on sight in the field and to identify by *family name, scientific name (binomial)* and *common name* major native and naturalized locally occurring trees and shrubs and the major plant communities. Field quizzes will be given spontaneously during class field trips, especially during the later half of the semester. Collectively, the field identification quizzes account for 10% of the course grade.

Keying quizzes. Several keying quizzes will be given to measure proficiency using dichotomous keys in *Manual of the Vascular Flora of the Carolinas*. Substantial lab time will be devoted to supervised determination of unknown specimens, with dichotomous keys. It is imperative that students attend lab and field trips regularly and practice identification of specimens in order to develop proficiency with these keys. Collectively, the keying quizzes account for 20% of the course grade.

Plant collection. Each student will be required to make a collection representing at least 25 plant families. Students must keep specimen data in a field notebook, to be submitted with the collection. Specimens must be properly identified, documented, and labeled. Plant presses will be checked out to students for preparing specimens, and specimens may be collected under supervision on course field trips. The plant collection accounts for 20% of the course grade.

Each student is required to make a plant collection representing 25 different seed plant families. This assignment is due at the end of the semester. Collections will be evaluated according to the following criteria: (1) completeness, (2) accuracy of determinations, (3) quality of specimens; (4) quality of data and labels; and (5) significance of collections (i.e., whether they represent new county records for our herbarium). Plant presses will checked out to students for use in preparing plant collections, and specimens may be dried using the herbarium dryer. See your instructor when you need to use the plant dryer, and affix a note to the outside of the press with your name and the time and date specimens were placed on the dryer. Normally, specimens are dried within 12-24 hours; however, specimens with thick, fleshy parts may require longer drying periods. Specimens should be prepared as follows.

- Specimens should be neat and made to fit standard size herbarium paper (11½ X 16½ inches). Use the plant press as a guide; it is especially constructed for making specimens this size.
- Specimens should be pressed flat in folded half-sheets of newsprint.
- Normally, specimens should possess flowers or fruits to allow for reliable identification.
- Ropes or straps should be tight when presses are placed on the dryer.
- Keep accurate field notes, and in a systematic manner record the following data for each specimen: (a) assign each separate collection a serial collection number beginning with "1"; (b) date of the collection; (c) locality data (i.e., country, state, county, road name or number, direction and distance from nearest town or other landmark); (d) habitat description (e.g., sandy soil,

wet roadside ditch, swamp margin, river bank, floating in swamp, etc.); (e) descriptive data about the plant, especially features such as flower color, plant height, presence of colored sap, or fragrance, which are not readily observed in dried specimens; and (f) relative abundance, i.e., rare, infrequent, common, locally common, locally abundant, etc. Data of the sort described in "d" and "e" are often important in identifying specimens.

- Each specimen should be accurately identified, and family, binomial and binomial authority should be provided for each.
- Each specimen should have with it a logically and neatly constructed label, prepared as follows. Labels are to be printed on acid-free, archival quality paper (to be provided by your instructor). A label template in Microsoft Word® format is available though the course page in WebCT. In addition to a hard-copy label with each specimen, a diskette with word-processed label data in Word® format should be submitted with your collection and field notes at the end of the semester.
- Additional detailed instructions will be provided during the course of the semester.

Miscellaneous assignments. A number of miscellaneous course assignments will be given during the semester, which, collectively, account for 10% of the final course grade. Some will be graded pass/fail, some with letter grades, and some with numerical grades. Some will be completed in class, but most will be posted under Course Content in WebCT to be completed outside of class. In class/lab assessments are mostly unannounced and most cannot be made up.

Grading. A ten-point grading scale is used (i.e., A=90-100, B=80-89, C=70-79, D=60-69, F=<60). Grades will be determined as follows:

Attendance, participation & attitude	10%
Lecture exams	30%
Field identification quizzes	20%
Keying quizzes	10%
Plant collection	20%
Misc. assignments	10%
TOTAL	100%

Class conduct. Students are expected to comport themselves courteously at all times during lecture and laboratory. Disruptive behavior will not be tolerated, and students behaving in a disruptive manner will be asked to relinquish their VSU student identification card and will be removed from class and referred to the Dean of Students for disciplinary action. Refer to pp. 57-62 of Appendix A: Student Code of Conduct in the VSU *Student Handbook*, accessible through the following Internet address.

http://www.valdosta.edu/studentaffairs/StudentHandbook.shtml

Consumption of food or drink (including water) and wearing of hats or caps is prohibited in the lecture room. Students should be punctual for all scheduled lecture and laboratory meetings, and, except in situations of emergency, students should not depart from lecture before being dismissed. Students are to direct their full attention to lecture and are to refrain from unwarranted discourse. Behavior contrary to these guidelines is disruptive.

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is prohibited during scheduled lectures or examinations. If students bring cellular telephones or similar devices to lecture, it is their responsibility to switch them off prior to the beginning of the lecture period. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave lecture immediately.

Academic integrity. Students are encouraged to work together and to learn from one another in an appropriate manner. Cooperation between students is especially encouraged in study outside of class. However, students should bear in mind that most work ultimately must be done individually and independently.

All examinations and tests are given to students individually and are to be completed independently. Cooperation by students on tests or examinations is prohibited and constitutes cheating. Unless otherwise indicated, tests and examinations are taken strictly from memory without use of textbooks, notes, etc. Unless otherwise indicated, assignments and assessments are to be completed individually and independently. Behavior contrary to these guidelines is prohibited and constitutes cheating. Plagiarism and cheating will not be tolerated and will be prosecuted to the full extent allowed by University policy and the law.

Students with disabilities. Students requiring classroom accommodations or modifications because of documented disabilities should discuss this need with their professor at the beginning of the semester. Disabled students who are not registered with the Access Office for Students with Disabilities should contact the Access Office, Nevins Hall 1115, Telephone 245-2498.

Additional requirements for graduate credit. In addition to the preceding requirements, students taking the course for graduate credit (BIOL 5600 only) will be required to write a term paper. Students registered for BIOL 5600 credit should confer with the instructor about potential topics for the research paper early in the term. An outline is due by mid-term.

BIOL 3600/5600 **LOCAL FLORA**

COURSE SCHEDULE WITH LIST OF MAJOR TOPICS **SPRING SEMESTER 2008**

Note: Items shown in **bold** are assignments posted on WebCT. The complete lecture outline with reading and other assignments, eHandouts, and links to useful web sites can be found under Course Content in WebCT. Various special dates, including holidays and all-day Saturday field trips, are shown in *italics*.

****

Week 1: 07 January
- Introduction to Course
- What is flora?
- Identification, classification, & nomenclature
- Identifying native & naturalized trees
- Lab: Adv. Botany Lab (BC 2042) & campus field trip

****

Week 2: 14 January
- Structure & terminology: flowers & inflorescences
- Preparation for field work
- **Biohazards in the field**
- Lab: Field trip, VSU Campus

****

Week 3: 21 January
- *Monday, 21 January, M.L. King Holiday*
- Structure & terminology: underground parts, stems, leaves, surface features
- Lab: none because of holiday

****

Week 4: 28 January
- Structure & terminology: habit, fruits & seeds
- Using dichotomous keys in a floristic manual
- Lab: Field trip, VSU Campus

****

Week 5: 04 February
- The herbarium
- Collection & care of voucher specimens
- **Uses of the herbarium & floristic data**
- Lab: indoors, Adv. Botany Lab (BC 2042)

****

Week 6: 11 February
- Recording data
- Keeping a field notebook
- **Where in the world were we?**
- Lab: Field trip, Lake Louise, Lowndes Co., GA

****

Week 7: 18 February
- Rare, threatened, & endangered flora
- **Survey of protected species**
- Lab: Field trip, Plowden Estate, Lowndes Co., GA

****

Week 8: 25 February
- Non-indigenous flora
- **Alien invaders**
- Lab: Field trip, Langdale Park, Lowndes Co., GA

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Week 9: 03 March
- Poisonous plants
- **Poisonous plants**
- Lab: Field trip, Lake Louise, Lowndes Co., GA

****

Spring Break Week
Monday, 10 March – Friday, 14 March

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Week 10: 17 March
- Phytogeography
- **How do we classify the vegetation at Lake Louise?**
- Lab: Field trip, vic. Mayday, Echols County, GA

****

Week 11: 24 March
- Vegetation Classification
- **Physiography & flora**
- Lab: Field trip, Grand Bay WMA, Lowndes Co., GA

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Week 12: 31 March
- Plant family survey
- Lab: no lab on Monday, 31 March
- *Field trip: Saturday, 05 April, 7:00 AM – 9:00 PM, Kings Bay Submarine Base & Crooked River State Park, vic. St. Marys, GA*

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Week 13: 07 April
- Plant family survey
- Lab: Field trip, Kinderlou, Lowndes Co., GA

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Week 14: 14 April
- Plant family survey
- Lab: no lab Monday, 14 April
- *Field trip: Saturday, 19 April, 8:00 AM – 5:00 PM, River Creek WMA, vic. Thomasville, GA*

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Week 15: 21 April
- Plant family survey
- Lab: Field trip, Plowden Estate, Lowndes Co., GA

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Monday, 28 April – Last Day of Classes
- Lab: Field trip, Broxton Rocks, Coffee County, GA, 10:00 AM – 7:00 PM

FINAL EXAM: Friday, 02 May, 8:00 – 10:00 AM

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Biology Department – College of Arts & Sciences – Valdosta State University

PLANT SYSTEMATICS – BIOL 3650/5650 SPRING SEMESTER 2009

Instructor: Dr. Carter
Office: BC 1105 or BC 1040
Telephone: 333-5759, ext. 5763
Office Hours: Mon. 8:00-9:00 AM, Tues. 4:00-5:00 PM, Wed. 8:00-9:00 AM, Thurs. 3:00-4:00 PM; other times by appointment.

Weekly Lecture and Lab Schedule:
Mon.: Lec 12:30-1:45 PM, BC 1024
Lab TBA
Wed.: Lec 12:30-1:45 PM, BC 1024

Course Description

A survey of the principles of plant systematics that includes identification, nomenclature, evolution, and classification within the plant kingdom, and a systematic survey of plant families, with emphasis on local representatives. [3-3-**4**]
Prerequisites: BIOL 2230 and BIOL 2270, or permission of instructor.
Contact hours: 150 mins lecture & 170 mins lab per week.
Credit hours: 4 sem hrs credit.

Course Outcomes

Following is a list of course outcomes linked to Biology Department Educational Outcomes (B) and Valdosta State University General Education Outcomes (V)

- The student will demonstrate understanding of the basic principles of systematics, including identification, nomenclature, classification, and the inference of evolutionary patterns from data. [B 2; V 4, 7]
- The student will demonstrate understanding of evolutionary processes and patterns in the major plant groups. [B 2; V 4, 7]
- The student will demonstrate the ability to handle and analyze plant materials in the laboratory and herbarium and in the field. [B 1; V 5, 7]
- The student will demonstrate the ability to work and use basic equipment effectively in the laboratory and herbarium and in the field. [B 1; V 4, 5, 7]
- The student will demonstrate comprehension of basic concepts and the ability to use scientific terminology accurately through effective oral and written communication and the use of dichotomous keys in a regional floristic manual. [B 1; V 4, 5, 7]
- The student will demonstrate the ability to follow oral and written instructions effectively. [V 4, 7]
- The student will demonstrate the ability to access course resources and complete assignments on-line using computer technology (i.e., WebCT Vista). [V 3]
- The student will demonstrate the ability to complete assignments and examinations ethically. [V 8]

Required Texts

Plant Systematics by Simpson, Elsevier-Academic Press, 2006. (abbrev. PS in syllabus).
Manual of the Vascular Flora of the Carolinas by Radford, Ahles & Bell, Univ. North Carolina Press, 1968. (abbrev. MVC in syllabus).

Other Required Items

- spiral bound notebook for taking notes on fieldtrips
- separate field notebook for recording plant collection data
- 3x5 note cards for field quizzes
- A hand-lens with lanyard will be provided in your individual lab kit for your use in the course. It is the student's responsibility to keep up with the hand lens and bring it on all fieldtrips.

Recommended Items

- old clothes, including long pants, and sturdy shoes or boots for fieldtrips
- insect repellant (with DEET) for fieldtrips
- Immediately upon returning from fieldtrips, students are urged to check their bodies thoroughly for ectoparasites (i.e. ticks) and, if possible, to shower.
- bottled water for fieldtrips
- food for all day fieldtrips

Course Requirements and Policies

Use of WebCT Vista as a course supplement. WebCT Vista will be used to make a variety of course resources and materials available, to administer certain assignments and assessments, and to post announcements and grades. Students should log onto WebCT daily in order to check for course announcements and to take course assessments. Also, the Mail tool in WebCT provides a convenient means for students to contact one another and their instructor and is the preferred means of communicating about matters relating to the course. Students experiencing technical difficulties using WebCT should seek assistance through the VSU Microcomputing & System Services HELP-Desk located in Odum Library (telephone 245-4357). To access WebCT, select the link near the lower left portion of the Valdosta State University homepage or go directly to the following address.

http://www.valdosta.edu/vista/

General statement. In order to complete BIOL 3650/5650 successfully, one must be mindful of all policies relating to attendance, grading, etc. Before the end of the first week of classes, after reading the course syllabus and comprehending the policies presented therein, log onto WebCT and use WebCT Mail to send a brief message to your instructor informing him that you have read the course syllabus and understand all course policies. Regular attendance of scheduled lecture and laboratory periods, daily preparation, and review are essential for success in this course. Students should prepare for each lecture session by reading the assigned sections from the textbook and any other resources made available through WebCT. Students should bring their PS text to each scheduled lecture period and their MVC text to laboratories and field trips. Notes should be taken regularly during lecture and laboratory and should be used along with the texts and materials made available through WebCT in studying for examinations.

Attendance and punctuality. Regular attendance and punctuality are expected. The student is responsible for all material missed, regardless of the reason for absence. Students arriving late for class should enter the lecture room or laboratory quietly and take the nearest seat to avoid disruption. Bear in mind that field trips normally require prompt departure from campus and that tardiness could easily result in a student missing transportation to the field site and absence from lab and that such absences will adversely affect the course grade. Attendance will normally be taken at the beginning of the period. Students who arrive after the roll is called are counted absent unless they inform their instructor immediately after class of their tardiness. It is the student's responsibility to inform the instructor of her/his tardiness. Each three cases of tardiness will be counted as one absence, and cases of tardiness will be counted as absences thusly, unless a satisfactory explanation in writing is provided to the instructor by the student. Any scheduling problems or other extenuating circumstances necessitating chronic tardiness should be explained to the instructor in writing and properly documented at the beginning of the semester. In order to have an absence excused, the student must provide a written explanation with proper documentation immediately upon returning to class. Providing an explanation of absence or tardiness by the student does not insure that the absence or tardiness will be excused. The instructor shall determine the validity of all excuses. Students are reminded that it might not be possible to make up certain labs, and whenever possible the student should clear an absence and request permission for a make-up with the instructor prior to the actual absence. *Points will be deducted from the final course grade for excessive unexcused absences.* Students absent from more than 20% of the regularly scheduled lecture and laboratory periods are subject to failure in the course. Refer to Absence Regulations in the Undergraduate Catalog.

Field trips. Identification of native and naturalized plants will be emphasized on field trips. Regular attendance of scheduled field trips is essential for success in the course. In addition to insect repellant and water and other items recommended above, students should bring their copy of MVC, handlens, 3x5 notecards, and notebook on field trips. Some field trips will be taken during the scheduled lab period. However, students will be required to attend at least two of the scheduled all day Saturday field trips. For all day trips, students should bring water, soft drinks, and food as needed. A complete laboratory and field trip schedule will be provided by the second week of the semester.

Examinations. Several exams and quizzes will be given during the semester, with at least one exam prior to midterm. Collectively, exams and lecture quizzes account for 45% of the course grade.

Field identification quizzes. The student will be required to recognize and identify locally occurring plants on sight in the field, by family or other higher group name and genus name. Field quizzes will be given spontaneously during class field trips, especially during the later half of the semester, and students will submit answers on 3x5 notecards. Collectively, the field identification quizzes account for 20% of the course grade.

Keying quizzes. Several keying quizzes will be given to measure proficiency using dichotomous keys in MVC. It is imperative that students attend lab and field trips regularly and practice identification of specimens in order to develop proficiency with these keys. Collectively, the keying quizzes account for 20% of the course grade.

Plant collection. Each student will be required to make a collection representing at least 25 plant families. Students must keep specimen data in a field notebook, to be submitted with the collection. Specimens must be properly identified, documented, and labeled. The plant collection accounts for 15% of the course grade.

Grading. If a student thinks an error has been made in grading an examination, quiz, or any other assignment, s/he should communicate about this directly with the instructor within one week of the instructor's posting of the exam or grade in question or returning of the graded quiz or assignment. In determining the final course grade, a 10-point scale is used (i.e., 90–100=A; 80–89=B; 70–79=C; 60–69=D; <60=F). The final course grade will be calculated as follows.

Examinations	*45%*
Keying quizzes	*20%*
Field identification quizzes	*20%*
Plant Collection	*15%*
Total	*100%*

Additional requirement for graduate credit. In order to receive graduate credit (BIOL 5650 only), students are required to write a term paper. Those registered for BIOL 5650 should confer with the instructor about potential topics for the research paper early in the term. An outline is due by midterm.

Academic integrity. Students are encouraged to work together and to learn from one another in an appropriate manner. Cooperation among students is especially encouraged in certain laboratory exercises and in study outside of laboratory and lecture. However, students should bear in mind that most work ultimately must be done individually and independently. All examinations and tests are given to students individually and are to be completed independently. Cooperation by students on tests or examinations is prohibited and constitutes cheating. Unless otherwise indicated, tests and examinations are taken strictly from memory without use of textbooks, laboratory manuals, notes, etc. Unless otherwise indicated, assignments are to be completed individually and independently. Behavior contrary to these guidelines is prohibited and constitutes cheating. Plagiarism and cheating will not be tolerated and will be prosecuted to the full extent allowed by University policy and the law.

Access to laboratory. Students will be granted access to the Advanced Botany Laboratory (BC 2042) after hours and during weekends via an access code that is entered into the punch pad on the lab door. Access to the laboratory after hours is a privilege; it is not a right. If problems occur with regard to safety, security, neatness, or general order in the lab, then this privilege will be revoked. It is up to each student to see that all equipment and materials are properly cared for and replaced for proper storage.

Consumption of food and drink. The distraction factor aside, food and drink in laboratory pose certain health and safety risks for students and in lecture present problems for maintenance of the building. Therefore, consumption of food or drink (including water) is absolutely prohibited during lecture and in the laboratory room. Bear in mind that food items or drink containers on desks, tables, benches, etc. in lecture rooms and laboratories create the appearance that these items are being consumed and will be treated accordingly by your instructor. Exceptions will be made to allow students to consume food and drinks (non-alcoholic) during field trips, so long as this does not interfere with the fulfillment of normal course obligations. However, it is the student's responsibility to insure that all food stuffs, paper and packaging, bottles and cans are removed from the vehicle and properly disposed.

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is not permitted during scheduled lectures, labs, or examinations. If students bring cellular telephones or similar devices to lecture, it is their responsibility to switch them off prior to the beginning of the lecture or laboratory period. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave lecture or lab immediately.

Students with disabilities. Students requiring classroom accommodations or modifications because of documented disabilities should discuss this need with their instructor at the beginning of the semester. Disabled students who are not registered with the Special Services Program should contact the Office of Special Services, Nevins Hall 1115, telephone (229) 245-2498.

Tentative Course Schedule with Reading Assignments

Week of 12 Jan.
Introduction to syllabus & course
PS, Chapt. 1 Plant Systematics: An Overview
Appendix 1. Plant Description
Appendix 2. Botanical Illustrations
Appendix 3. Scientific Journals in Plant Systematics

Week of 19 Jan.
M.L. King Holiday – Mon., 19 Jan.
PS, Chapt. 15. Plant Identification
PS, Chapt. 16. Plant Nomenclature

Week of 26 Jan.
PS, Chapt. 17. Plant Collecting & Documentation
PS, Chapt. 18. Herbaria & Data Information Systems

Week of 02 Feb.
PS, Chapt. 2. Phylogenetic Systematics
PS, Chapt. 3. Evolution & Diversity of Green & Land Plants

Week of 09 Feb.
PS, Chapt. 4. Evolution & Diversity of Vascular Plants
PS, Chapt. 5. Evolution & Diversity of Woody & Seed Plants

Week of 16 Feb.
PS, Chapt. 6. Evolution of Flowering Plants

Week of 23 Feb.
PS, Chapt. 7. Diversity of Flowering Plants: Amborellales, Nymphaeales, Austrobaileyales, Magnoliids, Ceratophyllales, & Monocots

Week of 02 Mar.
PS, Chapt. 7. Diversity of Flowering Plants: Amborellales, Nymphaeales, Austrobaileyales, Magnoliids, Ceratophyllales, & Monocots
Midterm date: Thurs., 05 Mar.

Week of 09 Mar.
PS, Chapt. 7. Diversity of Flowering Plants: Amborellales, Nymphaeales, Austrobaileyales, Magnoliids, Ceratophyllales, & Monocots

Week of 16 Mar.
Spring Break.

Week of 23 Mar.
PS, Chapt. 8. Diversity & Classification of Flowering Plants: Eudicots

Week of 30 Mar.
PS, Chapt. 8. Diversity & Classification of Flowering Plants: Eudicots

Week of 06 Apr.
PS, Chapt. 8. Diversity & Classification of Flowering Plants: Eudicots

Week of 13 Apr.
PS, Chapt. 8. Diversity & Classification of Flowering Plants: Eudicots

Week of 20 Apr.
PS, Chapt. 9. Plant Morphology
PS, Chapt. 10. Plant Anatomy
PS, Chapt. 11. Plant Embryology

Week of 27 Apr.
PS, Chapt. 12. Palynology
PS, Chapt. 13. Plant Reproductive Biology
PS, Chapt. 14. Plant Molecular Systematics

Week of 04 May
Final Exam, Wed., 06 May, 12:30–2:30PM

PLANT SYSTEMATICS – BIOL 3650/5650 **SPRING SEMESTER 2009**

FIELD TRIP SCHEDULE

Monday, 16 Feb., 12:30-4:50PM
Wolf Creek, vic. Cairo

Monday, 23 Feb., 2:00-4:50PM
Tuesday, 24 Feb., 8:00-11:00AM
Grassy Pond/Lake Louise, Lowndes Co.

Monday, 09 Mar., 2:00-4:50PM
Tuesday, 10 Mar., 8:00-11:00AM
Plowden/Lake Louise, Lowndes Co.

Saturday, 28 Mar., 8:00AM-8:00PM
Silver Lake WMA, vic. Bainbridge, GA

Saturday, 18 Apr., 8:00AM-8:00PM
Doerun Pitcherplant Bog Natural Area, vic. Doerun, GA

Saturday, 02 May, 8:00AM-8:00PM
Alapaha River bluffs, Irwin Co., GA

Biology Department – College of Arts & Sciences – Valdosta State University

BIOL 4010 – Dendrology — Fall Semester 2010

Instructor: Dr. Carter
Office: BC 1105
Telephone: 229/333-5759, ext. 5763
e-mail: Please use the mail tool in BlazeVIEW.

Office Hours: BC 1040 or BC 1105
Tues, 2:00-4:00 PM; Wed, 10:00-11:00 AM; Thurs 8:00-9:00 AM; other times by appointment

Weekly Course Schedule

Tues	Lec	11:00 AM – 12:15 PM, BC 1024
Thurs	Lec	11:00 AM – 12:15 PM, BC 1024
Thurs	Lab	1:00 – 3:50 PM, BC 2040

Miscellaneous
One or two day-long field trips and one three-day weekend field trip to the Appalachians will be included.

Course Description

Pre-requisite: Completion of Core Area D. A survey of the biology and diversity of trees and of the major forest communities. Course will emphasize species of the southeastern United States and forest communities of North America, including field identification, description and classification of forest communities, and a study of reproductive cycles, anatomy, and development of representative species. [3-3-**4**]

Lecture contact: 75 mins X 30 lectures = 2250 mins
Laboratory contact: 170 mins X 15 labs = 2550 mins
Credit: 4 semester hrs

Course Outcomes

Following is a list of course outcomes linked to Biology Department Educational Outcomes (B) and Valdosta State University General Education Outcomes (V).

- The student will demonstrate understanding of the basic principles of taxonomy, including identification, nomenclature, and classification. [B 2; V 4, 7]
- The student will demonstrate comprehension of basic concepts and the ability to use scientific terminology accurately through effective oral and written communication and the use of dichotomous keys. [B 1; V 4, 5, 7]
- The student will demonstrate the ability to handle and analyze plant materials in the field and laboratory. [B 1; V 5, 7]
- The student will demonstrate the ability to work and use basic equipment effectively in the field and laboratory. [B 1; V 4, 5, 7]
- The student will demonstrate the ability to gather and analyze data scientifically. [B 1, 5; V 3, 5]
- The student will demonstrate the ability to follow oral and written instructions effectively. [V 4, 7]
- The student will demonstrate the ability to access course resources and complete assignments on-line using computer technology (i.e., BlazeView). [V 3]
- The student will demonstrate the ability to complete assignments, quizzes, and examinations ethically. [V 8]

Assessment of Learning

- Three lecture examinations will be given.
- Routine field identification quizzes will be given.
- Students will submit a laboratory report written in the format of a journal article
- Students will keep a course notebook.

Grading
A = 900-1000 points
B = 800-899 points
C = 700-799 points
D = 600-699 points
F = <600 points

Allocation of points:

Lecture Exam 1	150 points
Lecture Exam 2	150 points
Final Exam	250 points
Field Quizzes	300 points
Course Notebook	100 points
Laboratory Report	50 points
Total	1000 points

Required Texts
- Elias, T. S. 1987. Complete Trees Of North America. Random House. 948 pp.
- Godfrey, R.K. 1989. Trees, Shrubs and Woody Vines of Northern Florida and Adjacent Southern Georgia and Alabama. University of Georgia Press, Athens. 734 pp

Miscellaneous Required Items
- Pencils or pens for recording notes, etc.
- Spiral bound notebook, convenient for field trips
- 200 3X5 inch note cards for field identification quizzes
- Hand-lens with lanyard

Additionally, the following are recommended.
- Old clothes, including long pants, and sturdy shoes or boots for field trips
- Rain gear and warm clothing, as appropriate
- Insect repellant for field trips
- *Immediately upon returning from field trips, students are urged to check their bodies thoroughly for ectoparasites (i.e. ticks) and, if possible, to shower.*
- Bottled water for field trips
- Food for all-day field trips

Attendance and punctuality. Regular attendance and punctuality are expected. The student is responsible for all material missed, regardless of the reason for absence. Students arriving late for class should enter the lecture room or laboratory quietly and take the nearest seat to avoid disruption. Bear in mind that field trips normally require prompt departure from campus and that tardiness could easily result in a student missing transportation to the field site and absence from the field trip, and that such absences will adversely affect the course grade. Attendance will normally be taken at the beginning of the period. Students who arrive after the roll is called are counted absent unless they inform their instructor immediately after class or lab of their tardiness. It is the student's responsibility to inform the instructor of her/his tardiness. Each three cases of tardiness will be counted as one absence, and cases of tardiness will be counted as absences thusly, unless a satisfactory explanation is provided to the instructor by the student. It is the instructor's prerogative to have the explanation in writing. Any scheduling problems or other extenuating circumstances necessitating chronic tardiness should be explained to the instructor in writing and properly documented at the beginning of the semester. In order to have an absence excused, the student must provide a written explanation with proper documentation immediately upon returning to class. Providing an explanation of absence or tardiness by the student does not insure that the absence or tardiness will be excused. The instructor shall determine the validity of all excuses. Students absent from more than 20% of the regularly scheduled lecture and laboratory periods are subject to failure in the course, as detailed under Absence Regulations in the VSU Undergraduate Catalog. Points will be deducted from the final grade for excessive unexcused tardiness or absence.

Field trips. On-site, spontaneous identification of native and naturalized trees will be emphasized on field trips. These field identification quizzes account for a substantial portion of the course grade; therefore, attendance of all scheduled field trips is essential for success in the course. In addition to insect repellant and water and other items recommended above, students should bring hand lens, 3×5 note cards, and notebook on all field trips. Most field trips will be taken during the scheduled lab period. However, several all day Saturday field trips are scheduled. For these trips, students should bring water, soft drinks, and food as needed. A complete field trip schedule will be provided during the first week of class.

Lecture examinations. Two lecture examinations will be given during the semester, one of these prior to midterm. Each of these exams accounts for 150 points in determining the overall course grade.

Final examination. A final examination will be given during the final examination period, which will comprise elements of both lecture and laboratory, and will account for 250 points in determining the overall course grade.

Field quizzes. The student will be required to recognize on sight in the field and to identify by *family name, scientific name (binomial)* and *common name* major native and naturalized locally occurring trees. Field quizzes will be given spontaneously during class field trips. Collectively, the field identification quizzes account for 300 points in determining the overall course grade.

Course notebook. Students will be required to keep and to submit a course notebook at the end of the semester. The course notebook will be evaluated based upon completeness, organization, clarity and neatness. The course notebook is due at the beginning of the final exam period accounts of 100 points in determining the overall course grade.

Laboratory report. Students will be required to submit a written laboratory report, based upon the results of a quantitative plant community analysis of one or more forest communities. Data will be gathered for this report on field trips during regularly scheduled laboratory periods. This report will be written in the format of a scientific paper, with instructions provided by your instructor. The laboratory report accounts for 50 points in determining the overall course grade.

Class conduct. Students are expected to comport themselves courteously at all times during lecture and laboratory. Disruptive behavior will not be tolerated, and students behaving in a disruptive manner will be asked to relinquish their VSU student identification card and will be removed from class and referred to the Dean of Students for disciplinary action. Refer to the Student Code of Conduct, Appendix A in the VSU *Student Handbook*. Consumption of food or drink (including water) and wearing of hats or caps is prohibited in the lecture room. Students should be punctual for all scheduled lecture and laboratory meetings, and, except in situations of emergency, students should not depart from lecture before being dismissed. Students are to direct their full attention to lecture and are to refrain from unwarranted discourse. Behavior contrary to these guidelines is disruptive. Disruptive behavior will result in deduction of points from the final grade.

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is prohibited during scheduled lectures or examinations. If students bring cellular telephones or similar devices to lecture, it is their responsibility to switch them off prior to the beginning of the lecture period. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave lecture immediately.

Academic integrity. Students are encouraged to work together and to learn from one another in an appropriate manner. Cooperation between students is especially encouraged in study outside of class. However, students should bear in mind that most work ultimately must be done individually and independently. All examinations, tests, and quizzes are given to students individually and are to be completed independently. Cooperation by students on quizzes, tests, or examinations is prohibited and constitutes cheating. Unless otherwise indicated, quizzes, tests, and examinations are taken strictly from memory without use of textbooks, notes, etc. Unless otherwise indicated, assignments and assessments are to be completed individually and independently. Behavior contrary to these guidelines is prohibited and constitutes cheating. Plagiarism and cheating will not be tolerated and will be prosecuted to the full extent allowed by University policy and the law.

Students with disabilities. Students requiring classroom accommodations or modifications because of documented disabilities should discuss this need with their professor at the beginning of the semester. Disabled students who are not registered with the Special Services Program should contact the Office of Special Services, Nevins Hall 1115, Telephone 245-2498.

Supplemental Reading

For current information on classification of angiosperm plant families –

Stevens, P. F. (2001 onwards). Angiosperm Phylogeny Website. Version 9, June 2008 [and more or less continuously updated since]. http://www.mobot.org/MOBOT/research/APweb/ (Accessed: November 29, 2009)

For plant community classification –

Barbour, M.G., M.G. and N.L. Christensen. 1993. Vegetation, pp. 97-131 in: Morin, N.R. (Ed.). Flora of North America, Vol. 1. Oxford University Press. New York.

Description of the Ecoregions of the United States, compiled by R.G. Bailey, U.S. Forest Service. March 1995. http://www.fs.fed.us/land/ecosysmgmt/index.html (Accessed: November 29, 2009)

Ecological Subregions of the United States, compiled by McNab, W.H. and P.E. Avers. U.S. Forest Service. WO-WSA-5. July 1994. http://www.fs.fed.us/land/pubs/ecoregions/ (Accessed: November 29, 2009)

Ecoregions, Nearctic. World Wildlife Fund, 1250 Twenty-Fourth Street, N.W., P.O. Box 97180, Washington, DC 20090-7180. http://www.worldwildlife.org/wildworld/profiles/terrestrial_na.html (Accessed: November 29, 2009)

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer (Accessed: November 29, 2009)

Peet, R.K., T.R. Wentworth, and P.S. White. 1998. A Flexible, Multipurpose Method for Recording Vegetation Composition and Structure. Castanea 63:262 -274.

Thorne, R.F. 1993. Phytogeography, pp. 132-153 *in:* Morin, N.R. (Ed.). *Flora of North America*, Vol. 1. Oxford University Press. New York.

Wharton, C.H. 1978. Physiography and Biota of Georgia. BioScience 28:336-339.

Wharton, C.H. 1978. The Natural Environments of Georgia. Bulletin 114, Georgia Department of Natural Resources. Atlanta.

Miscellaneous –

Peattie, D.C. 1980. Natural History of Western Trees. University of Nebraska Press. Lincoln. 751 pp.

Peattie, D.C. 2007. A Natural History of Trees: of Eastern and Central North America. Houghton Mifflin Co. New York. 606 pp.

Tomlinson, P. B. 2002. The Biology of Trees Native to Tropical Florida. Second Edition. Printed privately. Petersham, Massachusetts. 395 pp.

Tentative Course Outline with Laboratory Schedule

Week of Aug 16
Classes begin
Lecture:
Introduction to Course
What is a tree? What is a forest?
Overview of the Classification of Plants
Diversity of Trees
Gymnosperms
GINKGO
- Ginkgoales: Ginkgoaceae: *Ginkgo:* ginkgo

CONIFERS
- Pinales: Cupressaceae, Pinaceae, Taxaceae: *Chamaecyparis, Juniperus, Taxodium; Abies, Pinus, Picea, Tsuga; Taxus, Torreya:* white cedars, junipers, baldcypresses; firs, pines, spruces, hemlocks; yews, gopherwood

*Laboratory: Basic Vegetative Structure and Terminology

Week of Aug 23
Lecture: Diversity of Trees
Angiosperms
MONOCOTS
- Arecales: Arecaceae: *Sabal:* cabbage palm

MAGNOLIIDS
- Magnoliales, Laurales, Illiciales: Magnoliaceae, Annonaceae, Lauraceae, Illiciaceae: *Liriodendron, Magnolia; Asimina; Persea, Sassafras, Litsea; Illicium:* magnolias, yellow poplar; pawpaws; redbay, swampbay, sassafras, pondspice; Florida anise

EUDICOTS
- Proteales, Saxifragales: Platanaceae; Hamamelidaceae, Altingiaceae: *Platanus; Hamamelis, Liquidambar:* sycamore; witch hazel, sweetgum
- Malpighiales: Euphorbiaceae, Salicaceae, Rhizophoraceae: *Triadica; Populus, Salix; Rhizophora:* Chinese tallow; willows, cottonwoods; red mangrove

*Field Laboratory: Identification of Trees and Plant Communities

Week of Aug 30
Lecture: Diversity of Trees
- Fabales: Fabaceae: *Acacia, Albizia, Robinia, Gleditsia, Cercis:* acacias, mimosas, locusts, redbud
- Rosales: Rosaceae, Rhamnaceae, Ulmaceae, Celtidaceae, Moraceae: *Amelanchier, Crataegus, Malus, Prunus; Rhamnus; Planera, Ulmus; Celtis; Broussonetia, Morus:* serviceberries, hawthorns, crabapples, plums, cherries; Carolina buckthorn; elms; hackberries; mulberries

*Field Laboratory: Identification of Trees and Plant Communities

Week of Sep 6
Labor Day Holiday *– Mon., Sept. 6*
Lecture: Diversity of Trees
- Fagales: Fagaceae: *Castanea, Fagus, Quercus:* chestnuts, chinkapins, beeches, oaks

*Field Laboratory: Identification of Trees and Plant Communities

Week of Sep 13
Lecture: Diversity of Trees
Lecture: Diversity of Trees
- Fagales (continued): Betulaceae, Myricaceae, Juglandaceae: *Alnus, Betula; Morella, Myrica; Carya, Juglans:* alder, birches; bayberries; hickories, walnuts

*Field Laboratory: Identification of Trees and Plant Communities

Week of Sep 20
Lecture: Diversity of Trees
- Myrtales: Combretaceae: *Combretum, Laguncularia:* buttonwood, white mangrove
- Malvales: Malvaceae: *Tilia:* basswoods
- Sapindales: Rutaceae, Meliaceae, Anacardiaceae, Sapindaceae: *Poncirus, Ptelea, Zanthoxylum; Melia; Rhus, Metopium, Schinus, Toxicodendron; Acer, Aesculus, Sapindus:* mockorange, wafer ash, prickly ashes; Chinaberry; sumacs, poisonwood, Brazilian pepper; maples, buckeyes, soapberry

*Field Laboratory: Identification of Trees and Plant Communities

Week of Sep 27 / *Midterm exam* – *Thurs., Sept. 30*
Lecture: Diversity of Trees
- Cornales: Hydrangeaceae, Cornaceae: *Philadelphus; Cornus, Nyssa:* mock oranges; dogwoods, gums
- Ericales: Sapotaceae, Theaceae, Ericaceae, Ebenaceae, Cyrillaceae, Styraceae, Symplocaceae: *Sideroxylon; Gordonia, Stewartia; Kalmia, Lyonia, Oxydendrum; Diospyros; Cliftonia, Cyrilla; Halesia, Styrax; Symplocos:* buckthorns; loblolly bay, silky camellia; mountain laurel, lyonias, sourwood; persimmon; titis; silverbells, storaxes; sweetleaf

*Field Laboratory: Identification of Trees and Plant Communities

Week of Oct 4 / *Midterm date* – *Oct. 7*
Lecture: Diversity of Trees
- Gentianales: Rubiaceae: *Cephalanthus, Pinckneya:* buttonbush, feverbark
- Lamiales: Oleaceae, Bignoniaceae, Avicenniaceae: *Chionanthus, Fraxinus, Ligustrum, Osmanthus; Catalpa; Avicennia:* graybeard, ashes, ligustrums, wild olive; catalpas; black mangrove
- Aquifoliales: Aquifoliaceae: *Ilex:* hollies
- Apiales: Apiaceae: *Aralia:* devil's walking stick
- Dipsacales: Adoxaceae: *Sambucus, Viburnum:* elderberries, viburnums

*Field Laboratory: Identification of Trees and Plant Communities

Week of Oct 11
Lecture: Introduction to Forest Ecology
- Ecosystems and communities
- Mycorrhizae
- Ecological succession and fire

*Field Laboratory: Identification of Trees and Plant Communities

Week of Oct 18
Fall Break – *Mon. – Tues., Oct. 18-19*
Lecture: Major Forest Communities of North America
- Recapitulation and Classification of Communities Encountered on Field Trips

*Field Laboratory: Quantitative Characterization of a Forest Community

Week of Oct 25
Lecture: Major Forest Communities of North America
- Major Forest Communities of Eastern North America

*Field Laboratory: Quantitative Characterization of a Forest Community

Week of Nov 1
Lecture: Major Forest Communities of North America
- Major Forest Communities of Western North America

*Field Laboratory: Quantitative Characterization of a Forest Community

Week of Nov 8
Lecture: Reproductive Cycles of Trees
- Reproduction in Pine
- Reproduction in Oak

*Laboratory: Reproduction in Pine and Oak

Week of Nov 15
Lecture: Anatomy and Development of Trees
- Primary and Secondary Growth in Roots and Stems

*Laboratory: Primary and Secondary Growth in Roots and Stems

Week of Nov 22
Thanksgiving Holiday – *Wed. – Fri., Nov. 24-26*
Lecture: Anatomy and Development of Trees
- Primary and Secondary Growth in Roots and Stems

*No lab this week

Week of Nov 29
Lecture: Anatomy and Development of Trees
- Wood Anatomy
- Dendrochronology

*Laboratory: Wood Anatomy in Pine, Oak and Basswood

Week of Dec 6
Last class day – *Mon., Dec. 6*
Final Examination – *Fri., Dec. 10, 10:15AM-12:15PM*

BIOL 4010/6010 – Dendrology

Field Trip Schedule

Thursday, 09/09/2010, 1:00-3:50PM – Lake Louise Field Station, Lowndes Co., GA

Thursday, 09/16/2010, 1:00-3:50PM – Langdale Park, South Forty, Lowndes Co., GA

Saturday, 09/18/2010, 8:00AM-6:00PM – Reed Bingham State Park, Cook Co., GA

Thursday, 09/30/2010, 1:00-3:50PM – Lake Louise Field Station, Lowndes Co., GA

Saturday, 10/02/2010, 8:00AM-9:00PM – Wolf Creek Natural Area, Grady Co., GA / Arcadia Plantation, Thomas Co., GA

Thursday, 10/14/2010 – Kinderlou Plantation / Withlacoochee River Clyattville landing, Lowndes Co., GA

Friday, 11:00AM, 10/17 – Sunday, 9:00PM, 10/19 – Highlands Biological Station, Highlands, NC

Thursday, 10/28/2010, 1:00-3:50PM – Lake Louise Field Station, Lowndes Co., GA

Thursday, 11/04/2010, 1:00-3:50PM – Lake Louise Field Station, Lowndes Co., GA

Saturday, 11/06/2010 (instead of 11/13/2010), **8:00AM-9:00PM – Torreya State Park, vic. Chattahoochee, FL**

Biology Department – College of Arts & Sciences – Valdosta State University

BIOL 6010 – Dendrology — Fall Semester 2010

Instructor: Dr. Carter
Office: BC 1105
Telephone: 229/333-5759, ext. 5763
e-mail: Please use the mail tool in BlazeVIEW.

Office Hours: BC 1040 or BC 1105
Tues, 2:00-4:00 PM; Wed, 10:00-11:00 AM; Thurs 8:00-9:00 AM; other times by appointment

Weekly Course Schedule

Tues	Lec	11:00 AM – 12:15 PM, BC 1024
Thurs	Lec	11:00 AM – 12:15 PM, BC 1024
Thurs	Lab	1:00 – 3:50 PM, BC 2040

Miscellaneous
One or two day-long field trips and one three-day weekend field trip to the Appalachians will be included.

Course Description

Prerequisite: Admission into the graduate program or permission of the instructor. A survey of the biology and diversity of trees and of the major forest communities. The course will emphasize species of the southeastern United States and forest communities of North America, including field identification, description and classification of forest communities, and a study of reproductive cycles, anatomy, and development of representative species. [3-3-**4**]
Lecture contact: 75 mins X 30 lectures = 2250 mins
Laboratory contact: 170 mins X 15 labs = 2550 mins
Credit: 4 semester hrs

Course Outcomes

Following is a list of course outcomes linked to the M.S. in Biology Selected Educational Outcomes (G).

- The student will demonstrate understanding of the basic principles of taxonomy, including identification, nomenclature, and classification. [G 1]
- The student will demonstrate the ability to handle and analyze plant materials in the field and laboratory. [G 1, 2]
- The student will demonstrate comprehension of basic concepts and the ability to use scientific terminology accurately through effective oral and written communication and the use of dichotomous keys. [G 1]
- The student will demonstrate the ability to gather and analyze data scientifically. [G 1, 2]

Assessment of Learning

- Three lecture examinations will be given.
- Routine field identification quizzes will be given.
- Students will submit a laboratory report written in the format of a journal article.
- Students will keep a course notebook.
- Students will write a term paper and make an oral presentation.

Miscellaneous Required Items

- Pencils or pens for recording notes, etc.
- Spiral bound notebook, convenient for field trips
- 200 3X5 inch note cards for field identification quizzes
- Hand-lens with lanyard

Additionally, the following are recommended.

- Old clothes, including long pants, and sturdy shoes or boots for field trips
- Rain gear and warm clothing, as appropriate
- Insect repellant for field trips
- *Immediately upon returning from field trips, students are urged to check their bodies thoroughly for ectoparasites (i.e. ticks) and, if possible, to shower.*
- Bottled water for field trips
- Food for all-day field trips

Grading

A = 1100-1200 points
B = 1000-1099 points
C = 900-999 points
D = 800-899 points
F = <800 points

Allocation of points:

Lecture Exam 1	150 points
Lecture Exam 2	150 points
Final Exam	250 points
Field Quizzes	300 points
Course Notebook	100 points
Written laboratory report	50 points
Oral presentation	100 points
Term paper	100 points
Total	1200 points

Required Texts

- Elias, T. S. 1987. Complete Trees Of North America. Random House. 948 pp.
- Godfrey, R.K. 1989. Trees, Shrubs and Woody Vines of Northern Florida and Adjacent Southern Georgia and Alabama. University of Georgia Press, Athens. 734 pp

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- Food for all-day field trips

Attendance and punctuality. Regular attendance and punctuality are expected. The student is responsible for all material missed, regardless of the reason for absence. Students arriving late for class should enter the lecture room or laboratory quietly and take the nearest seat to avoid disruption. Bear in mind that field trips normally require prompt departure from campus and that tardiness could easily result in a student missing transportation to the field site and absence from the field trip, and that such absences will adversely affect the course grade. Attendance will normally be taken at the beginning of the period. Students who arrive after the roll is called are counted absent unless they inform their instructor immediately after class or lab of their tardiness. It is the student's responsibility to inform the instructor of her/his tardiness. Each three cases of tardiness will be counted as one absence, and cases of tardiness will be counted as absences thusly, unless a satisfactory explanation is provided to the instructor by the student. It is the instructor's prerogative to have the explanation in writing. Any scheduling problems or other extenuating circumstances necessitating chronic tardiness should be explained to the instructor in writing and properly documented at the beginning of the semester. In order to have an absence excused, the student must provide a written explanation with proper documentation immediately upon returning to class. Providing an explanation of absence or tardiness by the student does not insure that the absence or tardiness will be excused. The instructor shall determine the validity of all excuses. Students absent from more than 20% of the regularly scheduled lecture and laboratory periods are subject to failure in the course, as detailed under Absence Regulations in the VSU Undergraduate Catalog. Points will be deducted from the final grade for excessive unexcused tardiness or absence.

Field trips. On-site, spontaneous identification of native and naturalized trees will be emphasized on field trips. These field identification quizzes account for a substantial portion of the course grade; therefore, attendance of all scheduled field trips is essential for success in the course. In addition to insect repellant and water and other items recommended above, students should bring hand lens, 3×5 note cards, and notebook on all field trips. Most field trips will be taken during the scheduled lab period. However, several all day Saturday field trips are scheduled. For these trips, students should bring water, soft drinks, and food as needed. A complete field trip schedule will be provided during the first week of class.

Lecture examinations. Two lecture examinations will be given during the semester, one of these prior to midterm. Each of these exams accounts for 150 points in determining the overall course grade.

Final examination. A final examination will be given during the final examination period, which will comprise elements of both lecture and laboratory, and will account for 250 points in determining the overall course grade.

Field quizzes. The student will be required to recognize on sight in the field and to identify by *family name, scientific name (binomial)* and *common name* major native and naturalized locally occurring trees. Field quizzes will be given spontaneously during class field trips. Collectively, the field identification quizzes account for 300 points in determining the overall course grade.

Course notebook. Students will be required to keep and to submit a course notebook at the end of the semester. The course notebook will be evaluated based upon completeness, organization, clarity and neatness. The course notebook is due at the beginning of the final exam period accounts of 100 points in determining the overall course grade.

Laboratory report. Students will be required to submit a written laboratory report, based upon the results of a quantitative plant community analysis of one or more forest communities. Data will be gathered for this report on field trips during regularly scheduled laboratory periods. This report will be written in the format of a scientific paper, with instructions provided by your instructor. The laboratory report accounts for 50 points in determining the overall course grade.

Class conduct. Students are expected to comport themselves courteously at all times during lecture and laboratory. Disruptive behavior will not be tolerated, and students behaving in a disruptive manner will be asked to relinquish their VSU student identification card and will be removed from class and referred to the Dean of Students for disciplinary action. Refer to the Student Code of Conduct, Appendix A in the VSU *Student Handbook*. Consumption of food or drink (including water) and wearing of hats or caps is prohibited in the lecture room. Students should be punctual for all scheduled lecture and laboratory meetings, and, except in situations of emergency, students should not depart from lecture before being dismissed. Students are to direct their full attention to lecture and are to refrain from unwarranted discourse. Behavior contrary to these guidelines is disruptive. Disruptive behavior will result in deduction of points from the final grade.

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is prohibited during scheduled lectures or examinations. If students bring cellular telephones or similar devices to lecture, it is their responsibility to switch them off prior to the beginning of the lecture period. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave lecture immediately.

Academic integrity. Students are encouraged to work together and to learn from one another in an appropriate manner. Cooperation between students is especially encouraged in study outside of class. However, students should bear in mind that most work ultimately must be done individually and independently. All examinations, tests, and quizzes are given to students individually and are to be completed independently. Cooperation by students on quizzes, tests, or examinations is prohibited and constitutes cheating. Unless otherwise indicated, quizzes, tests, and examinations are taken strictly from memory without use of textbooks, notes, etc. Unless otherwise indicated, assignments and assessments are to be completed individually and independently. Behavior contrary to these guidelines is prohibited and constitutes cheating. Plagiarism and cheating will not be tolerated and will be prosecuted to the full extent allowed by University policy and the law.

Students with disabilities. Students requiring classroom accommodations or modifications because of documented disabilities should discuss this need with their professor at the beginning of the semester. Disabled students who are not registered with the Special Services Program should contact the Office of Special Services, Nevins Hall 1115, Telephone 245-2498.

Supplemental Reading

For current information on classification of angiosperm plant families –

Stevens, P. F. (2001 onwards). Angiosperm Phylogeny Website. Version 9, June 2008 [and more or less continuously updated since]. http://www.mobot.org/MOBOT/research/APweb/ (Accessed: November 29, 2009)

For plant community classification –

Barbour, M.G., M.G. and N.L. Christensen. 1993. Vegetation, pp. 97-131 in: Morin, N.R. (Ed.). Flora of North America, Vol. 1. Oxford University Press. New York.

Description of the Ecoregions of the United States, compiled by R.G. Bailey, U.S. Forest Service. March 1995. http://www.fs.fed.us/land/ecosysmgmt/index.html (Accessed: November 29, 2009)

Ecological Subregions of the United States, compiled by McNab, W.H. and P.E. Avers. U.S. Forest Service. WO-WSA-5. July 1994. http://www.fs.fed.us/land/pubs/ecoregions/ (Accessed: November 29, 2009)

Ecoregions, Nearctic. World Wildlife Fund, 1250 Twenty-Fourth Street, N.W., P.O. Box 97180, Washington, DC 20090-7180. http://www.worldwildlife.org/wildworld/profiles/terrestrial_na.html (Accessed: November 29, 2009)

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer (Accessed: November 29, 2009)

Peet, R.K., T.R. Wentworth, and P.S. White. 1998. A Flexible, Multipurpose Method for Recording Vegetation Composition and Structure. Castanea 63:262 -274.

Thorne, R.F. 1993. Phytogeography, pp. 132-153 *in:* Morin, N.R. (Ed.). *Flora of North America*, Vol. 1. Oxford University Press. New York.

Wharton, C.H. 1978. Physiography and Biota of Georgia. BioScience 28:336-339.

Wharton, C.H. 1978. The Natural Environments of Georgia. Bulletin 114, Georgia Department of Natural Resources. Atlanta.

Miscellaneous –

Peattie, D.C. 1980. Natural History of Western Trees. University of Nebraska Press. Lincoln. 751 pp.

Peattie, D.C. 2007. A Natural History of Trees: of Eastern and Central North America. Houghton Mifflin Co. New York. 606 pp.

Tomlinson, P. B. 2002. The Biology of Trees Native to Tropical Florida. Second Edition. Printed privately. Petersham, Massachusetts. 395 pp.

Tentative Course Outline with Laboratory Schedule

Week of Aug 16
Classes begin
Lecture:
Introduction to Course
What is a tree? What is a forest?
Overview of the Classification of Plants
Diversity of Trees
Gymnosperms
GINKGO
- Ginkgoales: Ginkgoaceae: *Ginkgo:* ginkgo

CONIFERS
- Pinales: Cupressaceae, Pinaceae, Taxaceae: *Chamaecyparis, Juniperus, Taxodium; Abies, Pinus, Picea, Tsuga; Taxus, Torreya:* white cedars, junipers, baldcypresses; firs, pines, spruces, hemlocks; yews, gopherwood

*Laboratory: Basic Vegetative Structure and Terminology

Week of Aug 23
Lecture: Diversity of Trees
Angiosperms
MONOCOTS
- Arecales: Arecaceae: *Sabal:* cabbage palm

MAGNOLIIDS
- Magnoliales, Laurales, Illiciales: Magnoliaceae, Annonaceae, Lauraceae, Illiciaceae: *Liriodendron, Magnolia; Asimina; Persea, Sassafras, Litsea; Illicium:* magnolias, yellow poplar; pawpaws; redbay, swampbay, sassafras, pondspice; Florida anise

EUDICOTS
- Proteales, Saxifragales: Platanaceae; Hamamelidaceae, Altingiaceae: *Platanus; Hamamelis, Liquidambar:* sycamore; witch hazel, sweetgum
- Malpighiales: Euphorbiaceae, Salicaceae, Rhizophoraceae: *Triadica; Populus, Salix; Rhizophora:* Chinese tallow; willows, cottonwoods; red mangrove

*Field Laboratory: Identification of Trees and Plant Communities

Week of Aug 30
Lecture: Diversity of Trees
- Fabales: Fabaceae: *Acacia, Albizia, Robinia, Gleditsia, Cercis:* acacias, mimosas, locusts, redbud
- Rosales: Rosaceae, Rhamnaceae, Ulmaceae, Celtidaceae, Moraceae: *Amelanchier, Crataegus, Malus, Prunus; Rhamnus; Planera, Ulmus; Celtis; Broussonetia, Morus:* serviceberries, hawthorns, crabapples, plums, cherries; Carolina buckthorn; elms; hackberries; mulberries

*Field Laboratory: Identification of Trees and Plant Communities

Week of Sep 6
Labor Day Holiday *– Mon., Sept. 6*
Lecture: Diversity of Trees
- Fagales: Fagaceae: *Castanea, Fagus, Quercus:* chestnuts, chinkapins, beeches, oaks

*Field Laboratory: Identification of Trees and Plant Communities

Week of Sep 13
Lecture: Diversity of Trees
Lecture: Diversity of Trees
- Fagales (continued): Betulaceae, Myricaceae, Juglandaceae: *Alnus, Betula; Morella, Myrica; Carya, Juglans:* alder, birches; bayberries; hickories, walnuts

*Field Laboratory: Identification of Trees and Plant Communities

Week of Sep 20
Lecture: Diversity of Trees
- Myrtales: Combretaceae: *Combretum, Laguncularia:* buttonwood, white mangrove
- Malvales: Malvaceae: *Tilia:* basswoods
- Sapindales: Rutaceae, Meliaceae, Anacardiaceae, Sapindaceae: *Poncirus, Ptelea, Zanthoxylum; Melia; Rhus, Metopium, Schinus, Toxicodendron; Acer, Aesculus, Sapindus:* mockorange, wafer ash, prickly ashes; Chinaberry; sumacs, poisonwood, Brazilian pepper; maples, buckeyes, soapberry

*Field Laboratory: Identification of Trees and Plant Communities

Week of Sep 27 / *Midterm exam* – *Thurs., Sept. 30*
Lecture: Diversity of Trees

- Cornales: Hydrangeaceae, Cornaceae: *Philadelphus; Cornus, Nyssa:* mock oranges; dogwoods, gums
- Ericales: Sapotaceae, Theaceae, Ericaceae, Ebenaceae, Cyrillaceae, Styraceae, Symplocaceae: *Sideroxylon; Gordonia, Stewartia; Kalmia, Lyonia, Oxydendrum; Diospyros; Cliftonia, Cyrilla; Halesia, Styrax; Symplocos:* buckthorns; loblolly bay, silky camellia; mountain laurel, lyonias, sourwood; persimmon; titis; silverbells, storaxes; sweetleaf

*Field Laboratory: Identification of Trees and Plant Communities

Week of Oct 4 / *Midterm date* – *Oct. 7*
Lecture: Diversity of Trees

- Gentianales: Rubiaceae: *Cephalanthus, Pinckneya:* buttonbush, feverbark
- Lamiales: Oleaceae, Bignoniaceae, Avicenniaceae: *Chionanthus, Fraxinus, Ligustrum, Osmanthus; Catalpa; Avicennia:* graybeard, ashes, ligustrums, wild olive; catalpas; black mangrove
- Aquifoliales: Aquifoliaceae: *Ilex:* hollies
- Apiales: Apiaceae: *Aralia:* devil's walking stick
- Dipsacales: Adoxaceae: *Sambucus, Viburnum:* elderberries, viburnums

*Field Laboratory: Identification of Trees and Plant Communities

Week of Oct 11
Lecture: Introduction to Forest Ecology

- Ecosystems and communities
- Mycorrhizae
- Ecological succession and fire

*Field Laboratory: Identification of Trees and Plant Communities

Week of Oct 18
Fall Break – *Mon. – Tues., Oct. 18-19*
Lecture: Major Forest Communities of North America

- Recapitulation and Classification of Communities Encountered on Field Trips

*Field Laboratory: Quantitative Characterization of a Forest Community

Week of Oct 25
Lecture: Major Forest Communities of North America

- Major Forest Communities of Eastern North America

*Field Laboratory: Quantitative Characterization of a Forest Community

Week of Nov 1
Lecture: Major Forest Communities of North America

- Major Forest Communities of Western North America

*Field Laboratory: Quantitative Characterization of a Forest Community

Week of Nov 8
Lecture: Reproductive Cycles of Trees

- Reproduction in Pine
- Reproduction in Oak

*Laboratory: Reproduction in Pine and Oak

Week of Nov 15
Lecture: Anatomy and Development of Trees

- Primary and Secondary Growth in Roots and Stems

*Laboratory: Primary and Secondary Growth in Roots and Stems

Week of Nov 22
Thanksgiving Holiday – *Wed. – Fri., Nov. 24-26*
Lecture: Anatomy and Development of Trees

- Primary and Secondary Growth in Roots and Stems

*No lab this week

Week of Nov 29
Lecture: Anatomy and Development of Trees

- Wood Anatomy
- Dendrochronology

*Laboratory: Wood Anatomy in Pine, Oak and Basswood

Week of Dec 6
Last class day – *Mon., Dec. 6*
Final Examination – *Fri., Dec. 10, 10:15AM-12:15PM*

BIOL 4100/6100 – MORPHOLOGY OF LAND PLANTS SPRING SEMESTER 2010

Instructor: Dr. Carter
Office: BC 1105
Telephone: 229/333-5763

Office Hours: BC 1040 or BC 1105
Tues. and Thurs., 11:00 AM – 12:00 Noon
Wed., 8:00 – 9:00 AM
Other times by appointment

Weekly Lecture and Lab Schedule

Tues:	Lec	8:00 – 9:15AM, BC 1025
Thurs:	Lec	8:00 – 9:15AM, BC 1025
	Lab	2:00 – 4:50PM, BC 2040

Course description. Prerequisites: BIOL 2230 and BIOL 2270. Study of vegetative organization and reproductive cycles of bryophytes, pteridophytes and seed plants, which incorporates phylogenetic and ecological relationships. [3-3-**4**]
Contact hours: 150 mins lecture & 170 mins lab per week.
Credit hours: 4 sem hrs credit.

Course objectives. The student should gain an understanding of the vegetative organization, reproductive cycles, life history, and ecology of representatives of the various plant phyla, and the evolutionary origins of the plant kingdom, and the evolutionary trends, homologous variation, and phylogeny within Kingdom Plantae.

Graduate credit. Students taking the course for graduate credit (i.e., BIOL 6100), will be required to prepare and present two lectures during the regularly scheduled lecture period. Lecture topics are subject to approval of the instructor. Please be advised that this must be coordinated with your instructor well in advance.

Course materials

- Required text: *Morphology of Plants and Fungi* by Bold, Alexopoulos & Delevoryas, 5th Ed., Harper & Row [abbreviated BAD below]
- Laboratory manual: *BIOL 4100/6100 Laboratory & Course Guide* will be made available free-of-charge, through BlazeVIEW.
- Supplementary text: *Biology of Plants* by Raven, P.H., R.F. Evert & S.E. Eichhorn, 2005, 7th Ed., W. H. Freeman & Co. [abbreviated REE below]
- Additional reading assignments will be made during the semester.

Course Outcomes linked to Biology Department Educational Outcomes (B) and Valdosta State University General Education Outcomes (V)

1. The student will demonstrate understanding of vegetative structure, life histories, reproductive cycles, and ecological relationships of the plant phyla. [B 2, 5; V 4, 7]
2. The student will demonstrate understanding of evolutionary trends and patterns and phylogeny within the plant kingdom. [B 2; V 4, 7]
3. The student will demonstrate the ability to identify, handle, and analyze plant materials in the laboratory and in the field. [B 1; V 5, 7]
4. The student will demonstrate the ability to use basic equipment and to work effectively in the laboratory. [B 1; V 4, 5, 7]
5. The student will demonstrate comprehension of basic concepts and the ability to use scientific terminology accurately through effective oral and written communication. [B 1; V 4, 5, 7]
6. The student will demonstrate the ability to follow oral and written instructions effectively. [V 4, 7]
7. The student will demonstrate the ability to complete assignments and examinations ethically. [V 8]

Course Requirements and Policies

Use of BlazeVIEW as a course supplement. BlazeVIEW will be used to make a variety of course resources and materials available, to administer certain assignments and assessments, and to post announcements and grades. Students should log onto BlazeVIEW daily in order to check for course announcements and to take course assessments. Also, the Mail tool in BlazeVIEW provides a convenient means for students to contact one another and their instructor and is the preferred means of communicating about matters relating to the course. To access BlazeVIEW, select the BlazeVIEW link under Quick Links on the left side of the Valdosta State University homepage. Students experiencing technical difficulties using BlazeVIEW should seek assistance through the VSU Microcomputing & System Services HELP Desk located in Odum Library (telephone 229/245-4357).

Academic integrity. Students are encouraged to work together and to learn from one another in an appropriate manner. Cooperation among students is especially encouraged in certain laboratory exercises and in study outside of laboratory and lecture. However, students should bear in mind that most work ultimately must be done individually and independently. All examinations and tests are given to students individually and are to be completed independently. Cooperation by students on tests or examinations is prohibited and constitutes cheating. Unless otherwise indicated, tests and examinations are taken strictly from memory without use of textbooks, laboratory manuals, notes, etc. Unless otherwise indicated, assignments are to be completed individually and independently. Behavior contrary to these guidelines is prohibited and constitutes cheating. Plagiarism and cheating will not be tolerated and will be prosecuted to the full extent allowed by University policy and the law.

Recognition of and respect for the ownership of property is one of the distinguishing features of civilization. Ideas come from individuals and are effectively owned by their originators; thus, ideas are intellectual property. In the academic sphere, we frequently deal with the ideas of others, most often in published form. As with tangible property, intellectual property is subject to ownership and protection. Moreover, publication establishes ownership of intellectual property. It is essential that we respect the ideas and writing of others and that we scrupulously cite all sources of any and all ideas that are not our own.

Random House Webster's College Dictionary (2000) defines **plagiarism** as "the unauthorized use of the language and thoughts of another author and the representation of them as one's own." There are many forms of plagiarism. Perhaps the most blatant form is copying from some other source without citing that source. Other types of plagiarism include using a paper written by another and the improper citation of references. When paraphrasing, the author of the paraphrased material must be properly cited, and, when words are taken directly from another source, their author must be properly cited and the quotation must be placed within quotation marks for short quotations or in a separate paragraph with special indentation for longer quoted passages. Plagiarism is theft of intellectual property, and the simplest way to avoid plagiarism is to give credit where credit is due! The following statement from the Writing Tutorial Services website at Indiana University is useful.

To avoid plagiarism, you must give credit whenever you use

- another person's idea, opinion, or theory;
- any facts, statistics, graphs, drawings – any pieces of information – that are not common knowledge;
- quotations of another person's actual spoken or written words; or
- paraphrase of another person's spoken or written words.

http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml; Copyright 2004; last updated 27 April 2004; last accessed 05 August 2007.

It is imperative that laboratory reports and papers be the student's own original work. Plagiarism will not be tolerated, and any student caught plagiarizing shall receive a failing grade on the report or assignment. Please be forewarned that various web search engines will be used to check for plagiarism.

Attendance, participation, and attitude. Regular attendance of all scheduled lectures and labs and punctuality are expected. The student is responsible for all material missed regardless of the reason for absence. Normally, attendance will be taken during each scheduled lecture and laboratory period.

Each three instances of unexcused tardiness will be counted as one absence. Tardiness will not be excused without a written explanation from the student and a determination by the instructor that the reason for tardiness is valid. Requests for excused tardiness must be submitted to the instructor in writing within 24 hours of the beginning of the period during which the student was late. It is the student's responsibility to initiate such requests. Any scheduling problems or other extenuating circum-stances necessitating chronic tardiness should be explained to the instructor in writing and properly documented at the beginning of the semester.

In order to have an absence excused, the student must provide a written explanation with proper documentation immediately upon returning to class or laboratory. Based upon the written explanation and associated documentation, the instructor will determine whether the reason for absence is valid and will excuse absences accordingly.

Students are reminded that it might not be possible to make up certain laboratory exercises, and, whenever possible, the student should clear an absence and request permission for a makeup with the instructor prior to the actual absence. In accordance with Valdosta State University Absence Regulations on page 90 of the *2009-2010 Undergraduate Catalog*, students absent from more than 20% of the regularly scheduled lecture and laboratory periods are subject to failure in the course:

http://www.valdosta.edu/catalog/0910/ugrad/

Moveover, the final course grade may be lowered because of poor attendance, participation, or attitude.

Conduct in lecture and laboratory. Students are expected to comport themselves courteously at all times during lecture and laboratory. Disruptive behavior will not be tolerated, and students behaving in a disruptive manner will be removed from the classroom and referred to the Dean of Students for disciplinary action. Refer to the Student Code of Conduct in the VSU *Student Handbook Volume III:*

http://www.valdosta.edu/studentaffairs/StudentHandbook.shtml.

Students should be punctual for scheduled lecture and laboratory meetings. Except in special situations (i.e., emergency), students should not depart from lecture before being dismissed. If a student departs from lecture early, re-entry into the lecture room during the same period will not be permitted. Students anticipating early departure from lecture should inform their instructor of this prior to the beginning lecture and seat themselves near an exit. Students are to direct their full attention to lecture and laboratory and are to refrain from unwarranted discourse. Behavior contrary to these guidelines is disruptive and may result in lowering of the final grade.

Valid identification. It is the student's respons-ibility to have her/his VSU identification card in his/her possession at all times during class and laboratory periods, especially during scheduled examinations. Normally, each student will be asked to present her/his valid VSU photo-identification card in order to take an examination.

Consumption of food and drink. The distraction factor aside, food and drink in laboratory pose certain health and safety risks to students and in lecture present problems for maintenance of the building. Therefore, the consumption of food or drink (including water) is absolutely prohibited during lecture and laboratory. Bear in mind that food items or drink containers on desks, tables, benches, etc. in lecture rooms and laboratories create the appearance that these items are being consumed and will be treated accordingly by your instructor.

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is not permitted during scheduled lectures, labs, or examinations. If students bring cellular telephones or similar devices to lecture, it is their responsibility to switch them off prior to the beginning of the lecture or laboratory period. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave lecture or lab immediately.

General suggestions. Regular attendance of scheduled lecture and laboratory periods and daily preparation and review are essential for success. Students should prepare for each lecture and laboratory session by reading the assigned sections from the textbook and laboratory manual and any additional supplementary material made available by the instructor. Students should bring their textbook to each scheduled lecture and laboratory period, since illustrations and diagrams from the text will be used regularly during lecture and lab. Notes should be taken regularly during lecture and lab and should be used along with the text and lab manual in studying for examinations.

General comments on laboratory. Success in the laboratory is largely dependent upon student interest, curiosity, and assumption of responsibility for independent learning. Material presented during lecture should be studied along with laboratory material in order to integrate the two learning experiences. Laboratory work emphasizes careful observations and the opportunity to repeat and confirm the work of others. It also provides for some experimentation and gathering of data. To gain the most from the laboratory experiences, students should be regular and punctual in attendance, especially to receive directions and instructions given by the instructor at the beginning of each laboratory period. Students also benefit by using the textbook frequently during laboratory sessions, by keeping descriptive notes on observations, by recording data accurately and systematically, and by making diagrams and drawings.

Field trips. Local field trips will be made frequently during regularly scheduled laboratory periods. Additionally, two *optional* Saturday field trips will be taken. Following are recommendations for field trips.

- Wear old clothes, including long pants, and sturdy shoes or boots.
- Use insect repellant (with DEET).
- Immediately upon returning from fieldtrips, students are urged to check their bodies thoroughly for ectoparasites (i.e. ticks) and, if possible, to shower.
- Bring bottled water, especially for all day trips.
- Bring food, especially for all day trips.

Examinations. Three major examinations will be given. Approximately half of each exam will be based on lecture material, and half on laboratory material. Dates for exams are provided in the course schedule.

Course notebook. The *BIOL 4100/6100 Laboratory & Course Guide* will comprise the nucleus of the course notebook. Each student will be required to submit a course notebook, including all assigned diagrams and drawings, the results from any other laboratory assignments, and completed short answers and essays in the *Guide*. The course notebook should be maintained in a large three-ring binder, and is due at the beginning of the Final Examination period.

Course project. Each student will be required to complete a research project and to submit a written report on the results of her/his research. The report may be in the format of a poster or a research paper. A *brief* proposal for the research project is due at the beginning of the lecture period Tuesday, 26 January 2010. Projects are subject to the approval of the instructor and should be discussed well in advance of the proposal due date. If applicable, students are responsible for obtaining permission to access properties where their research will be conducted, for providing their own transportation to and from field sites, and for their safety and well-being while engaged in field research.

Grading. If a student thinks an error has been made in grading an examination, quiz, or any other assignment, s/he should communicate about this directly with the instructor *within one week* of the instructor's posting of the exam or grade in question or returning of the graded quiz or assignment. In determining the final course grade, a 10-point scale is normally used (i.e., 90–100=A; 80–89=B; 70–79=C; 60–69=D; <60=F) and the final course average calculated as follows.

Examinations	*60%*
Course notebook	*20%*
Course project	*20%*
Total	*100%*

Meeting the minimum point requirement for a letter grade does not necessarily assure that the student will receive that grade. Assignment of the final grade is the prerogative of the instructor and will be based upon each individual student's overall performance, including patterns of consistency, trends toward improvement, and attitude as shown through attendance, participation, and cooperation.

Access to laboratory. Students will be granted access to the General Botany Laboratory (BC 2040) after hours until 11:00 PM on weekdays and until 9:00 PM during weekends. Frequently, the outer door near the northeast corner of the Bailey Science Center is unlocked after hours; check this door first. If this and other outside doors to Bailey Science Center are locked, then students should contact the University Police Department or a university police officer and present a valid student identification card upon request in order to gain entry into the building. A numerical code will be provided by your instructor, which will enable access to the General Botany Laboratory. Access to the laboratory after hours is a privilege; it is not a right. If problems occur with regard to safety, security, neatness, or general order in the lab, then this privilege will be revoked. It is up to each student to see that materials, slides, microscopes, etc. are properly cared for and replaced for proper storage.

Students with disabilities. Students requiring class-room accommodations or modifications because of documented disabilities should discuss this need with their professor at the beginning of the semester. Disabled students who are not registered with the Access Office for Students with Disabilities should contact the Access Office, Farber Hall, telephone 229/245-2498 (V/VP) and 229/219-1348 (TTY).

Tentative Course Schedule with Assigned Readings

Week of Jan. 11	Introduction; The Divisions of Plant Science, BAD Chapt. 1; Superkingdom Eukaryonta and Kingdom Phyta (Plantae), BAD Chapt. 3; Division Hepatophyta, BAD Chapt. 11; Bryophytes, REE Chapt. 16 *Laboratory – Introduction and Division Hepatophyta*
Week of Jan. 18	Division Anthocerotophyta, BAD Chapt. 11 cont.; Bryophytes, REE Chapt. 16 *Laboratory – Division Anthocerophyta*
Week of Jan. 25	Division Bryophyta, BAD Chapt. 12; REE Bryophytes; Chapt. 16 Introduction to Vascular Plants, BAD Chapt. 13, REE Seedless Vascular Plants; Chapt. 17 *Laboratory – Division Bryophyta*
Week of Feb. 01	Division Microphyllophyta, BAD Chapt. 14; Division Arthrophyta, BAD Chapt. 15; Seedless Vascular Plants, REE Chapt. 17 *Laboratory – Field Trip*
Week of Feb. 08	Division Pteridophyta I, BAD Chapt. 16; Seedless Vascular Plants, REE Chapt. 17 ***Exam I – Thursday, 11 February 2010***
Week of Feb. 15	Division Pteridophyta II, BAD Chapt. 17; Seedless Vascular Plants, REE Chapt. 17 *Laboratory – Division Microphyllophyta (=Lycophyta)*
Week of Feb. 22	Division Pteridophyta III, BAD Chapt. 18; Division Psilotophyta, BAD Chapt. 19; Seedless Vascular Plants, REE Chapt. 17 *Laboratory – Division Arthrophyta (=Sphenophyta) & Division Psilotophyta (=Psilophyta)*
Week of Mar. 01	Vascular Cryptogams Recapitulation and Fossil Record, BAD Chapt. 20; REE Seedless Vascular Plants, Chapt. 17 *Midterm date: Thurs., 04 Mar.; last day to withdraw from course.* *Laboratory – Division Pteridophyta*
Week of Mar. 08	Introduction to Seed Plants; Division Cycadophyta, BAD Chapt. 21; Division Ginkgophyta, BAD Chapt. 22; REE Gymnosperms, Chapt. 18 ***Exam II – Thursday, 11 March 2010***
Week of Mar. 15	*Spring Break*
Week of Mar. 22	Division Coniferophyta, BAD Chapt. 23; REE Gymnosperms, Chapt. 18 *Laboratory – Field Trip*
Week of Mar. 29	Division Gnetophyta, BAD Chapt. 24; REE Gymnosperms, Chapt. 18 *Laboratory – Division Cycadophyta & Division Ginkgophyta*
Week of Apr. 05	Gymnosperms: Recapitulation and Fossil Record, BAD Chapt. 25; REE Gymnosperms, Chapt. 18 *Laboratory – Division Coniferophyta & Division Gnetophyta*
Week of Apr. 12	Division Anthophyta I, BAD Chapt. 26; REE Angiosperms I, Chapt. 19 *Laboratory – Division Anthophyta*
Week of Apr. 19	Division Anthophyta II, BAD Chapt. 27; REE Angiosperms II, Chapt. 20 *Laboratory – Division Anthophyta*
Week of Apr. 26	Division Anthophyta II (cont.) *Laboratory – Field Trip*
Week of May 03	Last class day ***Final Examination – Wednesday, 05 May, 10:15 AM – 12:15 PM***

BIOL 4900 – Senior Seminar **Spring Semester 2009**

Instructor: Dr. Carter
Office: BC 1105 or BC 1040
Telephone: 333-5759, ext. 5763

Schedule

Senior Seminar	Tuesday	2:00-3:50 pm	BC 2045
Science Seminar Series	Thursday	4:00-4:50 pm	Powell Hall Auditorium

Office Hours: Mon. 8:00-9:00 AM, Tues. 4:00-5:00 PM, Wed. 8:00-9:00 AM, Thurs. 3:00-4:00 PM; other times by appointment.

Use of WebCT Vista. WebCT will be used to facilitate communication between instructor and students and to disseminate various course materials and information pertaining to plagiarism and other aspects of the course. Students are expected to log onto WebCT daily to check for announcements and updates and to use WebCT Mail for all communication relating to the course.

Course Description. Pre- or Co-requisite: Completion of all required courses in the senior curriculum for the biology major. Graded "Satisfactory" or "Unsatisfactory." The capstone course in biology. Students are required to attend outside lectures chosen by the instructor. This course assesses students' ability to research independently topics in biology, assimilate the information, and disseminate the information in an organized and understandable fashion in both written and oral forms. Besides demonstrating comprehension of their topic and competence in communication skills, students take the ETS Major Field test in biology and complete the departmental Senior Exit Questionnaire for successful course completion. [0-3-**1**]

Course Objectives. The purpose of this course is to assess the student's ability to research topics in biology independently, to assimilate information, and to disseminate information logically in both written and oral form. Besides demonstrating comprehension of their topic and competence in communication skills, students must satisfactorily complete the ETS Major Field Test in biology and complete the departmental Senior Exit Questionnaire for successful completion of the course.

Course Outcomes. This course meets the following educational outcomes.
VSU General Education Outcomes 4, 7
Biology Educational Outcome 1

Major Field Test. The ETS Major Field Test is a comprehensive, standardized test designed to evaluate the student's general knowledge in the sub-disciplines of biology. The test scores will be used to evaluate the effectiveness of the department's curriculum, and VSU's scores will be compared to the national average to identify possible weak areas in our curriculum. Thus, students should take the test seriously and make every effort to excel on it. *Completion of the ETS Major Field Test with a* **score of 140 or higher** *is a course requirement, and students who fail to complete the ETS Major Field Test will receive a grade of unsatisfactory for the course.*

Each individual student is responsible for contacting the VSU Testing Office (Powell Hall-West, First Floor, Room 1120; Telephone 229-245-3878) and arranging a time to take the ETS Major Field Test in Biology. Students must complete the Major Field Test **by Friday, 06 February 2009**. A fee is assessed to take the Major Field Test. The Biology Department will pay the fee for each student to take the test once. Students who fail to score at least 140 on the test must re-take it until a score of 140 is achieved. The student will bear the cost for any re-taking of the Major Field Test.

Science Seminar Series. Attendance and completion of an evaluation form is required for six (6) seminars in the Science Seminar Series. Normally these seminars are held Thursdays at 4:00 PM. The schedule with time, date and venue may be found at the following Internet address:

http://www.valdosta.edu/cas/scisem/. Printable evaluation forms are made available through the course page on WebCT and should be printed out in advance by the student. *In order for the student to receive credit for attending a science seminar, it is the student's responsibility to see the instructor immediately after each seminar and submit her/his signed, completed evaluation form.*

Plagiarism. Recognition of and respect for the ownership of property is one of the distinguishing features of civilization. Ideas come from individuals and are effectively owned by their originators; thus, ideas are intellectual property. In the academic sphere, we frequently deal with the ideas of others, most often in published form. As with tangible property, intellectual property is subject to ownership and protection. Moreover, publication establishes ownership of intellectual property. It is essential that we respect the ideas and writing of others and that we scrupulously cite all sources of any and all ideas that are not our own.

Random House Webster's College Dictionary (2000) defines **plagiarism** as "the unauthorized use of the language and thoughts of another author and the representation of them as one's own." There are many forms of plagiarism. Perhaps the most blatant form is copying from some other source without citing that source. Other types of plagiarism include using a paper written by another and the improper citation of references. When paraphrasing, the author of the paraphrased material must be properly cited, and, when words are taken directly from another source, their author must be properly cited and the quotation must be placed within quotation marks for short quotations or in a separate paragraph with special indentation for longer quoted passages. [See note below on limitations of length for quoted passages.] Plagiarism is theft of intellectual property, and the simplest way to avoid plagiarism is to give credit where credit is due! For your guidance, access to several websites dealing with issues of plagiarism is provided through WebCT VISTA. Also, the following statement from the Writing Tutorial Services website at Indiana University is useful.

> To avoid plagiarism, you must give credit whenever you
> - use another person's idea, opinion, or theory;
> - use any facts, statistics, graphs, drawings – any pieces of information – that are not common knowledge;
> - quote another person's actual spoken or written words; or
> - paraphrase another person's spoken or written words.
>
> http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml; Copyright 2004; last updated 27 April 2004

It is imperative that the term paper be the student's own original work. Plagiarism will not be tolerated, and any student caught plagiarizing shall receive a failing grade on the term paper and a grade of unsatisfactory in the course. Please be forewarned that various web search engines will be used to check for plagiarism. *Each student will be required to read the VSU Biology Department's* Plagiarism Policy *and to sign a form to be kept on file with the department, indicating they have read and comprehend this policy.*

Grading

Students will be evaluated and their grade determined as follows:	
Participation in discussions and asking questions	10 points
Outline of term paper with references – due by 5:00 PM, Thurs., 26 Febr.	10 points
Oral presentation	40 points
Term paper – due at time of oral presentation	40 points
Total	100 points

Additionally, the course grade will be adversely affected as follows:	
Plagiarism will result in an automatic final grade of unsatisfactory.	
Each absence from scheduled class or presentation	-10 points
Each absence from the Science Seminar Series*	-10 points
Failure to score 140 or higher on Major Field Test	-40 points
Failure to complete Senior Exit Questionnaire	-40 points

*Students are required to attend at least six seminars. Points will be deducted for each absence less than the six required. Failure to submit a signed, completed evaluation form to the instructor immediately following the seminar will constitute an absence.

Final Grade:
Satisfactory (S) ≥70 points
Unsatisfactory (U) <70 points

Outline of Term Paper. An outline of the term paper, bibliography, and photocopies of most references are due by 5:00 PM, Thurs., 26 February. The outline should include title, general sections or subheadings of the paper, and a list of references properly formatted for the Literature Cited section. The following example has four levels.

- I. Introduction
  - A. History of knowledge about *Azolla-Anabaena* symbiosis
  - B. General nature of *Azolla-Anabaena* symbiosis
    - 1. Symbiosis vs. mutualism
    - 2. Extent of symbiosis within *Azolla*
      - i. Number of species
      - ii. Distribution of species
      - iii. Proportion of species exhibiting symbiosis with *Anabaena*
    - 3. Extent of symbiosis within *Anabaena*
      - i. Number of species
      - ii. Distribution of species
      - iii. Proportion of species exhibiting symbiosis with *Azolla*
  - C. Significance of *Azolla-Anabaena* symbiosis to humans
    - 1. Historical
    - 2. Current
  - D. Statement of specific points to be discussed
- II. Discussion
  - A. ………..

Term Paper. The term paper is due at the time of the scheduled presentation. In addition to hard copy, the term paper must be submitted as a Word file on a functional floppy disk or CD. Throughout, including the literature cited section, the term paper must be double-spaced, left-justified, and printed using 12-point Times New Roman font. Excluding the title page, each page must be numbered in the lower right corner, and margins must be one inch on all sides. Numbering of pages should begin with the first page of the Introduction. Excluding title page, tables and figures (if used) and literature cited, the body or text of the term paper must be no shorter than 10 pages and no longer 12 pages. Excessive margins (i.e., greater than one inch) and spacing will be deducted in determining whether the 10 page minimum requirement has been met.

The term paper should begin with a **Title Page** (un-numbered) that shall include the title of the paper, name of the author, course title and number, name of instructor, and the submission date. As is the case with a good story, the term paper should have a beginning (introduction), a middle (discussion), and an end (conclusion). Under the heading of **Introduction**, the body of the paper shall begin with a general introduction to the topic. The introduction should be a synthesis of the knowledge in the area of research and the principal questions that will be examined in the discussion section. Under the heading of **Discussion**, the introduction is followed by a detailed discussion of the subject containing references to specific scientific studies. The subject should be discussed in detail, with references cited where appropriate. Finally, under the heading of **Conclusion**, the body of the term paper concludes with a summary based upon the student's interpretation of the articles. Summarize the current state of knowledge on the topic, possibly suggesting additional kinds of research or analyses that might be done to explore the topic more fully or answer questions posed in the discussion section. Subheadings for each section may also be included as appropriate. The final section of the term paper is headed **Literature Cited** and *must include at least 10 published references, at least seven of which must be primary literature*, i.e., scientific articles from biological journals. Review articles are synthesized from the primary literature; however, they are not primary literature, but are more comparable with a textbook or a term paper. All references included in the literature cited section must be cited at least once in the body of the paper. Each reference must be cited at the end of the appropriate sentence or section by author's last name and year enclosed in parentheses. If used at all, tables and figures should be numbered sequentially and placed in order (tables before figures) after the literature cited section.

Further restrictions on numbers and types of references. No more than one textbook or review article may be used or cited. Web sites and web pages shall neither be used, nor cited as sources.

Restrictions on use of direct quotations. Direct quotations are to be avoided. *No direct quotation shall exceed five (5) words in length.* If used, direct quotations must be set off in quotation marks and the author and date cited immediately after the quotation. Also, be reminded that sources of all paraphrased material and any ideas originating from others must be properly cited.

Citation of References. Citations within the body of the paper should be enclosed within brackets, and should include the author's last name and the year of publication. The following are examples: (Cronquist, 1981); (McNaughton and Wolf, 1973); (Baker, 1965; Chase *et al.*, 2000; Petřík, 2003). All references, including textbooks, must be cited where appropriate in the body of the paper and listed in alphabetical order in the **Literature Cited** section at the end of the paper in one of the following formats.

<u>For books by a single author or a group of authors:</u>

Cronquist, A. 1981. *An integrated system of classification of flowering plants*. Columbia University Press, New York. 1262 pp.

McNaughton, S. J. and L. L. Wolf. 1973. *General ecology*. Holt, Rinehart and Winston, Inc. New York. 710 pp.

Reed, C. F. 1977. *Economically important foreign weeds*. Agriculture Handbook No. 498. United States Department of Agriculture. Washington, D.C. 746 pp.

<u>For chapters in books:</u>

Baker, H. G. 1965. Characteristics and modes of origin of weeds, Pp. 147-172, in: Baker, H. G. and G. L. Stebbins (Eds.), *The genetics of colonizing species*. Academic Press, NY.

Chase, M. W., D. E. Soltis, P. S. Soltis, P. J. Rudall, M. F. Fay, W. H. Hahn, S. Sullvan, J. Joseph, M. Molvray, P. J. Kores, T. J. Givnish, K. J. Sytsma and J. C. Pires. 2000. Higher-level systematics of the monocotyledons: an assessment of current knowledge and a new classification, Pp. 3-16, in: Wilson, K. L. and D. A. Morrison (Eds.), *Monocots: Systematics and evolution*. CSIRO Publishing, Collingwood, Victoria.

<u>For articles in periodicals:</u>

Petřík, P. 2003. *Cyperus eragrostis* – a new alien species for the Czech flora and the history of its invasion of Europe. *Preslia, Praha* 75:17-28.

Simpson, D. A. and C. A. Inglis. 2001. Cyperaceae of economic, ethnobotanical, and horticultural importance: a checklist. *Kew Bulletin* 56:257-360.

Miscellaneous Instructions. Before beginning your research, become proficient with the system required by your instructor for proper citation of references. When photocopying articles or other materials, use the models provided by your instructor as guides to write the full reference citation, properly formatted, at the top of the first page of photocopied material. Errors can be readily corrected with minimal difficulty, if a good sharpened pencil is used instead of a pen.

Bear in mind that the student is expected to read and comprehend all cited materials. As each source is read and studied, notes should be taken with proper documentation, including the full reference citation. Detailed and precise citation of page numbers for each quoted or paraphrased element is especially useful and essential documentation. Note cards or larger sheets are useful to keep track of notes and documentation. If your notes include direct quotations, then set these off using quotation marks to avoid errors of plagiarism later; see restrictions on the use of direct quotations above . All sources of information should be accurately and scrupulously recorded at this stage of your research to avoid errors of plagiarism.

Read from a variety of sources, fully documenting each on note cards or sheets of paper, and develop concepts as you go. Then synthesize these into a series of coherent sentences in your own words, citing all sources of information, data, or ideas within. *Procrastinators beware!* This requires time and effort and cannot be done effectively at the last minute.

Whenever possible, use primary sources. Also, be aware that the introductory sections of most journal articles include a short review of the research topic in which earlier works (usually primary sources) are cited. Although review articles and most books are secondary sources, they can provide easy entry into the body of literature on a topic. When the author of a review or book cites data, results, or ideas from an earlier work, then it is the student's responsibility to go to the original source, read it thoroughly and critically, and cite it.

Oral Presentation. Each student will be required to make an oral presentation on his/her research topic and will be allocated a total of 30 minutes for this presentation. Oral presentations are scheduled for the last few weeks for the semester, and each student will be assigned a date and time for her/his presentation shortly after the beginning of the term. During the first 20 minutes the student will stand and discuss the topic, and the remaining 10 minutes will be reserved for questions and general discussion. PowerPoint is recommended as the medium for oral presentations. It is the student's responsibility to insure that her/his presentation can be properly shown using the computer and projection system available, which means the student is responsible for testing the system and presentation at least several hours ***before*** beginning the scheduled presentation. Students must work closely with their instructor well in advance of the presentation to prevent last minute problems. Students are urged to practice their oral presentations prior to delivering the real thing to enable them to become comfortable, confident, and proficient. As a general rule, the oral presentation should follow the same outline and rules as the term paper. In particular, plagiarism rules apply equally to oral presentations. All sources of materials, including photographs, diagrams, graphs, etc., must be appropriately and completely cited. Literature citations for oral presentations should be done in the same manner as in the term paper, and the final slide(s) should show all of the literature used and cited. Immediately upon completing the presentation, each student should submit to the instructor her/his PowerPoint presentation saved to a CD.

Seminar Theme: *Evolutionary Patterns & Reproductive Processes in Kingdom Plantae*
Research topics are to be chosen from the following list. Each topic may be chosen by only one student and must be approved by the instructor.

1. Origin of kingdom Plantae
2. Phylogenetic placement of the hornworts
3. Why sexual reproduction and why oogamy?
4. Why alternation of generations?
5. Specializations facilitating sperm transfer in bryophytes
6. Sexual reproduction in liverworts: process, patterns, and evolution
7. Sexual reproduction in hornworts: process, patterns, and evolution
8. Evolution and significance of sporophyte dominance
9. Sexual reproduction in homosporous ferns: process, patterns, and evolution
10. Evolution and significance of heterospory
11. Do *Salvinia* have seeds?
12. Evolution, diversity, nutrition and function of subterranean gametophytes
13. Phylogenetic placement of the horsetails
14. Phylogenetic placement of the whiskferns
15. Sexual reproduction in *Selaginella*: process, patterns, and evolution
16. Sexual reproduction in *Isoetes*: process, patterns, and evolution
17. Seed ferns
18. Evolution and significance of the ovule
19. Evolution and significance of pollen and pollination
20. Is the ovulate cone of pine homologous with the megastrobilus of a cycad?
21. Why is Gymnospermae no longer treated as a formal taxonomic group?
22. Are gnetophytes ancestors of angiosperms?
23. What is a flower? Function and homology
24. Phylogenetic placement of the magnoliids
25. Phylogenetic placement of the waterlilies

Checklist of Course Requirements:

___Completion of the Major Field Test in Biology with a score of 140 or above

___Completion of Senior Exit Questionnaire

___Outline with references for term paper (due 5:00 PM, Thurs., 26 February)

___Oral presentation

___Term paper

___Attendance of all regularly scheduled class meetings including all student seminar presentations

___Attendance of and submission of completed evaluation forms for *at least six (6)* seminars in the Science Seminar Series

BIOL 4900 SENIOR SEMINAR COURSE SCHEDULE
Spring Semester 2009
Section A / Instructor: Dr. Carter

WEEK 1

TUESDAY, 13 JANUARY
Introduction to Course
Review of Syllabus and Course Requirements
Review of Plagiarism Policy
THURSDAY, 15 JANUARY
No Science Seminar this week

WEEK 2

TUESDAY, 20 JANUARY
2:00–3:50PM, Library Orientation – Ms. Laura Wright, **Odum Library, Room 3270**
This session begins promptly at 2:00 PM; please be on time.
THURSDAY, 15 JANUARY
No Science Seminar this week

WEEK 3

TUESDAY, 27 JANUARY
No class scheduled
THURSDAY, 29 JANUARY
*4:00–5:00 PM, Science Seminar Series, Powell Hall Auditorium

WEEK 4

TUESDAY, 03 FEBRUARY
No class scheduled
THURSDAY, 05 FEBRUARY
*4:00–5:00 PM, Science Seminar Series, Powell Hall Auditorium
Deadline for completing Major Field Test (Friday, 06 February – details in Course Syllabus)

WEEK 5

TUESDAY, 10 FEBRUARY
No class scheduled
THURSDAY, 12 FEBRUARY
*4:00–5:00 PM, Science Seminar Series, Powell Hall Auditorium

WEEK 6

TUESDAY, 17 FEBRUARY
No class scheduled
THURSDAY, 19 FEBRUARY
*4:00–5:00 PM, Science Seminar Series, Powell Hall Auditorium

WEEK 7

TUESDAY, 24 FEBRUARY
No class scheduled
THURSDAY, 26 FEBRUARY
*4:00–5:00 PM, Science Seminar Series, Powell Hall Auditorium
Outlines due (Thurs., 26 Feb.; see course syllabus for details)

WEEK 8

TUESDAY, 03 MARCH
No class scheduled
THURSDAY, 05 MARCH
*4:00–5:00 PM, Science Seminar Series, Powell Hall Auditorium
Midterm (05 March) – last day to withdraw without penalty

WEEK 9

TUESDAY, 10 MARCH
No class scheduled
THURSDAY, 12 MARCH
*4:00–5:00 PM, Science Seminar Series, Powell Hall Auditorium

SPRING BREAK WEEK: 16-20 March

Biology Department – College of Arts & Sciences – Valdosta State University

BIOL 7900 – Graduate Seminar — Fall Semester 2010

Instructor: Dr. Carter
Office: BC 1105
Telephone: (229) 333-5759, ext. 5763
e-mail: Please use the mail tool in BlazeVIEW.

Office Hours: BC 1040 or BC 1105
Tues, 2:00-4:00 PM; Wed, 10:00-11:00 AM; Thurs 8:00-9:00 AM; other times by appointment

Weekly Course Schedule
Thurs 4:00 – 4:50 PM, Science Seminar*
Thurs 5:00 – 6:50 PM, BC 1024

*Attendance of the weekly Science Seminar series is mandatory; it is the student's responsibility to check the schedule posted on-line to be certain of the venue, etc.

Course Description
Prerequisite: Acceptance into the graduate program in biology. Discussion and reports of current topics in biology and related sciences. Students are expected to demonstrate comprehension of topics and communication skills, both oral and written. Students must take this course twice for credit. This course may be repeated for a maximum of six times for credit. [0-3-**1**]

Course Objectives
- To broaden students' exposure to and knowledge of various areas of biology and related sciences.
- To provide opportunities for students to improve their oral and written communication skills.

Required Reading
All students must read the primary reference before each seminar. It is each student's responsibility to make her/his article available through Blazeview, as a pdf at least one week in advance. In some cases, articles will probably have to be scanned to make the pdf.

Use of BlazeView
BlazeView will be used to facilitate communication between instructor and students and to disseminate various course materials and information pertaining to plagiarism and other aspects of the course. Students are expected to log onto BlazeView daily to check for announcements and updates and to use BlazeView Mail for all communication relating to the course.

General Course Requirements:
Student seminars. Each student is required to prepare and present 2 seminars, both dealing with some aspect of biology – one in the research area of the student, the other in some other subdiscipline of biology. Each student seminar will be **40-45 minutes in duration**. A 10-15 minute question-and-answer/discussion period will follow each seminar. Sufficient, but brief, background material should be given to allow the class to understand the presentation. Please keep in mind that the students will already know something about the topic from having read the primary article. In addition to the primary article, the presenter must also provide a reasonably detailed discussion of at least two other supporting articles; normally these would be articles cited in the bibliography of the primary article. **Most importantly, the seminar must provide an in-depth coverage of the primary scientific article: the experiments or procedures performed, the results obtained, and the significance of the research. The methods used in the research should also be explained in general terms. Students must use PowerPoint software for their presentations, and a substantial number of the figures and/or tables from the formal scientific paper must be covered in detail during the seminar.** A copy of the PowerPoint presentation must be given to the instructor immediately after the seminar; this copy may be a printed copy (provided that it is legible) or an electronic copy on a CD or DVD. Please do NOT email your PowerPoint presentation to the instructor.

The order in which students select their articles and give their seminars will be determined by a lottery. Once a topic has been chosen, it cannot be changed. Students are strongly encouraged to read their primary scientific article critically before settling on a particular topic.

Participation in discussion. After each student has chosen his/her seminar topic, two to three students will volunteer to facilitate the discussion of each student's seminar. All students are encouraged to contribute meaningful questions and/or comments regularly to the discussions.

Written reports. Each student is required to complete **2 written reports**. These must be **stapled and 4 pages long**, including the cover sheet. Each report must be based on a primary scientific research article and supplementary references cited therein. The cover sheet must include the following: the course number and title, instructor's name, student's name, date, and complete citations for the primary scientific article and any secondary references used. Following the cover sheet, the first page of the report must give a summary of the article, and state what the student found most interesting about the article. The second and third pages of the report must cover some specific aspect of the primary article in detail. For example, a student might select a particular set of experiments for in-depth discussion. Alternatively, if the study used an interesting or novel method, the student might discuss this and how it was used in the study. *The report must be written in the student's own words. The policy on plagiarism is detailed in the following section. Students should be aware of plagiarism issues and the consequences of plagiarism.*

Reports must be typed in Times New Roman font 12 pt, double-spaced, and left justified, with one-inch margins on all sides of the page. Please do NOT number the pages—if the report is stapled this won't be necessary. Please remember to re-set the margins, since the default margins on many word-processing programs are different. For submission to the instructor, reports must be in printed, not electronic, form. Please do NOT email your reports to the instructor. Scientific articles should be cited using the following format.

Petřík, P. 2003. *Cyperus eragrostis* – a new alien species for the Czech flora and the history of its invasion of Europe. *Preslia* 75:17-28.

Plagiarism. Recognition of and respect for the ownership of property is one of the distinguishing features of civilization. Ideas come from individuals and are effectively owned by their originators; thus, ideas are intellectual property. In the academic sphere, we frequently deal with the ideas of others, most often in published form. As with tangible property, intellectual property is subject to ownership and protection. Moreover, publication establishes ownership of intellectual property. It is essential that we respect the ideas and writing of others and that we scrupulously cite all sources of any and all ideas that are not our own.

Random House Webster's College Dictionary (2000) defines **plagiarism** as "the unauthorized use of the language and thoughts of another author and the representation of them as one's own." There are many forms of plagiarism. Perhaps the most blatant form is copying from some other source without citing that source. Other types of plagiarism include using a paper written by another and the improper citation of references. When paraphrasing, the author of the paraphrased material must be properly cited, and, when words are taken directly from another source, their author must be properly cited and the quotation must be placed within quotation marks for short quotations or in a separate paragraph with special indentation for longer quoted passages. Plagiarism is theft of intellectual property, and the simplest way to avoid plagiarism is to give credit where credit is due! For your guidance, access to several websites dealing with issues of plagiarism is provided through BlazeView. Also, the following statement from the Writing Tutorial Services website at Indiana University is useful.

> To avoid plagiarism, you must give credit whenever you use
> - another person's idea, opinion, or theory;
> - any facts, statistics, graphs, drawings – any pieces of information – that are not common knowledge;
> - quotations of another person's actual spoken or written words; or
> - paraphrase of another person's spoken or written words.
>
> http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml; Copyright 2004; last updated 27 April 2004

It is imperative that your papers be your own original work. Plagiarism will not be tolerated, and any student caught plagiarizing shall receive a failing grade on the term paper and a grade of unsatisfactory in the course. Please be forewarned that various web search engines will be used to check for plagiarism. *Each student shall read and sign the VSU Biology Department's Plagiarism Policy, which can be found on-line through the link on the Biology Department homepage.*

Science Seminar Series. Students are required to attend the presentations of the Science Seminar series, which is scheduled on Thursdays from 4:00-4:50 pm. The Science Seminar schedule is posted online, and the link is provided below with the Course Schedule. It is the student's responsibility to check the posted schedule well in advance in order to know the venue and topic for each Science Seminar presentation. *Be on time and do not depart early unless there is an emergency! Points will be deducted for tardiness and unwarranted early departure.*

Attendance. Students are required to attend ALL student seminars. Missing two student seminars will result in a deduction of 100 points from a student's grade. Missing more than two student seminars will result in a failing grade in the course. Each student is required to attend at least 75% of the presentations given at the Science Seminar on Thursdays. Missing more than 25% of these seminars will result in a failing grade in the course. The Science Seminar schedule is posted online. Each student will complete a Seminar Evaluation Form for each seminar. These forms must be given to the instructor immediately after each seminar; they will be used as a record of each student's attendance.

Scheduling of student seminars. Due to time constraints, it is important that student seminars be given at the scheduled times. The instructor should be notified as soon as possible if an emergency occurs that prevents a student from being present at his/her seminar as scheduled. If a student fails to give her/his seminar at the scheduled time in the absence of a serious, documented emergency, 200 points will be deducted from the student's grade.

Grading. In order to respect the privacy of each student, grades will not be posted, sent by email, given out by telephone, or given to another person.

Allocation of points:

Seminar presentation #1	200 points
Seminar presentation #2	400 points
Written report #1	100 points
Written report #2	150 points
Participation in discussion	150 points
TOTAL	1000 points

Determination of final course grade:

A = 900-1000 points
B = 800-899 points
C = 700-799 points
D = 600-699 points
F = <600 points

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is prohibited during class or Science Seminars. If students bring cellular telephones or similar devices to class or Science Seminars, it is their responsibility to switch them off prior to the beginning of the session. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave class immediately.

Students with disabilities. Students requesting classroom accommodations or modifications because of a documented disability should discuss this need with the instructor at the beginning of the semester. These students must contact the Access Office for Students with Disabilities, 1115 Nevins Hall. The phone numbers are 245-2498 (voice) and 210-1348 (tty).

Miscellaneous. Students are advised to consult the VSU Student Handbook, Graduate Catalog, Fall Semester Calendar, Schedule of Classes, & Registration Guide for information about VSU policies and procedures regarding registration, drop/add, and withdrawal. The official Midterm date is provided below in the course schedule. Students are not permitted to withdraw after the Midterm date except in cases of hardship.

Course Schedule

Science Seminar Series. Students are required to attend the weekly Science Seminars. These seminars are held on Thursday afternoons at 4 pm, in the Student Union Theater, except for September 23rd when it will be held in the Union Ballroom. The Science Seminar schedule can be found on-line through the following link.

http://www.valdosta.edu/cas/scisem/Fall2010.shtml

This Course Schedule is tentative, and subject to modification as necessary. Students will be informed of any changes via BlazeView.

Thursday, Aug 19
General course information (handouts: syllabus, evaluation forms)

Thursday, Aug 26
Selection of topics for seminars and written reports; class discussion about effective Powerpoint slides and seminars

Thursday, Sep 2
Distribution of schedule for student seminars

Thursday, Sep 9
Instructor will meet with interested students to answer questions; attendance is optional

Thursday, Sep 16
Instructor led seminar 1

Thursday, Sep 23
Instructor led seminar 2

Thursday, Sep 30
Student seminar 1 (**Newsome**)
First written report is due.

Thursday, Oct 7 (*Midterm date – Oct. 7)*
Student seminars 2 (**Nichols**) and 3 (**Malik**)

Thursday, Oct 14
Student seminar 4 (**Adhikari**) and 5 (**Lasseter**)

Thursday, Oct 21
Student seminar 6 (**Bare**) and 7 (**Perry**)

Thursday, Oct 28
Student seminar 8 (**Newsome**) and 9 (**Nichols**)

Thursday, Nov 4
Student seminar 10 (**Malik**) and 11 (**Adhikari**)
Second written report is due.

Thursday, Nov 11
Student seminar 12 (**Lasseter**) and 13 (**Bare**)

Thursday, Nov 18
Student seminar 14 (**Perry**) and 15 (**Bare**)

Thanksgiving Holiday: Wed. – Fri., Nov. 24-26

Thursday, Dec 2
Student seminar 16

Biology Department – College of Arts & Sciences – Valdosta State University

PERS 2490 – HISTORY AND USE OF MEDICINAL PLANTS — MAYMESTER 2010

Instructor: Dr. Carter
Office: BC 1105 *Telephone:* 229/333-5759, ext. 5763
e-mail: Please use the mail tool in BlazeVIEW.

Office Hours: BC 1040 or BC 1105
Monday through Friday, 11:00 AM – 12:00 Noon
Other times by appointment

Weekly Course Schedule

Monday	Lecture	9:00 – 10:50 AM, BC 1025
Tuesday	Lecture	9:00 – 10:50 AM, BC 1025
Wednesday	Lecture	9:00 – 10:50 AM, BC 1025
Thursday	Lecture	9:00 – 10:50 AM, BC 1025
Friday	Lecture	9:00 – 10:50 AM, BC 1025

Course description. A brief history of medicinal plants from prehistory to the present. The course examines the use of herbal and non- timber forest products found locally and in different cultures and countries. The course defines social, economic, and ecological importance of botanicals worldwide along with exploring their biological uses and plant chemistry. Zoopharmacognosy is also introduced. **[2-0-2]**
Contact hours: 110 mins lecture X 15 lectures = 1650 mins (27.5 hrs)
Credit: 2 semester hrs

Course objectives. Upon completion of this course, the student will be able to:
1. identify plants and botanical products used medicinally during prehistory and during various historical periods;
2. describe plant chemicals and their botanical sources, which may be toxic or curative;
3. cite significant botanical discoveries of medicinal importance;
4. explain the significance of protecting medicinal biodiversity and knowledge;
5. explain how non-timber forest products affect social, economic, and ecological systems locally and in different cultures and countries; and
6. describe the implications of zoopharmacognosy.

Valdosta State University General Education Outcomes met by this course
Students will demonstrate cross-cultural perspectives and knowledge of other societies.
Students will express themselves clearly, logically, and precisely in writing and in speaking, and they will demonstrate competence in reading and listening.
Students will demonstrate the ability to analyze, to evaluate, and to make inferences from oral, written. and visual materials.

Required texts
Sumner, J. 2000. *The natural history of medicinal plants.* Timber Press: Portland, Oregon. ***(MP)***
Joseph, J. A., D. A. Nadeau, and A. Underwood. 2002. *The color code: A revolutionary eating plan for optimum health.* Hyperion: New York. ***(CC)***

Course Requirements and Policies

Use of BlazeVIEW as a course supplement. BlazeVIEW will be used to make a variety of course resources and materials available, to administer certain assignments and assessments, and to post announcements and grades. Students should log onto BlazeVIEW daily in order to check for course announcements and to take course assessments. Also, the Mail tool in BlazeVIEW provides a convenient means for students to contact one another and their instructor and is the preferred means of communicating about matters relating to the course. To access BlazeVIEW, select the BlazeVIEW link under Quick Links on the left side of the Valdosta State University homepage. Students experiencing technical difficulties using BlazeVIEW should seek assistance through the VSU Microcomputing & System Services HELP-Desk located in Odum Library (telephone 245-4357).

Academic integrity. Students are encouraged to work together and to learn from one another in an appropriate manner. Cooperation among students is especially encouraged in leading chapter discussions and in study outside of lecture. However, students should bear in mind that most work ultimately must be done individually and independently. All examinations and tests are given to students individually and are to be completed independently. Cooperation by students on tests or examinations is prohibited and constitutes cheating. Unless otherwise indicated, tests and examinations are taken strictly from memory without use of textbooks, notes, etc. Unless otherwise indicated, assignments are to be completed individually and independently. Behavior contrary to these guidelines and contrary to the VSU Code of Conduct is prohibited and constitutes cheating. Plagiarism and cheating will not be tolerated and will be prosecuted to the full extent allowed by University policy and the law. Refer to the Student Code of Conduct in the VSU *Student Handbook Volume III:*

http://www.valdosta.edu/studentaffairs/StudentHandbook.shtml.

Attendance, participation, and attitude. Regular attendance of all scheduled lectures and punctuality are expected. The student is responsible for all material missed regardless of the reason for absence. Normally, attendance will be taken during each scheduled lecture period.

Daily attendance and punctuality are essential, particularly because of the compressed nature of the Maymester schedule. Each three instances of unexcused tardiness will be counted as one absence. Tardiness will not be excused without a written explanation from the student and a determination by the instructor that the reason for tardiness is valid. Requests for excused tardiness must be submitted to the instructor in writing within 24 hours of the beginning of the period during which the student was late. It is the student's responsibility to initiate such requests. Any scheduling problems or other extenuating circumstances necessitating chronic tardiness should be explained to the instructor in writing and properly documented at the beginning of the semester.

In order to have an absence excused, the student must provide a written explanation with proper documentation immediately upon returning to class or laboratory. Based upon the written explanation and associated documentation, *the instructor will determine whether the reason for absence is valid* and will excuse absences accordingly.

In accordance with Valdosta State University Absence Regulations on page 90 of the *2009-2010 Undergraduate Catalog*, students absent from more than 20% of the regularly scheduled lecture periods are subject to failure in the course:

http://www.valdosta.edu/catalog/0910/ugrad/

Moveover, the final course grade may be lowered because of poor attendance, participation, or attitude.

Conduct. Students are expected to comport themselves courteously at all times during lecture. Disruptive behavior will not be tolerated, and students behaving in a disruptive manner will be removed from the classroom and referred to the Dean of Students for disciplinary action. Refer to the Student Code of Conduct in the VSU *Student Handbook Volume III:*

http://www.valdosta.edu/studentaffairs/StudentHandbook.shtml.

Students should be punctual for scheduled lecture. Except in special situations (i.e., emergency), students should not depart from lecture before being dismissed. If a student departs from lecture early, re-entry into the lecture room during the same period will not be permitted. Students anticipating early departure from lecture should inform their instructor of this prior to the beginning of lecture and seat themselves near an exit. Students are to direct their full attention to lecture and class discussions and are to refrain from unwarranted discourse. Behavior contrary to these guidelines is disruptive and may result in lowering of the final grade.

Valid identification. It is the student's responsibility to have her/his VSU identification card in his/her possession at all times during lecture and exam periods. Normally, each student will be asked to present her/his valid VSU photo-identification card in order to take an examination.

Consumption of food and drink. The distraction factor aside, food and drink in lecture present problems for maintenance of the building. Therefore, the consumption of food or drink (including water) is absolutely prohibited during lecture. Bear in mind that food items or drink containers on desks, tables, chairs, etc. in lecture rooms create the appearance that these items are being consumed and will be treated accordingly by your instructor.

Use of cellular telephones, pagers, and other such devices. Use of cellular telephones, pagers, or any similar remote communication device is not permitted during scheduled lectures, labs, or examinations. If students bring cellular telephones or similar devices to lecture, it is their responsibility to switch them off prior to the beginning of the lecture period. Ringing, buzzing, or any other sounds emitted from such devices will be treated as disruptive behavior on the part of the owner/possessor, and the owner/possessor will be asked to leave lecture or lab immediately.

General suggestions. Regular attendance of scheduled lecture and daily preparation and review are essential for success. Students should prepare for each lecture and discussion by reading the assigned sections from the textbook and any additional supplementary material made available by the instructor. Students should bring their textbooks to each scheduled lecture period, since content from the texts will be drawn upon during discussions. Notes should be taken regularly during discussions and should be used along with the texts to study for the final examination.

SPECIFIC COURSE REQUIREMENTS

***Class participation and discussion*.** Students are expected to participate in all classroom activities and to become actively engaged in class discussion. Evidence of engagement will include general contribution to classroom discussions, asking relevant questions, and responding appropriately to instructions and questions. Obviously, attendance of class and remaining awake during class are essential for class participation. Class participation and discussion account for 20% of the course grade, and points will be deducted for unexcused absence and tardiness.

***Chapter presentation*.** Each student will be assigned a chapter from one of the two texts and will be responsible for thoroughly and completely reviewing the chapter content, highlighting interesting, and important topics in the chapter, and leading a general class discussion on the content. Additional pertinent information may also be included. Creativity and the use of audio-visual aids are encouraged. Students will be graded on content, organization, and clarity of presentation. Thorough coverage of the chapter content is expected. If more than one student is assigned the same chapter, then they are expected to cooperate fully in all aspects of the chapter presentation. The chapter presentation accounts for 20% of the course grade.

***Oral report*.** Each student will make an individual oral report on a selected food, culinary herb or medicinal herb. The student will choose a fruit, nut, vegetable, culinary herb, medicinal herb, alga, or fungus with which s/he is unfamiliar, and conduct research to gain basic knowledge of and personal experience with this new plant and its medicinal properties to enhance human health. Each student will make a 10 minute oral presentation on her/his chosen plant, including a photograph or illustration, common name, scientific name, and family name, major chemical constituents, mechanism of action, historical or current use, growth habit (i.e., whether a tree, shrub, vine, or herb), part of the plant used (e.g., root, stem, leaf, etc.), dosage, how it was administered, and any side effects. Describe your sensory experiences consuming this new food item or culinary or medicinal herb, and your overall impression of the experience. The oral report accounts for 20% of the course grade.

***Daily journal*.** Students will be required to keep a daily journal. Journal entries will be posted via the Discussion tool in BlazeVIEW, and will be based upon the 3 – 2 – 1 assessment method. After class each day, students will post a journal entry related to the current day's lesson. Each journal entry will consist of **three (3) facts**, **two (2) concepts**, and **one (1) question**, relating to the day's lesson. In order to receive credit, each journal entry must be posted before 11:59 PM each day. Journal entries will be evaluated based upon completeness, relevance, and significance. Collectively, the journal entries account for 20% of the course grade.

***Final examination*.** One examination will be given during the final exam period. The final examination accounts for 20% of the course grade.

Grading. A 10-point scale is normally used (i.e., 90–100=A; 80–89=B; 70–79=C; 60–69=D; <60=F) in determining the final course grade, and the final course average calculated as follows.

Class participation and discussion	20%
Chapter presentation	20%
Daily journal	20%
Oral report	20%
Final examination	20%
Total	100%

Meeting the minimum point requirement for a letter grade does not necessarily assure that the student will receive that grade. Assignment of the final grade is the prerogative of the instructor and will be based upon each individual student's overall performance, including patterns of consistency, trends toward improvement, and attitude as shown through attendance, participation, and cooperation.

Students with disabilities. Students requiring classroom accommodations or modifications because of documented disabilities should discuss this need with their professor at the beginning of the semester. Disabled students who are not registered with the Access Office for Students with Disabilities should contact the Access Office, Farber Hall, telephone 229/245-2498 (V/VP) and 229/219-1348 (TTY).

Course Outline with Assigned Readings from Texts

Day 1: Thursday, 13 May
Orientation and introduction
What is a plant?
Basic plant classification
Basic structure of the plant body
The Hidden Power of Plants (video)

Day 2: Friday, 14 May
Introduction to the herbarium
MP, Chapter 1 – A Brief History of Medicinal Botany

Day 3: Monday, 17 May
MP, Chapter 2 – Acquiring Knowledge

Day 4: Tuesday, 18 May
MP, Chapter 3 – Medicinal Plants in Nature

Day 5: Wednesday, 19 May
MP, Chapter 4 – Toxins and Cures

Day 6: Thursday, 20 May
MP, Chapter 5 – Defensive Strategies and Plant Chemistry

Day 7: Friday, 21 May
MP, Chapter 6 – Significant Discoveries

Day 8: Monday, 24 May
MP, Chapter 7 – Zoopharmacognosy and Botanical Toxins
Midterm – last day to withdraw

Day 9: Tuesday, 25 May
MP, Chapter 8 – Chemical Prospecting and New Plant Medicines

Day 10: Wednesday, 26 May
MP, Chapter 9 – Protecting Medicinal Biodiversity and Knowledge
MP, Chapter 10 – Herbal Histories, Considerations, and Caveats

Day 11: Thursday, 27 May
CC, Chapter 1 – Think Health – Think Color!

Day 12: Friday, 28 May
CC, Chapter 2 – Red

Day 13: Monday, 31 May
Memorial Day Holiday

Day 14: Tuesday, 01 June
CC, Chapter 3 – Orange-Yellow

Day 15: Wednesday, 02 June
CC, Chapter 4 – Green

Day 16: Thursday, 03 June
CC, Chapter 6 – The Color Code Eating Program
CC, Chapter 7 – The Truth in Black and White

Final Exam
Friday, 04 June: 8:00-10:00 AM

Appendix B. Results of Student Opinion of Instruction (SOI) surveys for the most recent two years, 2009-2010.

TERM	COURSE NUMBER	NEW PREPARATION*	ENROLLMENT	AVERAGE SOI
Spring 2009	BIOL 3650	YES	9	Items 1-15: 4.51 (N=6)
Spring 2009	BIOL 4900	NO	20	Items 1-14: 3.82 (N=19)
Fall 2009	BIOL 2230A	NO	20	Items 1-15: 4.29 (N=12)
Fall 2009	BIOL 2230B	NO	20	Items 1-15: 4.27 (N=12)
Fall 2009	BIOL 4950	NO	1	Not applicable
Spring 2010	BIOL 2230	NO	25	Items 1-15: 4.25 (N=18)
Spring 2010	BIOL 4100	YES	10	Items 1-15: 4.53 (N=9)
Spring 2010	BIOL 6100	YES	2	Items 1-15: 4.71 (N=1)
Summer 2010	PERS 2490	YES	29	Items 1-14: 3.99 (N=27)
Fall 2010	BIOL 4010	YES	12	Items 1-15: 4.83 (N=9)
Fall 2010	BIOL 6010	YES	1	Not applicable
Fall 2010	BIOL 7900	NO	7	Items 1-14: 4.64 (N=2)

*New Preparation is defined as a course taught for the first time or a course which has not been taught for a period of three years.

Beginning
Spring 2009

DEPARTMENT OF BIOLOGY

LAB INSTRUCTOR/LAB COURSE EVALUATION FORM

DIRECTIONS: This questionnaire gives you the opportunity to express your views of this course and the way it was taught. DO NOT PUT YOUR NAME ON THIS FORM OR THIS ANSWER SHEET. Your responses are anonymous, and the instructor will see the results only after final grades have been turned in at the end of the quarter.

1st. You will be given instructions about identifying the course and the instructor on the left side of the Answer Sheet. This will include the subject prefix plus course and CRN numbers (i.e. BIOL 1108-80242

2nd. As you answer the questions below be aware that successful learning requires effort by both the instructor and students. Please answer these questions on the scantron sheet from 5 (strongly agree). 4 (agree). 3 (neutral). 2 (disagree). 1 (strongly disagree).

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1. Course assignments were clearly explained in the syllabus or other handouts.
2. Course policies (for example. Attendance, late papers) were clearly explained in the syllabus or other handouts.
3. The instructor was well prepared for class.
4. The instructor made effective use of class time to cover course content.
5. Course assignments were returned in a timely manner.
6. The instructor explained grading criteria (for example, grammar, content) clearly.
7. The instructor was willing to discuss course related issues either in person or by email/telephone.
8. The instructor responded to student questions on course material in a professional manner.
9. This course increased my knowledge of the topic.
10. This course helped me further develop my academic skills (for example, reading, writing, speaking, critical analysis, performance, artistic abilities, etc.)
11. Instructor knows course material.
12. Instructor explains the material effectively.
13. Examinations or other assignments covered the course material.
14. The course was challenging.
15. The laboratory contributed to your learning of course material.

16. Please indicate your student classification. (1) = Freshman, (2) = Sophomore, (3) = Junior, (4) = Senior, (5) = Graduate.
17. Indicate how much time per week you spend on this course outside of class and laboratory. (1) = 0-1 hr. (2) = 2-4 hrs. (3) = 5-7 hrs. (4) = 8-10 hrs. (5) = 10+ hrs.
18. Indicate your final grade you expect to receive in this course.
    (1) = A, (2) = B, (3) = C, (4) = D, (5) = F.

19. I missed class __ times. (1) =Never. (2) = 1-5. (3) = 6-10 . (4) = 11-15. (5) = 16+

---

1. WHAT WERE THE BEST FEATURES ABOUT THIS COURSE?

2. WHAT ARE YOUR INSTRUCTOR'S STRENGTHS?

3. WHAT SUGGESTION WOULD YOU GIVE YOUR INSTRUCTOR FOR IMPROVING THE COURSE?

Beginning
Spring 2009

DEPARTMENT OF BIOLOGY

LECTURE INSTRUCTOR/LECTURE COURSE EVALUATION FORM

DIRECTIONS: This questionnaire gives you the opportunity to express your views of this course and the way it was taught. DO NOT PUT YOUR NAME ON THIS FORM OR THIS ANSWER SHEET. Your responses are anonymous, and the instructor will see the results only after final grades have been turned in at the end of the quarter.

1st. You will be given instructions about identifying the course and the instructor on the left side of the Answer Sheet. This will include the subject prefix plus course and CRN numbers (i.e. BIOL 1108-80242)

2nd. As you answer the questions below be aware that successful learning requires effort by both the instructor and students. Please answer these questions on the scantron sheet from 5 (strongly agree). 4 (agree). 3 (neutral). 2 (disagree). 1 (strongly disagree).

---

1. Course assignments were clearly explained in the syllabus or other handouts.
2. Course policies (for example. attendance, late papers) were clearly explained in the syllabus or other handouts.
3. The instructor was well prepared for class.
4. The instructor made effective use of class time to cover course content.
5. Course assignments were returned in a timely manner.
6. The instructor explained grading criteria (for example, grammar, content) clearly.
7. The instructor was willing to discuss course-related issues either in person or by email/telephone.
8. The instructor responded to student questions on course material in a professional manner.
9. This course increased my knowledge of the topic.
10. This course helped me further develop my academic skills (for example, reading, writing, speaking, critical analysis, performance, artistic abilities, etc.)
11. Instructor knows course material.
12. Instructor explains the material effectively.
13. Examinations or other assignments covered the course material.
14. The course was challenging.
15. Please indicate your student classification. (1) = Freshman, (2) = Sophomore, (3) = Junior, (4) = Senior, (5) = Graduate.

16. Please indicate your student classification. (1) = Freshman, (2) = Sophomore, (3) = Junior, (4) = Senior, (5) = Graduate.
17. Indicate how much time per week you spend on this course outside of class and laboratory. (1) = 0-1 hr. (2) = 2-4 hrs. (3) = 5-7 hrs. (4) = 8-10 hrs. (5) = 10+ hrs.
18. Indicate your final grade you expect to receive in this course. (1) = A, (2) = B, (3) = C, (4) = D, (5) = F.
19. I missed class __ times. (1) =Never. (2) = 1-5. (3) = 6-10 . (4) = 11-15. (5) = 16+

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1. WHAT WERE THE BEST FEATURES ABOUT THIS COURSE?

2. WHAT ARE YOUR INSTRUCTOR'S STRENGTHS?

3. WHAT SUGGESTION WOULD YOU GIVE YOUR INSTRUCTOR FOR IMPROVING THE COURSE?

Spring Term 2009 BIOL3650 A Plant Systematics (Crn: 20592)

Carter, J Richard

Response Distribution (Count/Percent)

Qst	Mean	StdDev	Resp	Resp-A (1)	Resp-B (2)	Resp-C (3)	Resp-D (4)	Resp-E (5)	Blanks
1	4.50	0.84	6	0/ 0.00	0/ 0.00	1/ 16.67	1/ 16.67	4/ 66.67	0/ 0.00
2	4.50	0.55	6	0/ 0.00	0/ 0.00	0/ 0.00	3/ 50.00	3/ 50.00	0/ 0.00
3	4.83	0.41	6	0/ 0.00	0/ 0.00	0/ 0.00	1/ 16.67	5/ 83.33	0/ 0.00
4	4.83	0.41	6	0/ 0.00	0/ 0.00	0/ 0.00	1/ 16.67	5/ 83.33	0/ 0.00
5	4.50	0.55	6	0/ 0.00	0/ 0.00	0/ 0.00	3/ 50.00	3/ 50.00	0/ 0.00
6	4.17	0.75	6	0/ 0.00	0/ 0.00	1/ 16.67	3/ 50.00	2/ 33.33	0/ 0.00
7	4.33	0.82	6	0/ 0.00	0/ 0.00	1/ 16.67	2/ 33.33	3/ 50.00	0/ 0.00
8	3.67	1.75	6	1/ 16.67	1/ 16.67	0/ 0.00	1/ 16.67	3/ 50.00	0/ 0.00
9	4.83	0.41	6	0/ 0.00	0/ 0.00	0/ 0.00	1/ 16.67	5/ 83.33	0/ 0.00
10	4.33	0.82	6	0/ 0.00	0/ 0.00	1/ 16.67	2/ 33.33	3/ 50.00	0/ 0.00
11	4.83	0.41	6	0/ 0.00	0/ 0.00	0/ 0.00	1/ 16.67	5/ 83.33	0/ 0.00
12	4.33	0.82	6	0/ 0.00	0/ 0.00	1/ 16.67	2/ 33.33	3/ 50.00	0/ 0.00
13	4.67	0.52	6	0/ 0.00	0/ 0.00	0/ 0.00	2/ 33.33	4/ 66.67	0/ 0.00
14	4.67	0.82	6	0/ 0.00	0/ 0.00	1/ 16.67	0/ 0.00	5/ 83.33	0/ 0.00
15	4.67	0.82	6	0/ 0.00	0/ 0.00	1/ 16.67	0/ 0.00	5/ 83.33	0/ 0.00
16	3.33	0.82	6	0/ 0.00	1/ 16.67	2/ 33.33	3/ 50.00	0/ 0.00	0/ 0.00
17	3.33	0.52	6	0/ 0.00	0/ 0.00	4/ 66.67	2/ 33.33	0/ 0.00	0/ 0.00
18	1.83	0.75	6	2/ 33.33	3/ 50.00	1/ 16.67	0/ 0.00	0/ 0.00	0/ 0.00
19	2.17	0.75	6	1/ 16.67	3/ 50.00	2/ 33.33	0/ 0.00	0/ 0.00	0/ 0.00
20	0.00	0.00	0	0/ 0.00	0/ 0.00	0/ 0.00	0/ 0.00	0/ 0.00	6/100.00
Questions 1 thru 3									
	4.61	0.61	18	0/ 0.00	0/ 0.00	1/ 5.56	5/ 27.78	12/ 66.67	0/ 0.00
Questions 4 thru 13									
	4.45	0.83	60	1/ 1.67	1/ 1.67	4/ 6.67	18/ 30.00	36/ 60.00	0/ 0.00
Questions 14 thru 20									
	3.33	1.31	36	3/ 7.14	7/ 16.67	11/ 26.19	5/ 11.90	10/ 23.81	6/ 14.29

Note: Qst - Question number
Resp - Number of responses in Mean
Mean - Average, excluding blanks
StdDev - Standard Deviation of Mean

Blanks are NOT used in calculating the Mean, Resp or StdDev

20592
BIOL 3650 A
Plant Systematics
J Carter Richard 15

WHAT WERE THE BEST FEATURES ABOUT THIS COURSE?

1. I enjoyed the practical application and being able to walk down the street and identify the store.
2. The practical use of knowledge that we received. Lecture was reinforced in the lab as well as on field trips. I was able to learn and understand most of the material.
3. Field trips, LAB.
4. It was practical. You get hands on experience.

WHAT WERE YOUR INSTRUCTORS STRENGTHS?

1. He is very knowledgeable in the course and extremely passionate about the course.
2. His way of teaching. Sometimes I was a little overwhelmed/intimidated. However you better believe that this made me learn. I felt like I was in high school again, the way we were taught & the hands on experience. I believe that this was a good thing.
3. Botany
4. He knows the subject really well.

WHAT SUGGESTION WOULD YOU GIVE YOUR INSTRUCTOR FOR IMPROVING THE COURSE?

1. Start the plant collection sooner in the semester, it has difficult to find time with school and work. Then give long assignments right at the beginning of Finals week. The actual assignment is not tough but very time consuming.
2. I guess just keep up the good work.
3. More field trips

Carter, J Richard

Qst	Mean	StdDev	Resp	Resp-A (1)	Resp-B (2)	Resp-C (3)	Resp-D (4)	Resp-E (5)	Blanks
				Response Distribution (Count/Percent)					
1	4.26	1.15	19	1/ 5.26	1/ 5.26	1/ 5.26	5/ 26.32	11/ 57.89	0/ 0.00
2	4.11	1.33	19	2/ 10.53	0/ 0.00	3/ 15.79	3/ 15.79	11/ 57.89	0/ 0.00
3	4.11	1.33	19	2/ 10.53	0/ 0.00	3/ 15.79	3/ 15.79	11/ 57.89	0/ 0.00
4	4.05	1.31	19	2/ 10.53	0/ 0.00	3/ 15.79	4/ 21.05	10/ 52.63	0/ 0.00
5	3.50	1.34	18	2/ 10.53	1/ 5.26	7/ 36.84	2/ 10.53	6/ 31.58	1/ 5.26
6	3.89	1.37	19	2/ 10.53	1/ 5.26	3/ 15.79	4/ 21.05	9/ 47.37	0/ 0.00
7	3.44	1.58	18	4/ 21.05	0/ 0.00	5/ 26.32	2/ 10.53	7/ 36.84	1/ 5.26
8	3.26	1.48	19	4/ 21.05	1/ 5.26	5/ 26.32	4/ 21.05	5/ 26.32	0/ 0.00
9	3.32	1.29	19	2/ 10.53	4/ 21.05	2/ 10.53	8/ 42.11	3/ 15.79	0/ 0.00
10	3.58	1.26	19	2/ 10.53	2/ 10.53	2/ 10.53	9/ 47.37	4/ 21.05	0/ 0.00
11	4.11	1.33	19	2/ 10.53	0/ 0.00	3/ 15.79	3/ 15.79	11/ 57.89	0/ 0.00
12	3.94	1.06	18	0/ 0.00	1/ 5.26	7/ 36.84	2/ 10.53	8/ 42.11	1/ 5.26
13	3.94	1.16	18	1/ 5.26	0/ 0.00	6/ 31.58	3/ 15.79	8/ 42.11	1/ 5.26
14	4.00	1.15	19	1/ 5.26	0/ 0.00	6/ 31.58	3/ 15.79	9/ 47.37	0/ 0.00
15	3.61	1.14	18	1/ 5.26	0/ 0.00	10/ 52.63	1/ 5.26	6/ 31.58	1/ 5.26
16	4.00	0.00	17	0/ 0.00	0/ 0.00	0/ 0.00	17/ 89.47	0/ 0.00	2/ 10.53
17	2.06	0.75	17	3/ 15.79	11/ 57.89	2/ 10.53	1/ 5.26	0/ 0.00	2/ 10.53
18	1.25	0.58	16	13/ 68.42	2/ 10.53	1/ 5.26	0/ 0.00	0/ 0.00	3/ 15.79
19	1.00	0.00	16	16/ 84.21	0/ 0.00	0/ 0.00	0/ 0.00	0/ 0.00	3/ 15.79
20	0.00	0.00	0	0/ 0.00	0/ 0.00	0/ 0.00	0/ 0.00	0/ 0.00	19/100.00

	Mean	StdDev	Resp	Resp-A (1)	Resp-B (2)	Resp-C (3)	Resp-D (4)	Resp-E (5)	Blanks
Questions 1 thru 3	4.16	1.25	57	5/ 8.77	1/ 1.75	7/ 12.28	11/ 19.30	33/ 57.89	0/ 0.00
Questions 4 thru 13	3.70	1.33	186	21/ 11.05	10/ 5.26	43/ 22.63	41/ 21.58	71/ 37.37	4/ 2.11
Questions 14 thru 20	2.72	1.48	103	34/ 25.56	13/ 9.77	19/ 14.29	22/ 16.54	15/ 11.28	30/ 22.56

Note: Qst - Question number
Resp - Number of responses in Mean
Mean - Average, excluding blanks
StdDev - Standard Deviation of Mean

Blanks are NOT used in calculating the Mean, Resp or StdDev

20602
BIOL 4900 A
Senior Seminar
J Carter Richard 20

WHAT WERE THE BEST FEATURES ABOUT THIS COURSE?

1. Learning the different characteristics or aspects in a variety of species.
2. Nothing
3. It's my last one!
4. The best features were that we all learned from each other.
5. Dr. Carter knows his stuff and all requirements were made crystal clear!
6. None.
7. There were none. This course was a complete waste of time and money. It in no way exemplified what was learned during the four year as an undergraduate student.

WHAT WERE YOUR INSTRUCTORS STRENGTHS?

1. He really knows the material
2. I am now confident in myself that I can research a topic, wide a paper and present it.
3. He knows his material
4. Knowledge of topic
5. Make sure you are thorough as a presenter.
6. He knows his material well, yet he was not very great at passing it on. He treated everyone like he was better instead of like humans.
7. Very knowledgable on the subject of plants.
8. See above (Dr. Carter knows his stuff and all requirements were made crystal clear!)
9. He knew material.
10. The instructor is knowledgeable about botany. And just because he is doesn't mean that everyone else is an expert like him, and we shouldn't be penalized For not knowing things in such detail as he does.
11. He knows the discipline of Botany extremely well.

WHAT SUGGESTION WOULD YOU GIVE YOUR INSTRUCTOR FOR IMPROVING THE COURSE?

1. Try to exhibit a positive attitude at all times. There have been many times when the instructor had a negative, unprofessional attitude and manner towards the students.
2. Smile more.
3. Be nicer &don't ask so many questions!!
4. Allow student s to choose the topic within all of biology. A very sew minority we interested in the assigned topics.
5. Dr. Carter's approach to students is a little harsh. The subject matter is difficult enough, but joined with his attitude it's even more difficult.
6. Return papers back some and let student know if they passed as failed. If they failed they would need to know to sign up for another smile seminar.
7. Let us pick our own topic for our paper & presentation, that way we can choose a topic that we understand and are not totally clueless about.

8. Let the students choose their own topic that way they will be interested & knowledgeable And if not then donot personalize them for not being as knowledgeable about your discipline as a professor. Also being willing to help students & not make them feel inadequate.

Carter, J Richard

Qst	Mean	StdDev	Resp	Resp-A (1)	Resp-B (2)	Resp-C (3)	Resp-D (4)	Resp-E (5)	Blanks
				Response Distribution (Count/Percent)					
1	4.33	0.98	12	0/ 0.00	1/ 8.33	1/ 8.33	3/ 25.00	7/ 58.33	0/ 0.00
2	4.75	0.45	12	0/ 0.00	0/ 0.00	0/ 0.00	3/ 25.00	9/ 75.00	0/ 0.00
3	4.58	0.51	12	0/ 0.00	0/ 0.00	0/ 0.00	5/ 41.67	7/ 58.33	0/ 0.00
4	4.50	0.52	12	0/ 0.00	0/ 0.00	0/ 0.00	6/ 50.00	6/ 50.00	0/ 0.00
5	4.25	0.62	12	0/ 0.00	0/ 0.00	1/ 8.33	7/ 58.33	4/ 33.33	0/ 0.00
6	3.83	1.11	12	0/ 0.00	2/ 16.67	2/ 16.67	4/ 33.33	4/ 33.33	0/ 0.00
7	4.08	1.00	12	0/ 0.00	1/ 8.33	2/ 16.67	4/ 33.33	5/ 41.67	0/ 0.00
8	3.58	1.24	12	1/ 8.33	0/ 0.00	6/ 50.00	1/ 8.33	4/ 33.33	0/ 0.00
9	4.33	0.65	12	0/ 0.00	0/ 0.00	1/ 8.33	6/ 50.00	5/ 41.67	0/ 0.00
10	3.82	0.75	11	0/ 0.00	0/ 0.00	4/ 33.33	5/ 41.67	2/ 16.67	1/ 8.33
11	4.75	0.62	12	0/ 0.00	0/ 0.00	1/ 8.33	1/ 8.33	10/ 83.33	0/ 0.00
12	4.08	1.00	12	0/ 0.00	1/ 8.33	2/ 16.67	4/ 33.33	5/ 41.67	0/ 0.00
13	4.58	0.51	12	0/ 0.00	0/ 0.00	0/ 0.00	5/ 41.67	7/ 58.33	0/ 0.00
14	4.75	0.45	12	0/ 0.00	0/ 0.00	0/ 0.00	3/ 25.00	9/ 75.00	0/ 0.00
15	4.08	0.79	12	0/ 0.00	0/ 0.00	3/ 25.00	5/ 41.67	4/ 33.33	0/ 0.00
16	3.25	0.87	12	0/ 0.00	2/ 16.67	6/ 50.00	3/ 25.00	1/ 8.33	0/ 0.00
17	2.58	1.00	12	1/ 8.33	5/ 41.67	5/ 41.67	0/ 0.00	1/ 8.33	0/ 0.00
18	2.00	0.74	12	3/ 25.00	6/ 50.00	3/ 25.00	0/ 0.00	0/ 0.00	0/ 0.00
19	1.50	0.53	10	5/ 41.67	5/ 41.67	0/ 0.00	0/ 0.00	0/ 0.00	2/ 16.67
Questions 1 thru 19									
	3.90	1.17	225	10/ 4.39	23/ 10.09	37/ 16.23	65/ 28.51	90/ 39.47	3/ 1.32

Note: Qst - Question number
Resp - Number of responses in Mean
Mean - Average, excluding blanks
StdDev - Standard Deviation of Mean

Blanks are NOT used in calculating the Mean, Resp or StdDev

81587
BIOL 2230 A
General Botany
R. Carter

Lab Course Evaluation

1. WHAT WERE THE BEST FEATURES ABOUT THIS COURSE?
   - It helped my overall understanding of biology.
   - The online quizzes were great study guides, the lab was well prepared and helped in the learning of new material.
   - The material was well covered and repeated for retention.
   - The hands on lab
   - It gave a clear presentation of basic botany.
   - More knowledge of this area of biology
   - Very thorough and repetitive in a good way. Content builds on itself and carries over to the next lab/lecture.
   - Learn everything in detail
2. WHAT ARE YOUR INSTRUCTOR'S STRENGTHS?
   - He knows his field well.
   - Knowledge of material
   - Explaining topics in an understandable way. He has a strong knowledge of the material and when presented with a question he doesn't have the answer to he admits it and finds someone with the answer.
   - Knowledge of the material.
   - Knowledge and enthusiasm about the course
   - Method of teaching; attention to detail and effort
   - Knowledge of material, the way he explains material
   - Thorough knowledge of content presented. Dr. Carter loves plants, so there is no way we can't learn anything.
   - Explaining stuff over and over.
3. WHAT SUGGESTION WOULD YOU GIVE YOUR INSTRUCTOR FOR IMPROVING THE COURSE?
   - Respect your students more. Though I enjoyed the material I hated coming to class because you are a bit rude in how you talk down to us. Yes, you are smarter but maybe not wiser.
   - It's hard to pay attention in lecture. It needs to more interesting and teacher less monotone when speaking.
   - Great course!

Fall Term 2009 BIOL2230 B General Botany (Crn: 81588)

Carter, J Richard

Response Distribution (Count/Percent)

Qst	Mean	StdDev	Resp	Resp-A (1)	Resp-B (2)	Resp-C (3)	Resp-D (4)	Resp-E (5)	Blanks
1	4.42	1.16	12	1/ 8.33	0/ 0.00	0/ 0.00	3/ 25.00	8/ 66.67	0/ 0.00
2	4.58	1.16	12	1/ 8.33	0/ 0.00	0/ 0.00	1/ 8.33	10/ 83.33	0/ 0.00
3	4.58	1.16	12	1/ 8.33	0/ 0.00	0/ 0.00	1/ 8.33	10/ 83.33	0/ 0.00
4	4.58	1.16	12	1/ 8.33	0/ 0.00	0/ 0.00	1/ 8.33	10/ 83.33	0/ 0.00
5	3.92	1.31	12	1/ 8.33	1/ 8.33	1/ 8.33	4/ 33.33	5/ 41.67	0/ 0.00
6	4.08	1.38	12	1/ 8.33	1/ 8.33	1/ 8.33	2/ 16.67	7/ 58.33	0/ 0.00
7	3.92	1.51	12	2/ 16.67	0/ 0.00	1/ 8.33	3/ 25.00	6/ 50.00	0/ 0.00
8	3.92	1.51	12	2/ 16.67	0/ 0.00	1/ 8.33	3/ 25.00	6/ 50.00	0/ 0.00
9	4.33	1.15	12	1/ 8.33	0/ 0.00	0/ 0.00	4/ 33.33	7/ 58.33	0/ 0.00
10	3.92	0.90	12	0/ 0.00	1/ 8.33	2/ 16.67	6/ 50.00	3/ 25.00	0/ 0.00
11	4.50	1.17	12	1/ 8.33	0/ 0.00	0/ 0.00	2/ 16.67	9/ 75.00	0/ 0.00
12	4.17	1.34	12	1/ 8.33	1/ 8.33	0/ 0.00	3/ 25.00	7/ 58.33	0/ 0.00
13	4.50	1.17	12	1/ 8.33	0/ 0.00	0/ 0.00	2/ 16.67	9/ 75.00	0/ 0.00
14	4.33	1.23	12	1/ 8.33	0/ 0.00	1/ 8.33	2/ 16.67	8/ 66.67	0/ 0.00
15	4.25	1.29	12	1/ 8.33	0/ 0.00	2/ 16.67	1/ 8.33	8/ 66.67	0/ 0.00
16	3.08	1.00	12	1/ 8.33	2/ 16.67	4/ 33.33	5/ 41.67	0/ 0.00	0/ 0.00
17	3.08	1.24	12	1/ 8.33	3/ 25.00	4/ 33.33	2/ 16.67	2/ 16.67	0/ 0.00
18	2.00	0.85	12	3/ 25.00	7/ 58.33	1/ 8.33	1/ 8.33	0/ 0.00	0/ 0.00
19	1.67	0.65	12	5/ 41.67	6/ 50.00	1/ 8.33	0/ 0.00	0/ 0.00	0/ 0.00

Questions 1 thru 19

	Mean	StdDev	Resp	Resp-A (1)	Resp-B (2)	Resp-C (3)	Resp-D (4)	Resp-E (5)	Blanks
	3.89	1.41	228	26/ 11.40	22/ 9.65	19/ 8.33	46/ 20.18	115/ 50.44	0/ 0.00

Note: Qst - Question number
Resp - Number of responses in Mean
Mean - Average, excluding blanks
StdDev - Standard Deviation of Mean

Blanks are NOT used in calculating the Mean, Resp or StdDev

81588
BIOL 2230B
General Botany
R. Carter

Lab Course Evaluation

1. WHAT WERE THE BEST FEATURES ABOUT THIS COURSE?
    - Lab activities
    - It satisfied a requirement
    - It was fun. The best feature is the lab handling real world examples of what we're studying in lecture establishes a new perspective .. ties it all together.
    - The assessments help students say on task with what they learned on a special section.
    - The best features about this class were nothing.
    - Laboratory exercises
    - Repetition of material
    - Being able to learn the basics about the plant life around us and its importance in our lives. Understanding basics about the structures and names of plants.
    - Learning to incorporate school work into everyday life.
2. WHAT ARE YOUR INSTRUCTOR'S STRENGTHS?
    - Patience, fair, helpful.
    - He knows the subject
    - He knew the subject very well. He repeated things a lot.
    - Dr. Carter makes an effort to give life skills and philosophy subjects intermittently during our lectures. He is very good at explaining course materials. You can tell Botany is his passion.
    - He went back to explain/repeat how our objectives build to current topic.
    - Knowledge
    - Knowledge, structured, encouraging.
    - He is nice in lab and answers questions
    - Knowledgeable about subject
    - Very systematic
    - He is really great at explaining the information clearly. He presents the information well and allows you to learn at your own pace. Repetition is the key.
    - He really knows the material and challenges you to know it. He also builds going back and reviewing briefly.

3. WHAT SUGGESTION WOULD YOU GIVE YOUR INSTRUCTOR FOR IMPROVING THE COURSE?
    - n/a
    - He is an immature teacher who is stuck on himself. Quit being an arrogant in your face jerk and act like you actually care about the students. Explanation were hard to understand at times
    - Make tests easier.
    - Allow field trip to be more interactive, less of a lecture.
    - Nothing
    - Some labs are a little too long to complete individually. Group lab exercises for those would be beneficial.
    - He does a very good job> I wouldn't know that to suggest
    - Nothing. He is really one of the best teachers I have had at VSU.
    - Break sections down.(Eg have 6 test on/sec. 1,2,3 broken down to sec. 1a. b) To make studying easier.

SOI Questions for Courses with Laboratory Component – 2010

1 Course assignments were clearly explained in the syllabus or other handouts.
2 Course policies (for example. Attendance, late papers) were clearly explained in the syllabus or other handouts.
3 The instructor was well prepared for class.
4 The instructor made effective use of class time to cover course content.
5 Course assignments were returned in a timely manner.
6 The instructor explained grading criteria (for example, grammar, content) clearly.
7 The instructor was willing to discuss course related issues either in person or by email/telephone.
8 The instructor responded to student questions on course material in a professional manner.
9 This course increased my knowledge of the topic.
10 This course helped me further develop my academic skills (for example, reading, writing, speaking, critical analysis, performance, artistic abilities, etc.)
11 Instructor knows course material.
12 Instructor explains the material effectively.
13 Examinations or other assignments covered the course material.
14 The course was challenging.
15 The laboratory contributed to your learning of course material.
16 Please indicate your student classification.
17 Indicate how much time per week you spend on this course outside of class and laboratory.
18 Indicate your final grade you expect to receive in this course.
19 I missed class __ times.
20 What were the best features about this course?
21 What are your instructor's strengths?
22 What suggestion would you give your instructor for improving the course?

SOI Questions for Courses without Laboratory Component – 2010

1 Course assignments were clearly explained in the syllabus or other handouts
2 Course policies (for example. attendance, late papers) were clearly explained in the syllabus or other handouts.
3 The instructor was well prepared for class
4 The instructor made effective use of class time to cover course content.
5 Course assignments were returned in a timely manner.
6 The instructor explained grading criteria (for example, grammar, content) clearly.
7 The instructor was willing to discuss course-related issues either in person or by email/telephone
8 The instructor responded to student questions on course material in a professional manner.
9 This course increased my knowledge of the topic.
10 This course helped me further develop my academic skills (for example, reading, writing, speaking, critical analysis, performance, artistic abilities, etc.)
11 Instructor knows course material
12 Instructor explains the material effectively.
13 Examinations or other assignments covered the course material
14 The course was challenging
15 Please indicate your student classification.
16 Indicate how much time per week you spend on this course outside of class and laboratory.
17 Indicate your final grade you expect to receive in this course.
18 I missed class __ times
19 What were the best features about this course?
20 What are your instructor's strengths?
21 What suggestion would you give your instructor for improving the course?

SPRING 2010
BIOL 2230 General Botany
Results of SOI Items 1-15

Q. No.	Total Resp.	Total Complete	Total Declined	Total Missing	Mean	Stvdev
1	18	18	0	0	4.39	1.01
2	18	18	0	0	4.5	0.6
3	18	18	0	0	4.44	0.5
4	18	18	0	0	4.53	0.5
5	18	18	0	0	4.22	0.79
6	18	18	0	0	4.28	1.04
7	18	18	0	0	3.78	1.13
8	18	18	0	0	3.56	1.34
9	18	18	0	0	4.17	1.12
10	18	18	0	0	3.72	1.15
11	18	18	0	0	4.61	0.95
12	18	18	0	0	4.33	0.88
13	18	18	0	0	4.22	0.85
14	18	18	0	0	4.5	0.96
15	18	18	0	0	4.44	0.76
Mean					**4.25***	

*In reporting SOI results for this section in my 2010 Annual Faculty Activity Report, I inadvertently omitted question 15. Question 15 was included in calculating the average here, hence the discrepancy.

SPRING 2010
BIOL 2230 General Botany
SOI Section Comments (unedited)

Q. No	Comment Text
20	The hands on labs and the powerpoint presentations were very helpful.
20	the online assessments. they helped guide what to study for on the exams.
20	Lab
20	the lab exercises
20	The instructor explained the material very well, and the online assesments were helpful.
20	The class was very challenging and it increased my knowledge of the course. I enjoyed the labs because the helped out with the lecture tests.
20	All material was explained thoroughly and effectively.
20	The best features about the course would probably be the assessments they were good for study material and they helped boost your grade kind of like homework assignments.
20	We got to learn about the plant world
20	Hands-on approach to learning during laboratory
20	I loved the labs. The actual information on the lecture tests sometimes seemed overwhelming. Dr. Carter is fair and as he says you definantely get your moneys worth.
20	the ethylene experiment, and learning the practical uses of plants
20	Dr. Carter was always well prepared and knew what he was talking about.
20	The lab, but other than that it really wasn't very interesting!
21	His knowledge of the subject is very good, and he taught lecture very proficiently.
21	the advise that he gives on how to study for his course
21	He knew the material very well.
21	Knows the material. Very Repetitious.
21	Very knowledgeable about subject content and enthusiastic.
21	I would say my instructors strength would be the overall knowledge of the subject.
21	Knew the topics very well and entertwined lab with lecture well.
21	His vast knowledge on the subject and his dedication to science.
21	The teacher knew this subject like the back of his hand.
21	Knows the material
21	Dr. Carter is a wonderful professor and really knows his material. He not only teaches botany very well but also teaches life lessons.
21	easy to talk to outside the classroom
21	Very knowledgable of the subjects tought.
21	Always has a few extra words of wisdom for life, and has a passion for the subject taught.
21	the lectures provided information that stuck with me during the exams. he gave good bakgroud information
22	Continue as is.
22	Try not to be so bipolar.
22	Sometimes questions on tests were worded strange.
22	more outdoor lab exercises
22	The powerpoints should be printable.
22	Nothing

SPRING 2010
BIOL 4100 Morphology of Land Plants
Results of SOI Items 1-15

Q. No.	Total Resp.	Total Complete	Total Declined	Total Missing	Mean	Stvdev
1	9	9	0	0	4.44	0.5
2	9	9	0	0	4.22	0.63
3	9	9	0	0	4.67	0.47
4	9	9	0	0	4.56	0.5
5	9	9	0	0	4.33	1.25
6	9	9	0	0	4	1.25
7	9	9	0	0	4.56	0.68
8	9	9	0	0	3.33	1.41
9	9	9	0	0	4.89	0.31
10	9	9	0	0	4.78	0.42
11	9	9	0	0	4.89	0.31
12	9	9	0	0	4.78	0.42
13	9	9	0	0	4.89	0.31
14	9	9	0	0	4.78	0.42
15	9	9	0	0	4.88	0.33
Mean					**4.53***	

*In reporting SOI results for this section in my 2010 Annual Faculty Activity Report, I inadvertently omitted question 15. Question 15 was included in calculating the average here, hence the discrepancy.

SPRING 2010
BIOL 4100 Morphology of Land Plants
SOI Section Comments (unedited)

Q. No	Comment Text
20	feild trips and laboratory work
20	field trip
20	The professor was well prepared for class and taught the material in the same fashion it was presented on the test.
20	This course was presented in a problem-based format. Whereas, other courses only ask you to memorize and regurgitate information. Such courses do the student no service. In this course, we were ask to complete theorectical cladograms based on the apomorphies we learned. We were asked to classify flowers based on investigative techniques and the project taught us the scientific method, which is the essence of not only medicine, but science in general.
20	Finding that there are multiple ways to interpret and analyze cladistics. There were many things learned in this course that help to better understand the relationships and reasons why extant plants are the way they are.
20	This class really tested what you learned in General Botany and challenged you to remain organized and stay on top of the material.
20	The field trips.
20	Field Trips and laboratory
21	most knowlegable
21	He knew the material very well.
21	The instructor is well published, well read, has superior knowledge of the material, and can explain such material effectively.
21	Very structurally organized, very clear about what he expects from students
21	knowledge of course material
21	knoledge of the material and successfully teaching it
21	His thorough knowledge of plants. Dr. Carter doesn't mess around, and that is meant in a good way.
21	He has a good knowledge of the material and is organized compared to other professors.
22	more outdoor labs
22	Less time looking through a microscope and more time in the field. It's understandable for this course considering it's a morphology course, but being out in the field is a much more engaging experience.
22	Lab work is very helpful but there is so much material that it is hard to cover everything in one lab period.
22	The instructor can facilitate a less intense environment. Making students nervous can destract from the courses purpose. The course should have two hours of lecture and four hours of lab in order to better serve students.
22	The course could be improved with more time in the field. Growth chambers would have been effective in research projects as well.
22	More field trips haha
22	Reducing the amount of material.
22	spend more time on the higher plant groups

SPRING 2010
BIOL 6100 Morphology of Land Plants
Results of SOI Items 1-14

Q. No.	Total Resp.	Total Complete	Total Declined	Total Missing	Mean	Stvdev
1	2	1	0	1	5	0
2	2	1	0	1	5	0
3	2	1	0	1	5	0
4	2	1	0	1	5	0
5	2	1	0	1	5	0
6	2	1	0	1	4	0
7	2	1	0	1	4	0
8	2	1	0	1	3	0
9	2	1	0	1	5	0
10	2	1	0	1	5	0
11	2	1	0	1	5	0
12	2	1	0	1	5	0
13	2	1	0	1	5	0
14	2	1	0	1	5	0
Mean					**4.71**	

SPRING 2010
BIOL 6100 Morphology of Land Plants
SOI Section Comments (unedited)

Q. No	Comment Text
20	Getting to view actual specimens and not just pictures or microscope slides.
21	Knows the material really well.
22	We need more time in lab.

Summer 2010
PERS 2490 History & Use of Medicinal Plants
Results of SOI Items 1-14

Q. No.	Total Resp.	Total Complete	Total Declined	Total Missing	Mean	Stvdev
1	27	27	0	0	4.22	0.92
2	27	27	0	0	4.27	1.09
3	27	27	0	0	4.15	0.85
4	27	27	0	0	3.96	1.14
5	27	27	0	0	3.74	1.11
6	27	27	0	0	3.96	1.26
7	27	27	0	0	3.56	1.42
8	27	27	0	0	3.19	1.39
9	27	27	0	0	4.41	0.87
10	27	27	0	0	3.7	1.08
11	27	27	0	0	4.41	0.99
12	27	27	0	0	3.81	1.09
13	27	27	0	0	4.26	0.58
14	27	27	0	0	4.15	0.66
Mean					**3.99**	

Summer 2010
PERS 2490 History & Use of Medicinal Plants
SOI Section Comments (unedited)

Q. No	Comment Text
19	Learned a great deal about botany
19	interesting subject matter goes by fast
19	it was very informative about medicinal plants
19	He arrived in a timely manner and always had discussions going.
19	The topic was very interesting and Dr. Carter way of teaching and getting us to discuss was a new method that I had never encountered. The book "The Color Code" is a very good book and it was my favorite book from the course.
19	Judith Sumner's book was the best part of the class. Interesting book that was easy to read and understand.
19	The interactions among the students was great. I love the discussions each class.
19	it teaches me about things i deal with everyday
19	the hands on experience
19	we got to work in groups.
19	We had fun while we were enhancing our health
19	This course was very informaional
19	The course was very informative and fun
19	It was very interesting and the professor was great. I enjoyed seeing examples of the plants we were discussing.
19	It was very fun and hands on
19	I loved getting to see real-life plants in person and how they worked differently.
19	The best features about this class was that i actually learned a lot about plants and started eating healthy.
19	I liked how the groups were the people who taught us about each section, and we did not have to sit and listen to lecture everyday.
19	the textbooks
19	The best features about this course were the class discussion. There were many opportunities for students to interact and understand each person's perspective of the material.
19	the information and books was very interesting
19	The material was interesting and the professor was quite knowledgeable about the subject. The group presentations and assignments were effective and fun.
19	A good grade was easy to get if the work was done throughly
19	Group discussions were the best features of this course.
19	The interaction and discussion amongst the students and instructor
20	Used class time very effectivley and very knowledgeable about botany.
20	He is very disciplined in his job as an instructor and knows exactly what he expects from his students.
20	he makes sure you participate
20	knowledgeable, prompt
20	Dr. Carter is very knowledgeable about the subject and posed some very interesting questions throughout the course.
20	I can't really say what those might be. I know he enjoys working in the herbarium, but as a teacher I didn't really see any strengths.
20	He knows what he's teaching about.
20	he knows his plants!
20	his knowledge
20	he was always well prepared for class and he knew what he was talking about.
20	His knowledge
20	Dr. Carter is very knowledgeable about the subject and his passion for the material is infectious
20	He knows a lot about plants.
20	Very knowledgeable.
20	he knew the material well

20 Dr. Carter knows his material VERY well. He can answer pretty much any question you have for him and tell the answer in a way in which you can understand.

20 My instructor strengths is that he knows the material.

20 knows the subject extremely well

20 making the entire class feel as if they are children, diverting questions by referring them to the syllabus

20 The instructor is very knowledgable about plants. He is interested in the material and pulls the information out of the students.

20 his knowledge of botany

20 intelligent, eloquent, helpful, and holds students to higher standards than most students are probably accustomed to (which is what professors of higher education should aim for)

20 adhering to rules

20 My instuctor was very knowledgeable of the topics.

20 very knowledgeable on the subject

21 Don't ignore emails sent by students

21 dont cut people off in the middle of a statement let us ask questions try to not nitpick so much

21 maybe use a different book besides the color code.

21 Sometimes he was rather abrupt with students which could be worked on.

21 The method of teaching did foster discussion but at times I felt a little lost in the material and wished he had talked/lectured first before we had class discussions.

21 1. Even though you're not out to make friends, making yourself seem more approachable IS CONDUCIVE to a learning environment. 2. Don't ignore student questions or comments. 3. Don't highjack student presentations.

21 He needs to learn how to talk to the students as adults and not as little kids. He needs to be more receptive to students when they pose a question to him. Basically, he needs to be more of a people person because he tends to rub students the wrong way with the way that he handles situations.

21 good first time teaching the class

21 nothing

21 make it more exciting. and the exam is going to be too hard. we should have 3 essays instead of 5 essays.

21 nothing

21 I would suggest that the professor not let students get under his skin so much. There are going to be ignorant people in the class, if you dont entertain them, then they will leave you alone. Also, when asked a question, try to answer without talking down to people. If I could give Dr. Carter a grade for attitude, I would say a D. Students give him a hard time because of the way he speaks to students. We are here to learn the subject, not to be made to feel stupid for not knowing or clarifying.

21 When a student asks a question, answer it. Don't just ignore the student no matter how stupid the question or comment may be.

21 See if it is possible to see any of the plants in there natual habitat.

21 teach more and not just have to students do it but i liked to concept and assume it would work better in a 9 week course.

21 nothing

21 Grades other than daily grades recieved prior before the last week of school and maybe a little nicer and friendlier to students when they ask a question. Other than that, great teacher and guy

21 needs to relate to his students better, and at times he can be rude and even out of line with some of the things he says

21 describe your late assignments policy try to treat your students as equals and not as if they are kindergardeners. your belittling response to students questions caused a major lack of motivation for me and other students.

21 The instructos could have listened more to the students concerns and questions. The instructor interrupted students on numerous occassions when they were expressing a concern. A classroom is a learning experience. There is a time for open discussion but many of the students did not have prior knowledge botany. There were times where students were discouraged when asking questions.

21 none

21 The majority of people who take a "perspectives" course do not expect the level of seriousness and

learnedly led discussions that you bring to the classroom. Many students in this course felt as if you interrupted or ignored them often; in my opinion your interjections were informative and interesting. However, managing assumptions about a person with seniority is something with which many people are not skilled. Maymester courses are intended to be fast-paced, but the final exam seems like it will be nearly impossible to ace due to the two hour time constraint and the level of detail expected. My strongest advice would be to spice up the lesson plan (no pun intended) and lighten the course load a bit. :) Overall, I enjoyed the course very much.

21 teach the course himself instead of assigning it to students to do themselves

21 possibly more content on the historical aspect, but course was very well taught and planned, very little criticism

Fall 2010
BIOL 4010 Dendrology
Results of SOI Items 1-15

Q. No.	Total Resp.	Total Complete	Total Declined	Total Missing	Mean	Stvdev
1	9	9	0	0	4.89	0.31
2	9	9	0	0	4.89	0.31
3	9	9	0	0	5	0
4	9	9	0	0	4.89	0.31
5	9	9	0	0	4.44	0.68
6	9	9	0	0	4.67	0.47
7	9	9	0	0	4.89	0.31
8	9	9	0	0	4.89	0.31
9	9	9	0	0	5	0
10	9	9	0	0	4.67	0.47
11	9	9	0	0	5	0
12	9	9	0	0	4.78	0.42
13	9	9	0	0	4.89	0.31
14	9	9	0	0	4.78	0.42
15	9	9	0	0	4.78	0.63
Mean					**4.83**	

Fall 2010
BIOL 4010 Dendrology
SOI Section Comments (unedited)

Q. No	Comment Text
20	Course materials were best learned through field study and then reconstituted through our lecture work.
20	the hands on learning made this class one of my favorites. I have never learned and retained so much information from one class. Dr. Carter was a great teacher. The class was extremely challenging, but very interesting. I'm really glad I took this course.
20	Everything was pretty straight forward. Dr. Carter loves what he's teaching. It was taught how a senior level course should be taught.
20	The most enjoyable and productive learning experiences of the class/lab were the field trips. Also the outdoor lab sessions were fun and productive giving students hands on experience in the field.
20	We were able to go and see live specimen
20	The field trips were great. The hands on approach of learning works great.
20	The field quizes pushed you to learn the material, how to identify certain species, and how to relate everything learned together.
20	Field trips were fun and very educational.
21	His knowledge and passion for trees and plants. He was very enthusiastic about teaching us.
21	His strengths were his knowledge of the subject (plants).
21	He knows his material, without question, and he wants you to know the material too.
21	He loved what he's teaching and knows the material as well as anyone. If he didn't know something he would be sure to know by the next class.
21	Very knowledgeable
21	Knowledge of the course and his abilities to make the students learn rather than memorize
21	Knew material very well and is passionate about the subject
21	He knew the material very well and loved talking about trees. It's nice to have a teacher who loves what he teaches. It made me want to learn everything I could about trees.
22	Get the administrator to give the teacher a big van and allow us to take more weekend trips. They were awesome to take. It makes it easier to learn when you can see the specimens in their habitats
22	None, everything seemed fair.
22	n/a
22	N/A
22	Just try to speak louder sometimes outdoors when encircled by students
22	None
22	Possibly cut down on the Saturday field trips. School on 5 days of the week is good enough

Fall 2010
BIOL 7900 Graduate Seminar
Results of SOI Items 1-14

Q. No.	Total Resp.	Total Complete	Total Declined	Total Missing	Mean	Stvdev
1	2	2	0	0	5	0
2	2	2	0	0	5	0
3	2	2	0	0	5	0
4	2	2	0	0	4.5	0.5
5	2	2	0	0	3.5	1.5
6	2	2	0	0	4	1
7	2	2	0	0	5	0
8	2	2	0	0	5	0
9	2	2	0	0	5	0
10	2	2	0	0	5	0
11	2	2	0	0	4.5	0.5
12	2	2	0	0	5	0
13	2	2	0	0	4	1
14	2	2	0	0	4.5	0.5
Mean					**4.64**	

Fall 2010
BIOL 7900 Graduate Seminar
SOI Section Comments (unedited)

Q. No	Comment Text
19	It was conducted in a very professional manner.
20	He is willing to help students.
21	Nothing. I liked the course as it is.

Appendix C. Reprints of peer-review articles published 2006-2010.

1. Rosen, D.J., R. Carter and C.T. Bryson. 2006. The spread of *Cyperus entrerianus* (Cyperaceae) in the southeastern United States and its invasive potential in bottomland hardwood forests. Southeastern Naturalist 5: 333-344.
2. Rosen, D.J., and R. Carter. 2007. Additional noteworthy collections of *Cyperus drummondii* (Cyperaceae) from Texas and first report from Mexico. J. Bot. Res. Inst. Texas 1(1): 779-780.
3. Rosen, D.J., S.R. Hatch and R. Carter. 2007. Infraspecific taxonomy and nomenclature of *Eleocharis acutangula* (Cyperaceae). J. Bot. Res. Inst. Texas 1(2): 875-888.
4. Carter, R., C.T. Bryson and S.J. Darbyshire. 2007. Preparation and use of voucher specimens for documenting research in weed science. Weed Technology 21: 1101-1108.
5. González-Elizondo, M.S., D.J. Rosen, R. Carter and P.M. Peterson. 2007. *Eleocharis reznicekii* (Cyperaceae), a new species from the Mexican High Plateau. Acta Botanica Mexicana 81: 35-43.
6. Carter, R. 2007. Nomenclatural notes on *Cyperus retrorsus* Chapm. and «*Cyperus retroversus* Chapm.» (Cyperaceae). Vulpia 6: 1-3.
7. Whittier, D.P., and R. Carter. 2007. The gametophyte of *Lycopodiella prostrata*. Amer. Fern J. 97(4): 230–233.
8. Bryson, C.T., and R. Carter. 2008. A novel design for a light weight and durable field press. J. Bot. Res. Inst. Texas 2(1): 517-520.
9. Bryson, C.T., V.L. Maddox and R. Carter. 2008. Spread of Cuban Club-rush [*Oxycaryum cubense* (Poeppig & Kunth) Palla] in the Southeastern United States. Invasive Plant Science and Management 1: 326-329.
10. Rosen, D.J., S.R. Hatch and R. Carter. 2008. Taxonomy and nomenclature of three closely related species of *Eleocharis* subg. *Limnochloa* (Cyperaceae). Blumea 53: 235-246.
11. Bergstrom, B.J., and R. Carter. 2008. Host tree selection by an epiphytic orchid, *Epidendrum magnoliae* Muhl., in an inland hardwood hammock in Georgia. Southeastern Naturalist 7: 571-580.
12. Carter, R. 2008. Floristic highlights from Camden County. Tipularia 23: 34-42.
13. Bryson, C.T., and R. Carter. 2008. The significance of Cyperaceae as weeds. Pp. 15-101 in R. F. C. Naczi and B. A. Ford (editors), *Sedges: Uses, Diversity, and Systematics of the Cyperaceae*. Monogr. Syst. Bot. Missouri Bot. Gard. 108.
14. Carter, R., W.W. Baker and M.W. Morris. 2009. Contributions to the flora of Georgia, U.S.A. Vulpia 8: 1-54.
15. Carter, R., C.W. Allen, P. and D. Lewis. 2009. *Cyperus pilosus* Vahl (Cyperaceae) new to the flora of Texas. J. Bot. Res. Inst. Texas 3: 457-459.
16. Goddard, R.H., T.M. Webster, R. Carter and T.L. Grey. 2009. Resistance of Benghal Dayflower *(Commelina benghalensis)* seeds to harsh environments and the implications for dispersal by Mourning Doves *(Zenaida macroura)* in Georgia, U.S.A. Weed Science 57: 603-612.
17. Carter, R. 2009. Rediscovery of *Platanthera chapmanii* in Georgia. Native Orchid Conference Journal 6(4): 1-3.
18. Bryson, C.T., and R. Carter. 2010. Spread, growth parameters and reproductive potential for brown flatsedge (*Cyperus fuscus*). Invasive Plant Science and Management. 3: 240-245.

2006 SOUTHEASTERN NATURALIST 5(2):333–344

The Recent Spread of *Cyperus entrerianus* (Cyperaceae) in the Southeastern United States and its Invasive Potential in Bottomland Hardwood Forests

David J. Rosen[1,*], Richard Carter[2], and Charles T. Bryson[3]

Abstract - *Cyperus entrerianus*, a native of temperate South America, has become a tenacious weed in the southeastern United States. Herbarium and field studies revealed records of *C. entrerianus* from an additional 39 counties in the southeastern United States, increasing the number of counties where it is known by 118%. Vegetation sampling at two southeast Texas bottomland hardwood stands showed that *C. entrerianus* is capable of invading the understory of a mature forest with old-growth characteristics and that native herbaceous species richness and aerial cover are negatively correlated with increasing aerial cover of *C. entrerianus*. Life-history characteristics of *C. entrerianus* suggest it will continue to spread and could alter both herbaceous and woody plant dynamics in bottomland forests of the southeastern United States.

Introduction

Nonnative invasive species are estimated to cost the American public about $138 billion annually (Pimentel 2002). This cost includes the overall adverse effects and control measures for invasive species in agricultural, forest, urban, and natural areas. In addition to economic losses, non-indigenous species negatively affect native-plant community structure, diversity, and community dynamics (Westbrooks 1998, 2001; Woods 1993; Zimdahl 1995). The homogenization of native flora by introduced species can lead to modification of native habitats and local extinctions (Olden and Poff 2003), a classical example being the conversion of California grasslands from perennial-dominated to exotic annual-dominated ecosystems (Heady et al. 1992). Invasion of forest communities in the eastern United States by introduced plant species has been well documented (Barden 1987, Luken 2003, Nuzzo 1999, Rosen and Faden 2005), and, indeed, the invasion of intact climax or late successional forests followed by reduction in native-plant diversity (Woods 1993).

Cyperus entrerianus Böckeler (deeprooted sedge), a native of temperate South America, has become a tenacious weed in the southeastern United States (Carter 1990, Carter and Bryson 1996). Over the past decade, the authors have observed *C. entrerianus* in a variety of disturbed and native habitats, forming monotypic stands to the exclusion of native flora. Since its

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introduction prior to 1941, probably by separate events in Florida and Texas, *C. entrerianus* has dispersed rapidly (Bryson and Carter 1994, Carter 1990, Carter and Bryson 1996, Carter and Jones 1991). Voucher specimens from a total of 33 counties in Alabama, Florida, Georgia, Louisiana, Mississippi, and Texas were previously cited (Bryson and Carter 1994, Carter 1990, Carter and Bryson 1996, Carter and Jones 1991). Over the past decade, we have observed the continuous spread of *C. entrerianus*, and its adverse affect in agricultural areas and natural plant communities.

Field work throughout the southeastern United States over the past decade suggests that the dispersal of *Cyperus entrerianus* is being accelerated by human activities. Recently, we have observed the invasion of intact bottomland forests by *C. entrerianus* in southeastern Texas. We have found no published studies examining the response of native plant communities following invasion of *C. entrerianus*. The objectives of this research were to document additional spread of *C. entrerianus* and to determine its potential impact on a typical bottomland hardwood forest in southeastern Texas. We hypothesized that native herbaceous species richness and cover would be negatively correlated with the presence of *C. entrerianus*.

Materials and Methods

Study sites

In order to determine if *Cyperus entrerianus* could invade a bottomland forest with old growth canopy structure and understand which native species it might displace, we selected and compared two bottomland forest stands administered by the San Bernard National Wildlife Refuge. Both study sites are located in southwestern Brazoria County, TX, between 29º08'39.7" and 29º05'15.1"N latitude and 95º48'54.6" and 95º45'58.1"W longitude. The Dance Bayou Unit, a 263-ha old-growth bottomland forest stand, is not infested by *C. entrerianus*. The Bird Pond Unit is a 38-ha bottomland forest stand located 2 km north of the Dance Bayou Unit, similar in woody composition, but infested in the herbaceous layer with *C. entrerianus*. Soils at both sites are mapped as clayey textured, somewhat poorly drained, and very slowly permeable (Crenwelge et al. 1981). Topography at both sites comprises nearly level flats or pit and mound microtopography. Both sites are similar in their proximity to disturbed areas and activities that could facilitate invasion by *C. entrerianus*. Bird Pond has a history of understory disturbance and clearing for hunting, which might have promoted dispersal of *C. entrerianus* from an adjacent pipeline right-of-way. Both forest stands were acquired as stopover and staging habitat for Nearctic-Neotropical migrant land-birds. An additional conservation role of Bird Pond is to protect a large stand of *Leitneria floridana* A. Chapman (corkwood).

Vegetation sampling

Similar areas were selected at both sites and randomly sampled for woody and herbaceous vegetation in order to characterize a forested stand invaded by *C. entrerianus* and to contrast it with an un-infested stand. At both sites, random points were placed within each sampling area. Once located in the field using a hand-held GPS, points were used to establish a corner for a 250-m^2 (10-m x 25-m) rectangular plot, with the long axis oriented in a north–south direction. Three 250-m^2 plots were permanently established at each stand (six plots total). Within each plot, all trees were sampled that possessed a diameter at breast height (DBH; about 1.4 m above the ground) ≥ 7.5 cm. Ten randomly placed 1-m x 1-m (1-m^2) quadrats within each of the 250-m^2 plots were sampled by estimating percentage of aerial cover (0–100%) of all herbaceous species (including woody vegetation < 0.5 m tall) for a total of thirty 1-m^2 quadrats at each stand (sixty total). All field work was conducted in early April 2004 and 2005.

Data analysis

Data obtained from the plots were used to calculate density and dominance (= basal area) for trees and frequency and dominance (= percent cover) for herbaceous vegetation. Importance values were obtained for each species in each plot by summing relative density and relative dominance for trees, and relative frequency and relative dominance for herbaceous vegetation. Native herbaceous species aerial cover and richness were arcsin transformed, and then their relationships with aerial cover of *Cyperus entrerianus* were examined using simple linear regression.

Results

Distribution

Intensive field surveys and review of herbarium specimens have led to discovery of populations of *Cyperus entrerianus* in an additional 39 counties in the southeastern United States, increasing the number of counties where it is known by 118% and documenting substantial range expansions both northward and southward in Florida, Mississippi, and Texas (Fig. 1, Appendix I). Although previously known only from disturbed sites, over the past decade, *C. entrerianus* has been increasingly observed in relatively undisturbed, natural habitats, including bottomland forests, riparian forests over deep sands, tall-grass prairies, and coastal grasslands dominated by *Spartina spartinae* (Trin.) Merr. ex A. S. Hitchc.

Vegetation sampling

Dominant and sub-dominant canopy species composition were similar for Bird Pond and Dance Bayou (Table 1). Based on importance value, both stands are dominated by *Ulmus crassifolia* Nutt. (cedar elm; Table 1). Bird Pond is sub-dominated exclusively by *Quercus virginiana* Mill. var. *virginiana* (live oak), whereas Dance Bayou is sub-dominated almost equally by *Celtis laevigata* Willd. var. *laevigata* (sugar hackberry), *Q. virginiana* var. *virginiana*, and *Q. nigra* L. (water oak; Table 1). Even though Dance Bayou had higher canopy-class species richness, Bird Pond

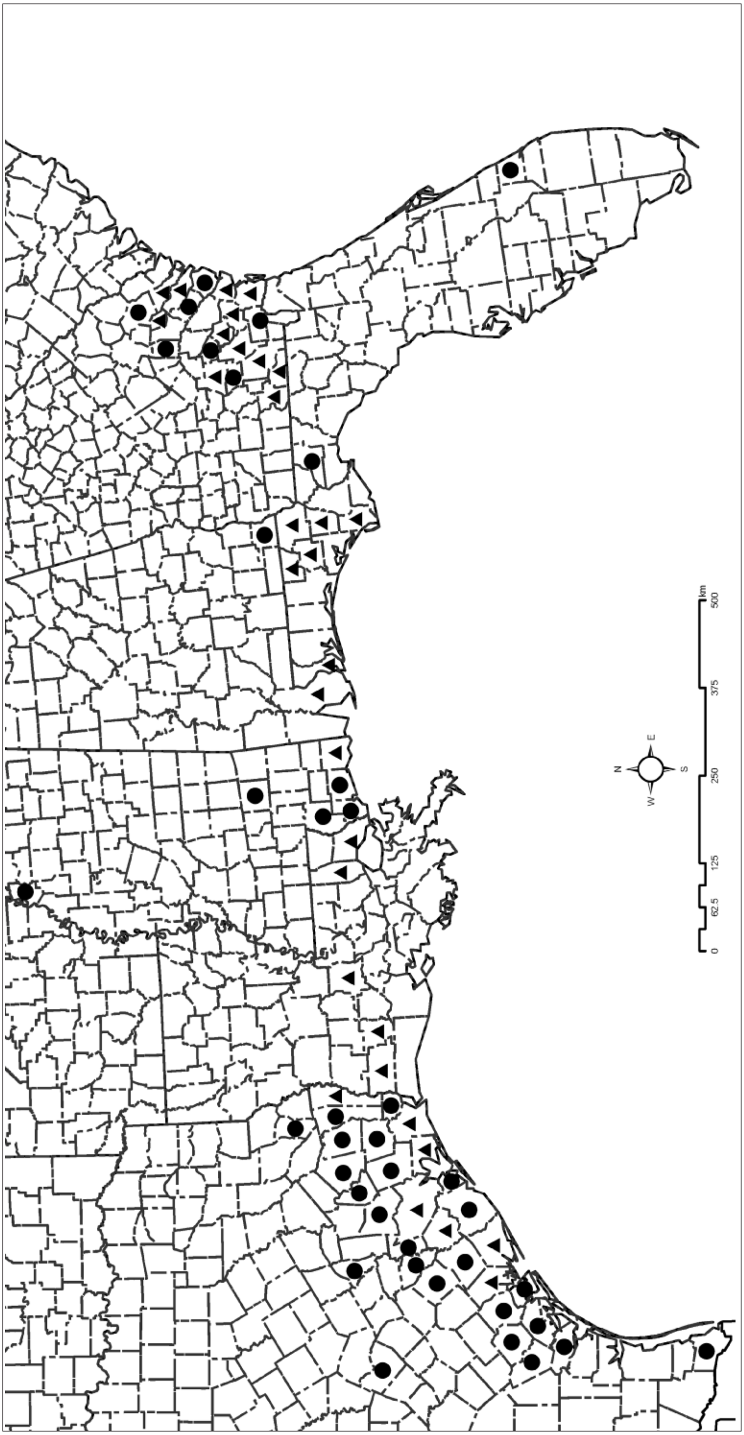

Figure 1. Distribution of *Cyperus entrerianus* in North America, North of Mexico. Specimens previously reported by Carter (1990), Carter and Jones (1991), Bryson and Carter (1994), and Carter and Bryson (1996) are indicated by solid triangles (▲) and records reported for the first time here by solid circles (●).

Table 1. Composition table for canopy size class (> 20 cm DBH) woody vegetation sampled at the Bird Pond Unit (infested with *Cyperus entrerianus*) and Dance Bayou Unit (no *C. entrerianus*), San Bernard National Wildlife Refuge. De = density (stems ha^{-1}), R.De. = relative density, Do = dominance (m^2 ha^{-1}), R.Do. = relative dominance, I.V. = importance value.

	Bird Pond					Dance Bayou				
	De	R.De.	Do	R.Do.	I.V.	De	R.De.	Do	R.Do.	I.V.
Ulmus crassifolia	173.3	65	13.1	26.1	91.1	120.0	50.0	10.2	31.1	81.1
Quercus virginiana	40.0	15	33.9	67.4	82.4	13.3	5.6	9.1	27.6	33.2
Celtis laevigata	26.7	10	2.0	3.9	13.9	40.0	16.7	3.8	11.6	28.3
Fraxinus pennsylvanica	13.3	5	0.8	1.7	6.7	-	-	-	-	-
Quercus nigra	13.3	5	0.5	0.9	5.9	26.7	11.1	4.1	12.5	23.6
Carya illinoiensis	-	-	-	-	-	13.3	5.6	2.4	7.4	13.0
Quercus shumardii	-	-	-	-	-	13.3	5.6	2.1	6.5	12.1
Acer negundo	-	-	-	-	-	13.3	5.6	1.1	3.4	9.0
Totals	266.6	100.0	50.3	100.0	200.0	240.0	100.0	32.8	100.0	200.0

Table 2. Composition table for herbaceous species with 100% occurrence sampled at the Bird Pond Unit (infested with *Cyperus entrerianus*) and Dance Bayou Unit (no *C. entrerianus*), San Bernard National Wildlife Refuge. %F = % frequency, R%F = relative % frequency, Do = dominance (% cover), R.Do. = relative dominance, I.V. = importance value.

	Bird Pond					Dance Bayou				
	%F	R%F	Do	R.Do.	I.V.	%F	R%F	Do	R.Do.	I.V.
Cyperus entrerianus	100	3.53	44.67	42.11	45.63	-	-	-	-	-
Sabal minor	100	3.53	21.33	20.11	23.64	100	2.4	8.92	4.56	6.96
Carex cherokeensis	100	3.53	17.08	16.10	19.63	100	2.4	43.33	22.17	24.57
Ulmus crassifolia	100	3.53	3.42	3.22	6.75	100	2.4	1.92	0.98	3.38
Carex flaccosperma	100	3.53	1.75	1.65	5.18	-	-	-	-	-
Viola sororia var. *sororia*	100	3.53	1.75	1.65	5.18	100	2.4	1.92	0.98	3.38
Quercus nigra	100	3.53	0.92	0.86	4.39	-	-	-	-	-
Carex leavenworthii	100	3.53	0.75	0.71	4.24	-	-	-	-	-
Fraxinus pennsylvanica	100	3.53	0.67	0.63	4.16	-	-	-	-	-
Carex caroliniana	100	3.53	0.67	0.63	4.16	-	-	-	-	-
Solidago canadensis	100	3.53	0.42	0.39	3.92	-	-	-	-	-
Toxicodendron radicans	100	3.53	0.42	0.39	3.92	100	2.4	17.42	8.91	11.31
Symphyotrichum racemosum	100	3.53	0.33	0.31	3.84	-	-	-	-	-
Tovara virginiana	-	-	-	-	-	100	2.4	23.33	11.94	14.34
Oplismenus hirtellus	-	-	-	-	-	100	2.4	15.67	8.01	10.41
Chasmanthium laxum	-	-	-			100	2.4	7.00	3.58	5.98
Campsis radicans	-	-	-	-	-	100	2.4	6.00	3.07	5.47
Parthenocissus quinquefolia	-	-	-	-	-	100	2.4	5.67	2.90	5.3
Sanicula canadensis	-	-	-	-	-	100	2.4	5.33	2.73	5.13
Carex blanda	-	-	-	-	-	100	2.4	3.67	1.88	4.28
Carex texensis	-	-	-	-	-	100	2.4	3.00	1.53	3.93
Myosotis macrosperma	-	-	-	-	-	100	2.4	2.58	1.32	3.72
Malvaviscus drummondii	-	-	-	-	-	100	2.4	2.50	1.28	3.68
Carex bulbostylis	-	-	-	-	-	100	2.4	2.17	1.11	3.51
Viola sororia	-	-	-	-	-	100	2.4	1.92	0.98	3.38
Spigelia texana	-	-	-	-	-	100	2.4	1.08	0.55	2.95
Galium aparine	-	-	-	-	-	100	2.4	1.00	0.51	2.91
Cyperus thyrsiflorus	-	-	-	-	-	100	2.4	0.75	0.38	2.78
Celtis laevigata	-	-	-	-	-	100	2.4	0.67	0.34	2.74
Berchemia scandens	-	-	-	-	-	100	2.4	0.67	0.34	2.74

had higher stem density (stems ha^{-1}) and dominance (m^2 ha^{-1}) indicating the canopy is structurally equivalent to the old-growth stand at Dance Bayou (Table 1). Based on importance value, the herbaceous layer at Bird Pond was dominated by *Cyperus entrerianus*, with sub-dominants of *Sabal minor* (dwarf palmetto) and *Carex cherokeensis* (cherokee sedge), while Dance Bayou is dominated by *C. cherokeensis* (Table 2). Species diversity, evenness, and richness were higher at Dance Bayou than Bird Pond (Table 3, Appendix II). At Bird Pond, native herbaceous species richness and aerial cover showed significant ($P < 0.05$) decline with increasing aerial cover of *Cyperus entrerianus* (Figs. 2, 3).

Discussion

Quantitative sampling of forest vegetation at the Bird Pond and Dance Bayou Units of the San Bernard National Wildlife Refuge demonstrated that

Table 3. Diversity indices for herbaceous vascular plants sampled at the Bird Pond unit (infested with *Cyperus entrerianus*) and Dance Bayou unit (no *C. entrerianus*), San Bernard National Wildlife Refuge.

Stand	H' = Diversity	J' = Evenness	Species richness
Bird Pond unit	3.3	0.86	49
Dance Bayou unit	3.7	0.89	65

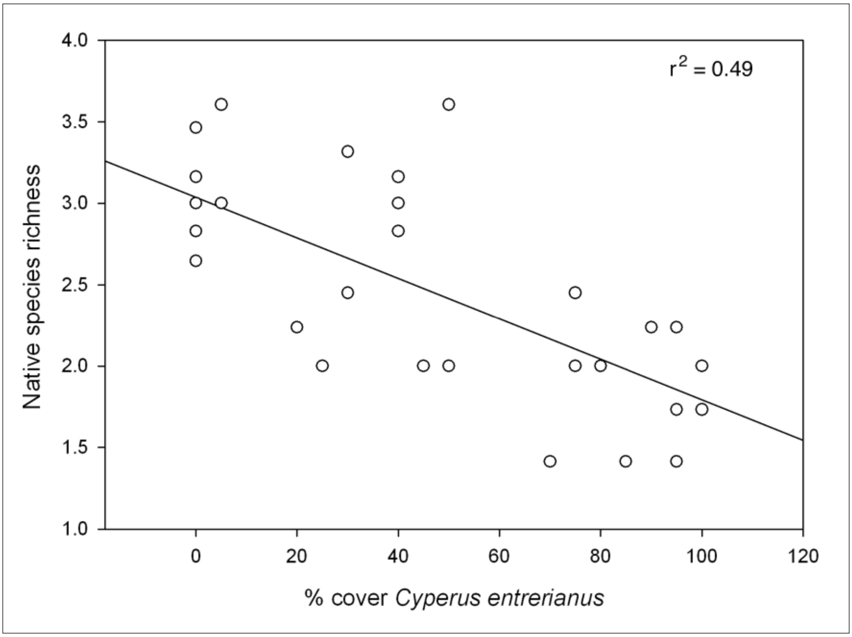

Figure 2. Linear least-squares regression line of native herbaceous species richness (arcsin transformed) vs. aerial % cover of *Cyperus entrerianus*. Points represent richness from single 1-m^2 quadrats.

Cyperus entrerianus became established under a canopy with old-growth attributes and that its presence was negatively correlated with native herbaceous species. *Cyperus entrerianus* may have less effect on more robust herbaceous species such as *Sabal minor* (dwarf palmetto) and *Carex cherokeensis* (cherokee sedge) than it does on species of smaller stature, or those with life history characteristics that would make them more sensitive to competition. The effect of *C. entrerianus* on seedlings of woody plants needs further study, although fewer woody species were sampled at Bird Pond (Appendix II) suggesting a negative effect. A comparison of species richness and diversity between the two study sites is not intended to suggest the reduced richness at Bird Pond is due entirely to invasion by an exotic species, since differences could be due to factors other than the occurrence of *C. entrerianus*. However, within each 250-m^2 plot at Bird Pond, cover and richness of herbaceous species was negatively correlated with cover of *C. entrerianus*. Our conclusions are based on a limited study at only two sites and our previous field observations. More research is needed to better understand the invasion of bottomland forests and other native habitats by *C. entrerianus*, and its effect on native vegetation.

Invasion of old-growth forests by exotic plants followed by depression of native species diversity is not well documented, but has been observed in North America (Woods 1993). The well-established ecological theory that

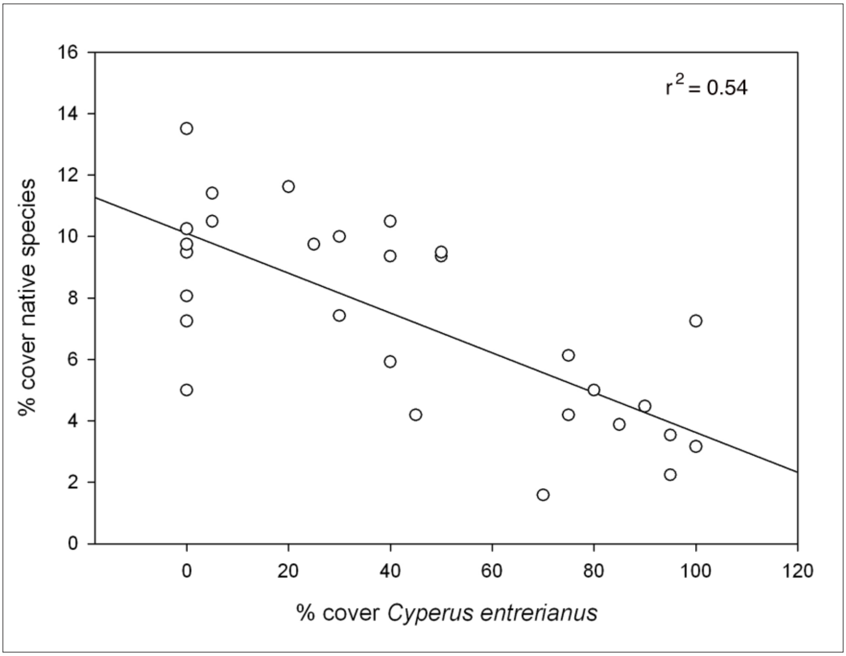

Figure 3. Linear least-squares regression line of native herbaceous species aerial % cover (arcsin transformed) vs. aerial % cover of *Cyperus entrerianus*. Points represent richness from single 1-m^2 quadrats.

productive, diverse habitats are resistant to exotic plant invasions has recently been challenged (Huston 2004). Our field observations of *Cyperus entrerianus* over the last decade indicate that its tiny seeds are readily dispersed, establishing new populations in a variety of habitats that increase in spatial extent and invade new areas. Life-history characteristics, including perennial habit, asexual reproduction, and high reproductive output (i.e., prolific seed production, high seed viability, and spring and fall flowering events) could give *C. entrerianus* a competitive advantage in a productive habitat such as bottomland hardwood forests. Results presented herein and observations of its life-history characteristics indicate *C. entrerianus* is a Type 8 colonizer. Type 8 colonizers are "quintessential invaders" with the following attributes: non-endemic, introduced via long-distance dispersal, and having a great impact on their new ecosystem (Davis and Thompson 2000). Its potential for competitive exclusion, apparent shade tolerance, and absence of native herbivores suggest that *C. entrerianus* could alter both herbaceous and woody plant dynamics in bottomland forests of the southeastern United States.

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Literature Cited

Barden, L. 1987. Invasion of *Microstegium vimineum* (Poaceae), an exotic, annual, shade tolerant, C_4 grass, into a North Carolina floodplain. American Midland Naturalist 118:40–45.

Bryson, C.T., and R. Carter. 1994. Notes on *Carex*, *Cyperus*, and *Kyllinga* (Cyperaceae) in Mississippi with records of eight species previously unreported to the state. Sida 16:171–182.

Carter, R. 1990. *Cyperus entrerianus* (Cyperaceae), an overlooked species in temperate North America. Sida 14:69–77.

Carter, R., and C.T. Bryson. 1996. *Cyperus entrerianus*: A little-known aggressive sedge in the southeastern United States. Weed Technology 10:232–235.

Carter, R., and S.D. Jones. 1991. Additional records of *Cyperus entrerianus* (Cyperaceae) in the United States. Sida 14:615–616.

Crenwelge, G.W., J.D. Crout, E.L. Griffin, M.L. Golden, and J.K. Baker. 1981. Soil survey of Brazoria County, Texas. United States Department of Agriculture, Soil Conservation Service, Washington, DC. 140 pp.

Davis, M., and K. Thompson. 2000. Eight ways to be a colonizer; Two ways to be an invader. Bulletin of the Ecological Society of America 81:226–230.

Heady, H.F., J.W. Bartolome, M.D. Pitt, G.D. Savelle, and M.C. Stroud. 1992. California Prairie. Pp. 313–335, *In* R.T. Coupland (Ed). Ecosystems of the World 8A. Natural Grasslands: Introduction and Western Hemisphere. Elsevier, Amsterdam, Holland. 469 pp.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett. 1990. Index Herbariorum Part I: The Herbaria of the World. New York Botanical Garden. New York, NY.

Huston, M.A. 2004. Management strategies for plant invasions: Manipulating productivity, disturbance, and competition. Diversity and Distributions 10:167–178.

Luken, J.O. 2003. Invasions of forests in the eastern United States. Pp. 283–301, *In* F.S. Gilliam and M.R. Roberts (Eds.). The Herbaceous Layer in Forests of Eastern North America. Oxford University Press, New York, NY.

Nuzzo, V. 1999. Invasion pattern of the herb garlic mustard (*Alliaria petiolata*) in high quality forests. Biological Invasions 1:169–179.

Olden, J.D., and N.L. Poff. 2003. Toward a mechanistic understanding and prediction of biotic homogenization. The American Naturalist 162:442–460.

Pimentel, D. (Ed.). 2002. Biological Invasions: Economic and Environmental Plants, Animals, and Microbe Species. CRC, Boca Raton, FL. 369 pp.

Rosen, D.J., and R.B. Faden. 2005. *Gibasis pellucida* (Commelinaceae), a new and potentially weedy genus and species for Texas. Sida 21:1931–1934.

Westbrooks, R.G. 1998. Invasive Plants, Changing the Landscape of America: Fact Book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds, Washington, DC.

Westbrooks, R.G. 2001. Invasive species, coming to America: New strategies for biological protection through prescreening, early warning, and rapid response. Wildland Weeds 4:5–11.

Woods, K.D. 1993. Effects of invasion by *Lonicera tatarica* L. on herbs and tree seedlings in four New England Forests. American Midland Naturalist 130:62–74.

Zimdahl, R.L. 1995. Introduction. Pp. 1–18, *In* A.E. Smith (Ed.). Handbook of Weed Management Systems. Marcel Decker, Inc., New York, NY.

Appendix I. Specimen citations for additional collections not reported by Carter (1990), Carter and Jones (1991), Bryson and Carter (1994), and Carter and Bryson (1996). Herbarium acronyms follow Holmgren et al. (1990).

ALABAMA. Houston Co.: sandy gravelly railroad switch area, just S of US 84, downtown Dothan, 14 Oct 1996, *Kral 86914* (VSC).

FLORIDA. Escambia Co.: Pensacola, roadside, 06 Aug 1941, *Brinker 413* (US). Leon Co.: small flood-control pond at E end of Municipal Drive, just W of Mabry and S of Pensacola Streets in Tallahassee, 15 Jun 2000, *Anderson 19354* (VSC). St. Lucie Co.: just W of Fort Pierce, along Hwy FL 70, ca 200 m E jct. Florida Turnpike and Hwy FL 70, 27°24.46'N 80°23.57'W, 22 Sep 1996, *Carter 13828* (VSC).

GEORGIA. Atkinson Co.: just W of Kirkland, ditch along N side Hwy. US 82, 31°18.560'N 082°54.851'W, 25 Aug 2005, *Carter 16109* (VSC). Bacon Co.: W side Alma, by Hwy GA 32, near N end Bacon County Airport, ditch along N side Hwy GA 32, locally common, 06 Aug 1998, *Carter 14173* (VSC). Bulloch Co.: S side Statesboro, W side Hwy. US 301, disturbed vacant lot, 32°24.763'N 081°48.239'W, 29 Oct 2005, *Carter and Kral 16257* (VSC). Charlton Co.: Homeland, jct. Bowery Lane and Guinn Place Drive, ruderal staging area for truck transport company, 30°51.143'N, 082°01.061'W, local, 22 Oct 2003, *Carter 15232* (VSC). Long Co.: Ludowici, S edge of town, open disturbed area adjacent to truck stop, SE Hwy US 84, locally common, UTM 17 428662E 3508333N, 23 Aug 2002, *Carter and Rosen 14736* (VSC).

McIntosh Co.: Eulonia, just W jct. hwys. US 17 and GA 99, 31°31.519'N 081°25.903'W, ditch and backslope by Hwy GA 99, 19 Sep 2003, *Carter 15087* (VSC). Toombs Co.: Parkers, 0.75 mi N jct. Hwys US 1 and GA 56, ditch by Paul Lockley Rd, SE jct. with Hwy US 1, local, 06 Aug 1998, *Carter 14150* (VSC).

MISSISSIPPI. Harrison Co.: Gulfport, ca. 0.5 mi. NE jct. Hwy I-10 and US 49, T7S R11W Sect 9 or 10, open disturbed area, vacant lot across from shopping strip mall, 08 Oct 2004, *Bryson 20389* (SWSL, VSC). Jones Co.: Laurel, SE quadrant intersection I-59 and Hwy US 84, 31°41.811'N 089°06.891'W, poorly drained area of truck stop, S Hwy US 84, locally common, 20 Sep 2004, *Carter 15800* (VSC). Pearl River Co.: ca. 3 mi. S Picayune, Nicholson Community, between Hwy US 11 and RR to W jct. of Hwy US 11 and MS 607, T6S R17W Sect. 38, open area, 10 Sep 2004, *Bryson 19789* (SWSL, VSC). Tunica Co.: ca. 0.6 mi. NE of Robinsville Community, SE jct. of Hwy US 61 and Grand Casino Parkway South, T3S R11W Sect. 18 NE/4 of NE/4 (34°50.195'N 090°16.639'W) E of Hwy US 61, Delta Region, 15 Aug 2004, *Bryson and Bryson 20319* (SWSL).

TEXAS. Austin Co.: N of I-10, 3.1 mi E of FM 1458, E of Sealy, between service road and interstate, N29º46'18.2" W96º03'30.4" (NAD83), 17 Sep 2004, *Rosen 3100* (VSC, SBSC). Bee Co.: overgrazed prairie S of TX Hwy. 202, about 8.3 miles W of its intersection with FM 2441, W of the town of Beeville, N28°23'17.3" W97° 33'02.5"), 12 Sep 2004, *Rosen and Carter 3093* (TEX, BRIT). Brazoria Co.: S corner of TX 35 and FR 2917, SW of Alvin., 09 Sep 1997, *Jones 13067* (SAT). Brazos Co.: N side of Briarcrest Dr., ca. halfway between TX 6 and Wildflower Drive in Bryan, 06 Jun 1997, *Jones 13047* (SAT). Calhoun Co.: Myrtle Foester-Whitmire Unit of the Aransas National Wildlife Refuge, about 1 mile SE of County Rd. 316 in the town of Indianola, N28º30'26.7" W96 º32'38.7", 02 Oct 2004, *Rosen et al. 3146* (BRIT, TEX, VSC). Cameron Co.: about 20 miles north of Brownsville, Paredes Line Road, 16 Jun 1941, *Runyon 2761* (TEX). Colorado Co.: median of Interstate Highway 10, about 1.5 miles W of CORD 217, between the towns of Schulenberg and Columbus, UTM 14 719802E 3286772N, 30 Jun 2004, *Rosen 2994* (VSC, SBSC). Galveston Co.: roadside FM 1266 at intersection with Hwy. 96, S of Gulf Airport., 15 Sep 2001, *Rosen 1645* (TAES). Goliad Co.: N roadside of TX Hwy. 239, about 13.2 mi W of its intersection with Hwy US 77, SE of the town of Goliad, N28 º 35' 23.8" W97 º 13' 37.1", 12 Sep 2004, *Rosen and Carter 3090* (TEX). Hardin Co.: N of FM 418 at Village Creek, between Kountze and Silsbee, frequent in deep, sandy soils of disturbed riparian forest remnant, N30º23'53.3" W94º15'52.6", 13 Jun 2005, *Rosen 3426* (TEX, VSC). Jasper Co.: East of State Highway 62, 5.1 miles N of its intersection with State Highway 12, 3.8 miles S of Farm Road 2246, S of the town of Buna, 13 Jun 2005, *Rosen 3425* (TEX, VSC). Liberty Co.: Trinity River NWR, adjacent to tributary of Picketts Bayou, NW of pipeline right-of-way, UTM 15 327219E 3311629N, 29 Aug 2002, *Rosen 2310* (SBSC). Montgomery Co.: Jones State Park, edge camping lake, sandy soil, 01 Jul 1982, *Kessler 6240* (TAES). Orange Co.: Adjacent to service road south of Interstate 10, 1.5 miles W of its intersection with State Highway 62, W of the town of Orange, 13 Jun 2005, *Rosen 3424* (TAES, TEX, VSC). Polk Co.: Big Thicket National Park (Big Thicket Unit), old well pad site along Horse Trail, south of Sun Flower Road, 18 Sep 2002, *Jones 14937* (SAT). Refugio Co.: Vidaurri Ranch, about 1.8 miles W of entrance to ranch, about 8 miles SW intersection Hwy US 77 and Hwy TX 239, 28 mi S Victoria, N28º25'38.6"W97º10'30.0", 12 Sep 2004, *Rosen and Carter 3083* (TEX, BRIT). San Augustine Co.: Angelina National Forest, 09 June 05, *Conway s.n.* (SFA). San Jacinto Co.: roadside ditch N of Hwy. 150, 1.4 miles W of its intersection with Hwy 59, W of Shepherd., 11 Sep 2003, *Rosen 2627* (VSC, SBSC). San Patricio.: S side Odem, parking area of truck stop E Hwy US 77, between Hwy US 77 and railroad, 27°56.577'N, 097°35.275'W, 13 Sep 2004, *Carter 15535* (VSC). Travis Co.: Austin; headwaters of Gaines Creek, about 400' NW intersection Brodie Ln. and US 290, 27 Nov 2004, *Turner s.n.* (VSC, TEX). Tyler Co.: On and W of US Hwy. 287, 7.7 miles S of its intersection with U. S. Hwy. 190 in the town of Woodville, 13 Jun 2005, *Rosen 3427* (TEX, VSC). Victoria Co.: S Victoria, RV Park, N Hwy US 59, ca. 6.5 mi NE jct. hwys. US 59 and TX 185, N28°49'27.0" W96°55'13.5", disturbed ground, *Carter and Rosen 15520* (VDB, VSC). Waller Co.: 0.1 mi S on Schlipf Road from its jct. with Morton Road., 24 Sep 1992, *Jones 9687* (VSC). Wharton Co.: Roadside of Highway 102, about 8 miles S of Eagle Lake, UTM 14 762260E 3263940N (NAD 83), 30 Jun 2004, *Rosen 2995* (VSC).

Appendix II. Species sampled in the herbaceous layer at Bird Pond and Dance Bayou. Species considered capable of reaching the shrub or canopy layer are indicated by an asterisk (*).

Species	Bird Pond	Dance Bayou
**Ampelopsis arborea* (L.) Köhne		x
Arisaema dracontium (L.) Schott		x
**Baccharis halimifolia* L.	x	
**Berchemia scandens* (Hill) K. Koch	x	x
Brunnichia ovata (Walter) Shinners		x
**Callicarpa americana* L.		x
Callitriche peploides Nutt.	x	
**Campsis radicans* (L.) B. Seemann ex E. Bureau	x	x
Carex basiantha Steud.		x
Carex blanda Dewey	x	x
Carex bulbostylis Mack.		x
Carex caroliniana Schwein.	x	
Carex cherokeensis Schwein.	x	x
Carex corrugata Fernald		x
Carex flaccosperma Dewey	x	x
Carex leavenworthii Dewey	x	x
Carex oxylepis Torr. & Hook. var. *oxylepis*		x
Carex texensis (Torr. ex L.H. Bailey) L.H. Bailey		x
**Celtis laevigata* Willd. var. *laevigata*		x
Chasmanthium laxum (L.) H. O. Yates var. *sessiliflorum* (Poiret) Wipff & S. D. Jones	x	x
**Cocculus carolinus* (L.) DC.		x
Conoclinium coelestinum (L.) DC.	x	
Cynosciadium digitatum DC.	x	
Cyperus entrerianus Böeck.	x	
Cyperus thyrsiflorus Jungh.		x
Cyperus virens Michx. var. *virens*	x	
Desmodium glabellum (Michx.) DC.	x	x
Dichondra carolinensis Michx.	x	x
Eleocharis acicularis (L.) Roem. & Schult. var. *acicularis*	x	
Eleocharis montana (Kunth) Roem. & Schult.	x	
Eleocharis wolfii (A. Gray) A. Gray ex Britton	x	
Elephantopus carolinianus Raeusch.		x
Elymus virginicus L. var. *virginicus*		x
Eupatorium serotinum Michx.		x
**Forestiera ligustrina* (Michx.) Poiret		x
**Fraxinus pennsylvanica* Marshall	x	x
Galium aparine L.	x	x
Galium tinctorium (L.) J. Scopoli	x	
Geum canadense Jacq. var. *camporum* (Rydb.) Fernald & Weath.		x
Hydrocotyle verticillata Thunb.	x	
Hygrophila lacustris (Cham. & Schltdl.) Nees	x	
Hypericum hypercoides (L.) Crantz	x	
**Ilex decidua* Walter		x
**Ilex vomitoria* Aiton	x	x
Juncus tenuis Willd. var. *tenuis*	x	

Species	Bird Pond	Dance Bayou
Leersia virginica Willd.	x	x
Malvaviscus drummondii Torr. & A. Gray		x
Matelea gonocarpos (Walter) Shinners		x
Melica mutica Walter		x
Micromeria brownei (Sw.) Benth. var. *pilosiuscula* A. Gray	x	
Muhlenbergia schreberi J.F. Gmel.		x
Myosotis macrosperma Engelm.	x	x
Oplismenus hirtellus (L.) P. Beauv. subsp. *setarius* (Lam.) Mez	x	x
Oxalis dillenii Jacq.	x	
Panicum commutatum Schult. var. *commutatum*	x	x
**Parthenocissus quinquefolia* (L.) Planch. var. *quinquefolia*	x	x
Passiflora lutea L.		x
Poa autumnalis Muhl. ex Elliott		x
Polygonum punctatum Elliot	x	
**Prunus caroliniana* Aiton		x
**Quercus nigra* L.	x	x
**Quercus shumardii* Buckley		x
Ranunculus hispidus Michx. var. *nitidus* (Chapm.) T. Duncan		x
Ranunculus pusillus Poiret	x	
Rubus argutus Link	x	x
Ruellia strepens L.		x
Sabal minor (Jacq.) Pers.	x	x
Sanicula canadensis L.	x	x
Sanicula odorata (Raf.) Pryer & Phillippe		x
Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L.D. Benson		x
Scleria oligantha Michx.		x
Sida rhombifolia L.	x	
Smallanthus uvedalia (L.) Mack. ex Small		x
**Smilax bona-nox* L.		x
**Smilax rotundifolia* L.	x	
**Smilax smallii* Morong		x
Solidago canadensis L. var. *scabra* (Muhl. ex Willd.) Torr. & A. Gray	x	
Spigelia texana (Torr. & A. Gray) A. DC.	x	x
Stellaria prostrata Baldwin ex Elliott		x
Symphoricarpos orbiculatus Moench		x
Symphyotrichum racemosum (Elliott) G. Nesom var. *subdumosum* (K. Wiegand) G. Nesom	x	
Teucrium canadense L. var. *canadense*	x	
Thelypteris kunthii (Desv.) C.V. Morton		x
Tovara virginiana (L.) Raf.		x
**Toxicodendron radicans* (L.) Kuntze	x	x
**Ulmus crassifolia* Nutt.	x	x
Urtica chamaedryoides Pursh		x
Verbesina virginica L. var. *virginica*		x
Viola sororia Willd. var. *sororia*	x	x

ADDITIONAL NOTEWORTHY COLLECTIONS OF *CYPERUS DRUMMONDII* (CYPERACEAE) FROM TEXAS AND FIRST REPORT FROM MEXICO

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ABSTRACT

Recent noteworthy collections of *Cyperus drummondii* from the Texas Gulf Prairies and Marshes, Piney Woods Natural Regions, and a first record from Mexico are reported.

RESUMEN

Se citan colecciones recientes notables de of *Cyperus drummondii* de las paraderas y charcas del Golfo de Texas, Piney Woods Natural Regions, y una primera cita de Mexico.

Collections of *Cyperus drummondii* Torr. & Hook. from the Gulf Coast Prairies and Marshes as defined by Gould (1975) from Texas counties not previously reported by Rosen (2004) were made during field work in 2004–2007 as follows:

TEXAS. Fort Bend Co.: Buffalo Creek Unit of the San Bernard National Wildlife Refuge, S of FM 442, 7.2 km W of its intersection with Hwy. 36, between the towns of Boling and Needville, 10 May 2007, *Rosen 4114* (BRIT, TAES, TEX, VSC).

At this location, *Cyperus drummondii* occurred frequently in prairie wetlands on clayey-loam soils with *Carex aureolensis* Steud., *C. festucacea* Schkuhr ex Willd., *C. triangularis* Boeck., *Cyperus reflexus* Vahl, *Eleocharis* sp., *Juncus acuminatus* Michx., *J. brachycarpus* Engelm., *J. marginatus* Rostk., *Polygonum* sp., *Sesbania drummondii* (Rydb.) Cory., and *Steinchisma hians* (Elliott) Nash.

Victoria Co.: McFaddin Ranch, about 2.8 mi E of the jct. of U.S. Hwy. 77 and FM 445 in the town of McFaddin, 11 Sep 2004, *Rosen 3056 & Carter* (MICH, TEX); *Carter 15438 & Rosen* (VDB, VSC, others to be distributed).

At this location, *Cyperus drummondii* was locally abundant in a large prairie wetland on clayey-loam soils of the Lissie Formation with *Acacia farnesiana* (L.) Willd., *Andropogon gerardii* Vitman, *Cyperus* spp., *Eleocharis ravenelii* Britton, *Leersia hexandra* Sw., *Paspalum* spp., *Polygonum* sp., *Prosopis glandulosa* Torr., and *Rhynchospora* spp.

Reports of *Cyperus drummondii* from the Piney Woods in the *Illustrated Flora of East Texas, Vol. 1.* (Diggs et al. 2006) are based on two very old collections from the southeast margin of East Texas (Rosen 2004). Recent field work in Hardin County has resulted in collections of *C. drummondii* from a hillside seepage bog and the margins of a flat-woods pond as cited here:

TEXAS. Hardin Co.: Roy E. Larsen Sandyland Sanctuary, N of State Hwy. 327, between the towns of Silsbee and Kountze, 08 Oct 2006, *Rosen 3949 & Brown and Boensch* (BRIT, MICH, TAES, TEX, VSC).

The label data from the historic collections of *Cyperus drummondii* from eastern Texas provide no details on its habitat (Rosen 2004). We expand the habitat description of this species in Texas to include hillside seepage bogs and flat-woods ponds, in addition to the relict Coastal Prairie wetlands noted by Rosen (2004). At the Roy E. Larsen Sandyland Sanctuary, *C. drummondii* was occasional to frequent on sandy soils in shallow water on the fringes of a flatwoods pond and wet sandy soils of a hillside seep with *Dichanthelium* sp., *Eleocharis* spp., *Fuirena* sp., *Morella cerifera* (L.) Small, *Panicum hemitomon* Schult., *Saccharum giganteum* (Walter) Pers., and *Scirpus cyperinus* (L.) Kunth. This is very similar to the habitat of this species in the Gulf Coastal Plain of Georgia and Mississippi (Carter et al. 1999).

Denton (1978) reported *Cyperus drummondii* [as *C. virens* Michx. var. *drummondii* (Torr. & Hook.) Kük.] as occurring in North America (Texas and Louisiana), Nicaragua, Jamaica, the Galapagos Islands, Surinam, and Brazil. Tucker (1994) and Espejo Serna and López-Ferrari (1997) included *C. drummondii* under *C. virens* in Mexico. During field work near the city of Durango following the Second Botanical Symposium of Northern Mexico, we collected specimens of *C. drummondii*, confirming its occurrence in Mexico. Review of specimens at CIIDIR also resulted in the discovery of other collections of *C. drummondii* from the Mexican state of Durango previously identified as *C. virens*.

Specimens examined. **MÉXICO. Durango:** proximidad a Canelas, terrenos de la UAF Topia, Mpio. Canelas, montemojino, transición entre el bosque tropical caducifolio y el bosque de pino, 1414 m snm, suelo profundo, café muy pedregoso, con pendientes hasta de 45°, 27 Sep 1990, *Benítez 2409* (CIIDIR), Carretera Durango-Nombre de Dios, Km 246.5, Mpio. Nombre de Dios, Aug1997, matorral xerófilo, *González 354* (CIIDIR); 17 km al E de Durango por la carretera a Fresnillo, lugar inundado cerca de la carretera, localmente abundante, 1960 m, 18 Oct 1983, *Gonzalez & Acevedo 2747* (CIIDIR); Rio Tunal, bajo puente en libramento de carretera Zacatecas–Torreón (cerca del Balneario San Juan), Mpio. Durango, 19 Jan 1999, *Pinedo 24* (CIIDIR), 31 km de La Guajolota, por el camino a Los Charcos, Mpio. El Mezquital, estanque en medio de bosque de pino-encino, escaso, dentro del agua, 2000 m, 8 Oct 1983, *Gonzalez 2701* con *Gonzalez y Acevedo* (CIIDIR), Carretera 45 al E de la Ciudad de Durango (Puente Gavilanes). Mpio. Durango, 24°0'51" N, 104°29'25" W, 1850 m, vegetación riparia (*Salix bonplandiana*), común, hierba, 08 Oct 1999, *Gonzalez 3195* (CIIDIR); Mpio. Durango, 17.7 km al SSE de Durango, por la carretera a El Mezquital, al S de Felipe Ángeles, 23°55'21" N, 104°32'40" W, 1850 m, vegetacion subacuatica, abundante a orilla de canal, 16 Sep 2005, *González 7091* con *Guaglianone, Torres, Rosen, Carter y Peterson* (CIIDIR, ANSM, ENCB, IEB, MEXU, SD); *Carter 16149, 16150 & Gonzalez, Guaglianone, Torres, Rosen, & Peterson* (VDB, VSC, others to be distributed); *Rosen 3493, 3494 & Carter, González, Guaglianone, Torres, & Peterson* (TAES).

The following key modified from Denton (1978) and Carter et al. (1999) will separate *Cyperus drummondii* from other members of the *C. virens* complex in Mexico.

1. Primary peduncles 3–5; floral scales 1.0–1.5(–1.8) mm long; spikelets at least 2.25 mm wide __________ **C. drummondii**
1. Primary peduncles 6–12(–14); floral scales 1.5–2.4 mm long; spikelets (2–)2.2–3.3 mm wide.
   2. Achenes (2.5–)3–5 times longer than wide, (1–)1.2–1.5 mm long; spikelets (5–)7–15 mm long __________ **C. virens** var. **virens**
   2. Achenes 2–2.5 times longer than wide, 1–1.2 mm long; spikelets 5–6.5 mm long __________ **C. virens** var. **minarum**

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REFERENCES

Carter, R., D.K. Alexander, C.T. Bryson, and A. Lazari. 1999. The taxonomy of *Cyperus virens* and *Cyperus drummondii* in the southeastern United States. Sida 18:1049–1063.

Denton, M.F. 1978. A taxonomic treatment of the *Luzulae* group of *Cyperus*. Contr. Univ. Michigan Herb. 11: 197–271.

Diggs, G.M. Jr., B.L. Lipscomb, M.D. Reed, and R.J. O'Kennon. 2006. Illustrated flora of East Texas, Vol. 1. Sida, Bot. Misc. 26.

Espejo Serna, A. and A.R. López-Ferrari. 1997. Las monocotiledóneas mexicanas Una sinópsis floristica. 1. Lista de Referencia. Parte V Cyperaceae. Consejo Nacional de la Flora de México, A.C., México, D.F.

Gould, F.W. 1975. Texas plants—a checklist and ecological summary. MP-585 Revised, Texas Agricultural Experiment Station, College Station.

Rosen, D.J. 2004. Noteworthy collections of *Cyperus drummondii* (Cyperaceae) from Texas. Sida 21:495–497.

Tucker, G.C. 1994. Revision of the Mexican species of *Cyperus* (Cyperaceae). Syst. Bot. Monogr. 43:1–213.

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Preparation and Use of Voucher Specimens for Documenting Research in Weed Science

Richard Carter, Charles T. Bryson, and Stephen J. Darbyshire*

Voucher specimens and herbarium collections provide the foundation for many aspects of research in the plant sciences. Available for study and verification by contemporary and future workers, voucher specimens promote reproducibility in scientific method because permanent records document identification, distribution, and interspecific and intraspecific variation of species. The utility and importance of voucher specimens and herbarium collections in supporting research in weed science are discussed, and the collection, preparation, documentation, storage, and shipment of voucher specimens are detailed.

Key words: Herbarium; herbarium specimen; documentation of research; use of herbarium specimens; preparation of herbarium specimens; handling of herbarium specimens; storage of herbarium specimens.

Properly prepared voucher specimens are fundamentally essential in documenting occurrences and distributions of plant species. The specimen itself is tangible, permanent, and verifiable evidence, and its label includes geographical and ecological data. Vouchers also provide evidence of hybridization, seed set, flowering, and fruiting dates and may even be sources of seed for germination studies. Voucher specimens should be deposited in an officially recognized public herbarium (Holmgren and Holmgren 1998; Holmgren et al. 1990), where they will receive proper care and will become permanent records available to other researchers. An herbarium is a collection of dried plant specimens, a permanent repository of specimens and data, and a component of most state universities, natural history museums, botanical gardens, and federal plant-research facilities. Excellent background and introduction to the herbarium are provided by von Reis Altschul (1977) and Simpson (2006). Herbarium specimens will last indefinitely if properly prepared, cared for, and protected from water, humidity, and a variety of pests, such as insects and fungi. Each specimen is a voucher, providing a permanent record of the occurrence of a species at a particular geographical location and time; thus, specimens without associated data are of limited use. Although often neglected by weed scientists (cf. Muenscher 1955; Zimdhal 1999), voucher specimens and the herbarium fulfill a vital role by enabling the accurate identification of weeds and documentation of research. The essential role of vouchers and herbarium collections in scientific research and the importance of citing voucher specimens in publications are emphasized by Funk and Morin (2000) and Funk et al. (2005).

Herbarium specimen data have been used to map historical distributions and to elucidate pathways and means of dispersal in North America of introduced weeds, such as dog mustard [*Erucastrum gallicum* (Willd.) O. E. Schulz] (Luken et al. 1993) and European brooklime (*Veronica beccabunga* L.) (Les and Stuckey 1985). Voucher specimens routinely provide documentation about the introduction and dispersal of newly introduced weeds (e.g., Carter and Mears 2000; Carter et al. 1996), and morphometric data taken from herbarium specimens were analyzed to establish the origin of the introduced weed bloodscale sedge (*Cyperus sanguinolentus* Vahl) and thereby resolve its nomenclature (Carter and Bryson 2000). Herbarium specimen data were used by Petřík (2003) to analyze dispersal dynamics since 1854 of an introduced weed, lovegrass sedge (*Cyperus eragrostis* Lam.), in Europe and by Rosen et al. (2006) to revise concepts relating to the historical distribution and introduction of deeproot sedge (*Cyperus entrerianus* Boeck.) in the United States, to map its distribution, and to evaluate its status. Barney (2006) used herbarium specimen data to recreate the historic phytogeographical distributions of two invasive plant species, mugwort (*Artemisia vulgaris* L.) and Japanese knotweed (*Polygonum cuspidatum* Sieb. & Zucc.), in North America. Observations of characters present on herbarium specimens were used to explain increased vigor (heterosis) through hybridization or introgression in a highly competitive invasive weed (Carter 1990). Phenology data documented by herbarium specimens have recently been used to investigate climate change (e.g., Lavoie and Lachance 2006; Miller-Rushing et al. 2006), and DNA studies of herbarium specimens are possible under certain conditions (e.g., Drábková et al. 2002; Ribeiro and Lovato 2007; Šmarda and Stančik 2006).

Weed science research is greatly enhanced when substantiated by voucher specimens available for study by contemporaries and scientists in the decades and centuries to come. Therefore, preparation of voucher specimens should be a routine part of research in weed science. The purpose of this article is to provide information to the weed science community on basic procedures for preparing and handling plant specimens.

Preparing Voucher Specimens

The following steps are normally involved in preparing a voucher specimen from start to finish: (1) locate the plant,

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Specimen data

Geographical data
- ➡ Country
- ➡ State
- ➡ County
- ➡ Locality (e.g., distance and direction from nearest town or other landmark, hwy intersection, etc.)

Ecological data
- Habitat (e.g., roadside, pasture, coastal prairie, bayswamp, etc.)
- Size and extent of population

Misc. data
- Flower color
- Habit (e.g., 3 m shrub, 40 ft tree, vine, etc.)

➡ Collector name(s) & number

➡ Collection date

Figure 1. Data elements normally recorded in the field notebook when preparing voucher specimens; arrows indicate essential elements.

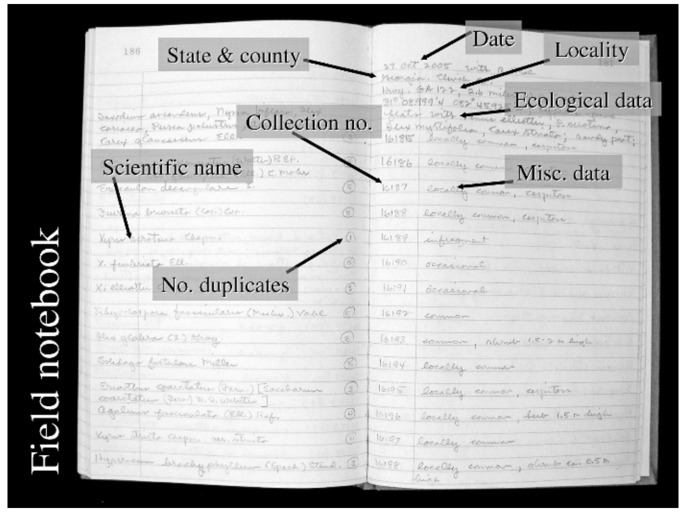

Figure 2. Field notebook showing organization of the basic data elements: date, state, county, locality, ecological and miscellaneous data, collection number, number of duplicate specimens, and determination (scientific name) of voucher.

(2) prepare the plant for pressing, (3) record geographical and other data in a field notebook, (4) press the specimen, (5) dry the specimen, (6) identify the specimen, (7) prepare the label, (8) mount the specimen, (9) apply a serial accession number to the herbarium sheet, (10) sort the specimens, and (11) file the specimen systematically into the herbarium. Steps 9 through 11 are normally done by herbarium staff. Most herbarium curators will accept well-prepared, unmounted voucher specimens so long as they include adequate data, and many will accept unidentified vouchers and identify them in exchange for the specimen as a contribution to the herbarium collection. Therefore, it is generally acceptable to complete only steps 1 through 5 or 6 and still send the voucher to an herbarium where it will be further processed and properly stored. Now available online, *Index Herbariorum* (Holmgren and Holmgren 1998; Holmgren et al. 1990) is a catalog of the world's officially recognized herbarium collections and a useful source with addresses and contact information for herbaria.

Recording Specimen Data. Ideally, the following kinds of data are recorded: geographical data, including country, state, county, and specific locality with latitude and longitude coordinates; ecological data, particularly type of habitat, size, and extent of population, soil type, names of associated plant species, and the type and identity of plants on which parasites and epiphytes are growing; miscellaneous data denoting features of the plant that might not be evident in the finished specimen, such as flower color or plant height; collector's name; collection number; and date of collection. If the voucher provides documentation for a particular project, then the name of the project or a brief statement about it might be included in the specimen data. Voss (1999) provides useful guidelines for recording data and preparing specimen labels. The arrows in Figure 1 indicate essential data elements.

Although field botanists normally record collection data in a field notebook, data could be included in any research record book. The field notebook should be small enough to be conveniently slipped into a daypack and should have a permanent binding and high-quality paper. Field notebooks are available from most forestry, engineering, or scientific supply houses. Figure 2 shows how the basic data elements might be organized in the field notebook. Also, after the voucher specimen is identified, its determination is normally recorded in the notebook correlated with a unique collection number. Although a variety of systems are used for designating collection numbers, we recommend beginning with "0001" and increasing serially with each new voucher collection. Normally, duplicate collections made from the same population at one site on the same day are given the same serial collection number. Most field botanists use serial collection numbers because they are a convenient means of keeping track of large numbers of specimens and data, and we would hope researchers who routinely collect vouchers for preservation in the herbarium would see their value and use some system for numbering specimens sequentially. However, the absence of collection numbers should never deter a scientist from submitting voucher specimens to an herbarium. Figure 3 shows a data sheet for voucher specimens that might be adapted to accompany unlabeled specimens sent to an herbarium. Herbaria may or may not have the resources to produce labels for extrinsic specimens, but processing of specimens at any herbarium is expedited when properly prepared labels are included. Nevertheless, specific details about responsibilities and requirements with regard to contributions of voucher specimens should be arranged in advance with the individual herbarium curator.

Duplicate Specimens. In most cases it is desirable to collect more than one voucher specimen per population. Disseminated to multiple herbaria through specimen exchange programs by herbarium curators, duplicate vouchers are readily available to a wider field of researchers. Duplicates are especially important in the documentation of newly introduced weeds, as they greatly facilitate identification at new geographical stations by other scientists. Also, with problematical specimens, it is sometimes desirable to send a duplicate to a taxonomic specialist for determination or

VOUCHER SPECIMEN DATA
Required elements shown in bold at top of form

Date of collection:

Collector name(s): Collection number:

Country:

State:

County (Parish):

Locality (e.g., 3.5 miles west of intersection of Interstate 75 and Hwy. US 84 in Valdosta):

GPS coordinates:

Habitat type (e.g., bayswamp, marsh, pasture, roadside):

Size and extent of population:

Misc. data (e.g., flower color, plant height):

Figure 3. Sample data sheet for voucher specimens sent without labels to an herbarium.

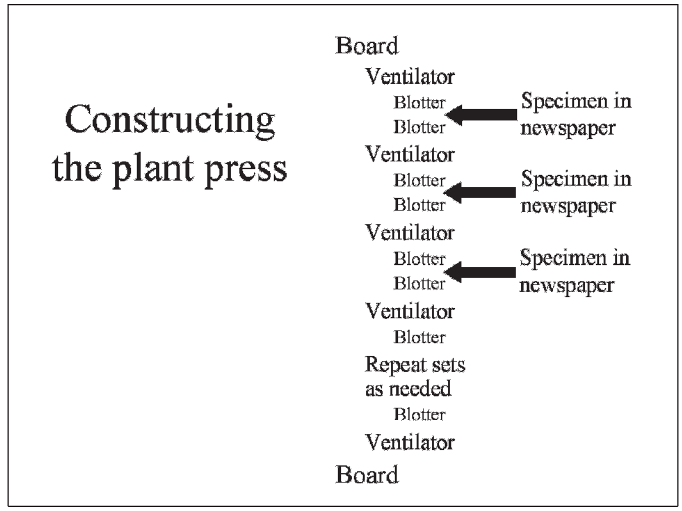

Figure 4. Schematic showing how the press is constructed with each specimen enfolded in a newspaper page inserted between press sets.

confirmation. Under standard practice, the specialist would keep the duplicate for addition to his or her institutional herbarium in exchange for the identification service.

Pressing Specimens. The two main objectives in pressing plant specimens are (1) to flatten the plant in a size and conformation that display important characteristics and are convenient for storage in standard herbarium cabinets and (2) to dry the plant material as quickly as possible maximizing preservation of structures and chemical compounds as well as preventing degradation by organisms that grow or feed on organic substrates (i.e., fungi, bacteria, etc.). Certain types of plants require special treatment (e.g., aquatics and succulents), but for most plants, preparing specimens is a simple process.

Specimens are normally pressed enfolded in single newspaper pages. Whereas most any absorbent paper may be used, newspaper is inexpensive and readily available, and a folded single sheet of newspaper is slightly smaller than the standard herbarium sheet and, thus, is a practical guide for preparing properly sized voucher specimens. The entire newspaper section (e.g., the sports section) is easily reduced to individual pages by tearing lengthwise in half along the vertical center crease. The collection number is then written along the margin of the folded newspaper page, and the newspaper page with enfolded specimen is then placed between two ventilator-blotter sets in the plant press.

Plant press components may be purchased from scientific or herbarium supply companies or constructed and assembled from basic materials. The standard press consists of two straps or ropes, two plywood or lattice header boards [1.3 by 30.5 by 45.7 cm (0.5 by 12 by 18 inches)], paper blotters [30.5 by 45.7 cm (12 by 18 inches)] to absorb moisture from the specimen, and ventilators [30.5 by 45.7 cm (12 by 18 inches)] with channels oriented parallel to their 30.5-cm (12-inch) edges. The ventilators allow warm air to flow through the press as the specimens are dried. Ventilators are commonly constructed of corrugated cardboard. Although relatively inexpensive and lightweight, corrugated cardboard ventilators become crushed with repeated use and must be routinely inspected and replaced. This is especially a problem under wet, humid field conditions; therefore, more expensive corrugated aluminum sheets are sometimes employed as ventilators in the tropics. Heavy-duty press straps with parachute buckles are recommended because they tend to be more durable than rope and are not prone to slipping. Open-cell foam sheets [0.5 by 30.5 by 45.7 cm (0.2 by 12 by 18 inches)] may be used in place of paper blotters for specimens with both thick, hard parts and thin, delicate structures. Figures 4–7 show how to construct the plant press and place the voucher specimen for efficient drying.

Additional Considerations in Preparing Specimens. The plant base should always be rinsed free of soil before the specimen is placed in the newspaper fold. Ideally, to the extent possible, the appearance of the finished specimen should conform to the living plant, and it is important to include parts and life stages that are useful for identification. If specimens are too large to fit the newspaper page, their stems and leaves should be carefully broken and folded or cut to fit. Cutting or breaking and folding are preferable to bending the stems, because with cutting or breaking there is usually no doubt about how the specimen was altered during preparation. In contrast, artificial bending of the stem is to be avoided because with bending one cannot so easily discern whether the condition is natural or artificial.

Small Herbs. With small herbs (< 1 m tall), the entire plant is generally preserved. If they are small enough, several plants should be pressed within the newspaper fold, although crowding plants within the newspaper will prolong the drying period. Include as much of the plant base as practical or at least a representative portion of the root system, rhizome, or other subterranean organ. Plants should be dug from the ground because important underground structures are often broken off by pulling.

Large Herbs. With larger herbs, the stem may be broken and folded one or more times to fit the newspaper page or may be cut into two or more sections, each pressed in a separate

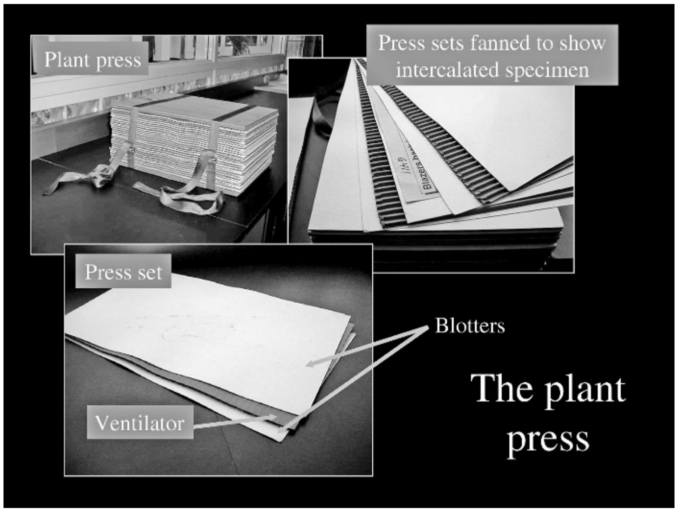

Figure 5. Each press set consists of a ventilator placed between two blotters, and each voucher specimen, enfolded in a newspaper page, is intercalated between two press sets.

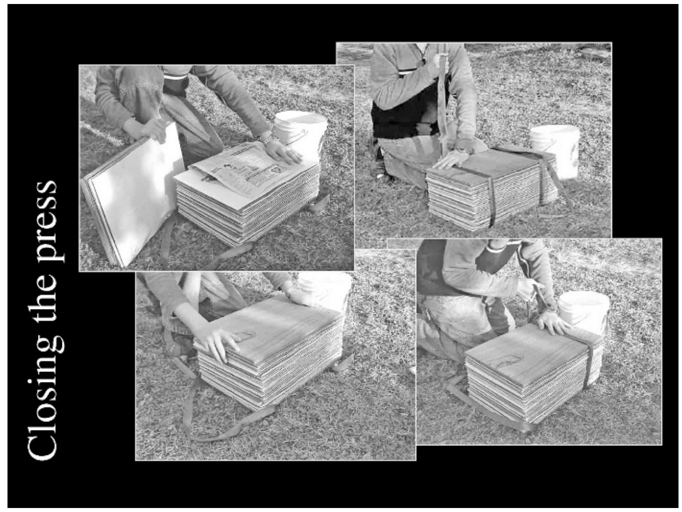

Figure 7. Steps in closing a press for drying.

newspaper fold. If it is impractical to preserve the entire plant, then cut it in pieces and include representative portions: the plant base, a portion of the midstem with attached leaves, and the upper stem with leaves and flowers or fruits. If the entire plant is not preserved, then its height should be estimated and recorded in the field notebook.

Trees, Shrubs, and Vines. Only representative portions of trees, shrubs, and vines are preserved. Be sure to include enough of the stem to show the pattern of leaf arrangement. Also, position the leaves to show both upper and lower surfaces, and include flowers or fruits. Break and fold the stems, and estimate the plant height and record it in the field notebook.

Large fleshy fruits, stems, or subterranean organs (e.g., taproots, corms, tubers, bulbs) can be especially difficult to dry, and they are normally sliced into two or more sections before placement into the newspaper fold and pressed for drying. Normally, large dry fruits and seed cones are not pressed. Instead, they are tagged separately with the same collection number as the pressed voucher specimen.

Figure 6. Steps in preparing and pressing specimens.

Well-preserved voucher specimens with intact flowers or fruits are essential for positive identification, especially of poorly known species, newly introduced nonindigenous species, or other species not represented in the herbarium. Voucher specimens should include the anatomical structures necessary to identify each particular group. Mature fruits are essential for positive identification of grasses, sedges, rushes, and similar kinds of plants, and characteristics of the plant base are also critically important in identifying such plants. Therefore, care should be taken to include representative portions of rhizomes or other subterranean structures when the specimen is removed from the ground.

Jones and Luchsinger (1986) discuss general plant collection techniques, and Hicks and Hicks (1978) provide a thorough review on practices of herbarium curation and plant collection. The wet, humid environment of lowland tropical areas presents special challenges in drying voucher specimens and preserving them against pests, especially in remote locations. Under such conditions, numbered specimens enfolded in newspaper are doused with alcohol, bundled together, and placed in large, heavy-duty plastic bags to prevent decomposition before access can be found to a dryer. Blotters are changed daily to remove moisture from specimens during drying. Additionally, specialized collection methods are employed for certain kinds of plants, e.g., aquatics (Haynes 1984), succulents (Baker et al. 1985), aroids (Croat 1985), and palms (Dransfield 1986).

Special Considerations for Invasive Weeds. During and after collection, every precaution should be taken to prevent dispersal of seeds or other reproductive parts of plants, especially of noxious weeds. This would normally include cleaning of footwear, trowels, mattocks, buckets, or other collecting gear in the field; proper disposal of plastic bags used to hold specimens; and proper housekeeping indoors in areas where specimens are dried and handled. A stiff brush is useful

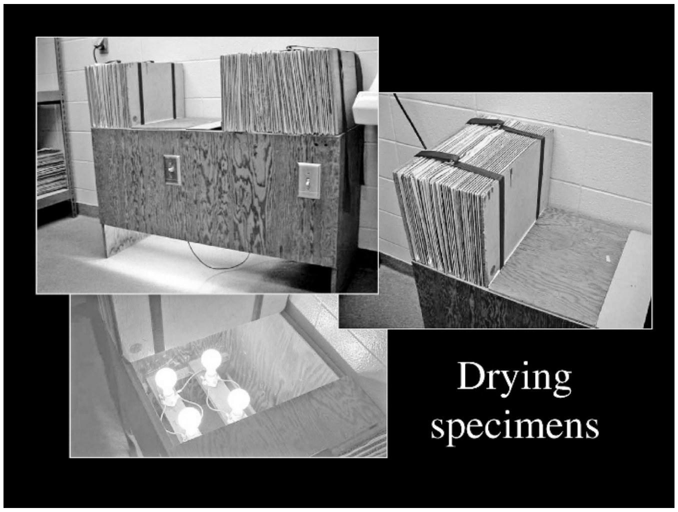

Figure 8. Drying voucher specimens with a simple plant dryer.

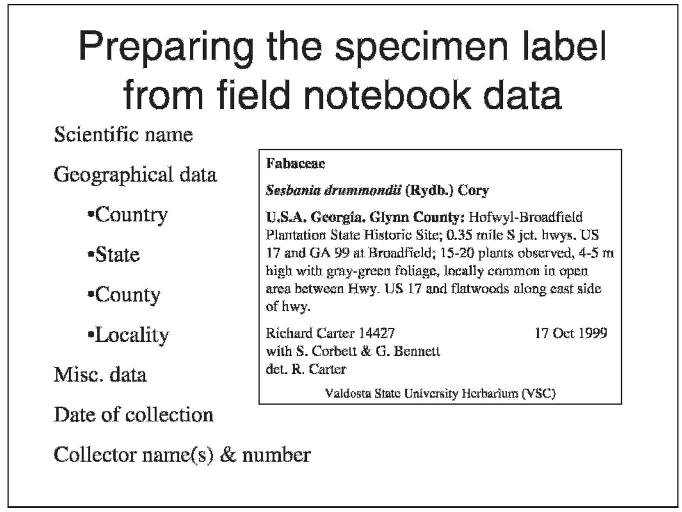

Figure 9. A sample label showing organization of the various data fields.

in cleaning footwear, clothing, and collecting equipment in the field, and equipment can be heat treated with an autoclave to prevent dispersal of seeds or other propagules. Plastic sleeves are useful to prevent dispersal of seeds and to protect the collector from stinging hairs or toxic compounds.

In the United States, federal laws provide for control and management of importation, transportation, and commerce of noxious weeds (Tasker 2007). Additionally, individual states have laws preventing transportation, possession, or sale of harmful weeds. All federal, state, and local regulations should be followed in preparing, handling, transporting, and shipping of jurisdictional weeds and their propagules.

Refrigerating Specimens. Refrigeration (4 C) is a convenient means of keeping fresh specimens for short periods (i.e., several days) when immediate processing is not possible. The fresh specimen should be kept in a closed plastic bag during refrigeration, and precautions should be taken to prevent freezing. Also, it may be beneficial to place a dry paper towel in the bag during refrigeration to absorb excess moisture.

Drying Specimens. Once the press is assembled with a header board and ventilator on each end (Figure 4), the straps are positioned and tightened. The plant press is then placed on a dryer so that warm air rises up through the ventilators taking moisture away from the specimens as it passes between them. The simple dryer shown in Figure 8 is essentially a plywood box open at the top and bottom. Heat, generated by 150-watt incandescent bulbs or some other source, rises by convection and passes through the presses above. For increased efficiency and safety, the dryer should be used in a well-ventilated room and precautions should be taken (e.g., installation of a hardware-cloth or screen barrier beneath the press) to prevent paper components of the press or parts of the specimen from coming into contact with heating elements. Frequently, at colleges and universities, arrangements can be made to use drying facilities at the local institutional herbarium. When a dryer is unavailable, a fan may be positioned to circulate air through the press and speed moisture removal. This can be an effective alternative under conditions of low relative humidity, but is largely ineffective in humid environments.

Identifying Specimens. A stereo-dissecting microscope is useful when identifying plant specimens, and regional floristic manuals are usually employed for routine determinations. However, newly introduced, nonindigenous plants present much greater difficulty, and their reliable identification usually requires access to a wide variety of primary literature (e.g., scientific journals and monographs), exotic floras, or the assistance of a taxonomic specialist. Because most taxonomic identification keys are based largely upon characteristics of flowers and mature fruits, it is essential that specimens of poorly known or newly introduced species possess these structures. Reference specimens already deposited in the herbarium are indispensable and greatly facilitate the determination of problematic specimens.

Preparing Labels. Data taken from the field notebook are used to prepare labels for the voucher specimens, as shown in Figure 9. Labels are permanently printed on archival-quality paper. Word processors and databases are widely available, easy to use, and can greatly expedite label preparation. With laser printing the ink is bonded to the paper and is less susceptible to fading; therefore, laser printers should be used in label production instead of inkjet printers. As indicated previously, many herbarium curators accept well-prepared specimens without labels, so long as they are accompanied by adequate data. A form for recording collection data to submit with a voucher specimen in the absence of a finished label is shown in Figure 3.

Mounting Specimens. This discussion is not intended to provide complete instructions on mounting herbarium specimens. Instead, its aim is only to provide some general background about how the dried voucher specimen is processed into a finished herbarium specimen. Mounting of the plant on a sheet of stiff herbarium paper (Figure 10) enables convenient storage while providing a certain degree of protection to the

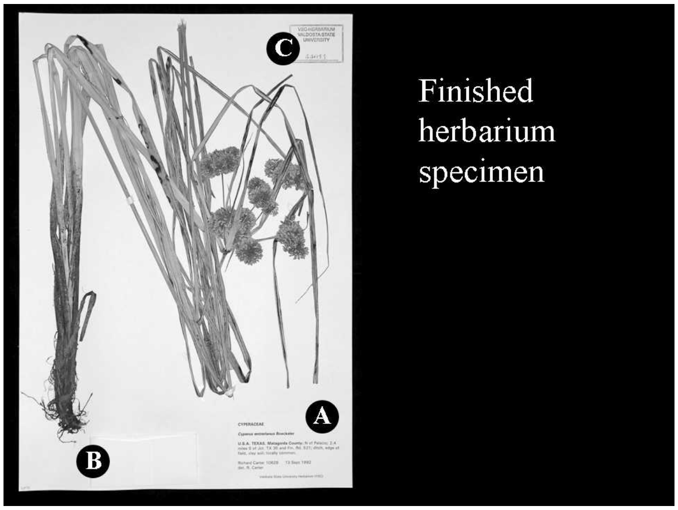

Figure 10. A finished herbarium specimen showing (A) label, (B) fragment packet, and (C) herbarium stamp with accession number.

specimen during handling. To ensure longevity, only archival-quality materials (i.e., buffered, neutral pH) are used in preparing herbarium specimens. The dried voucher specimen is mounted on a sheet [29.2 by 41.9 cm (11.5 by 16.5 inches)] of archival-quality herbarium paper with a specimen label printed on archival-quality paper. Specimen fragments and loose seeds are normally preserved in archival-quality paper packets, and glue or linen tape is used to affix the specimen, label, and fragment packet to the herbarium sheet. Archival-quality herbarium materials are available from most herbarium, museum, and library supply companies.

A variety of mounting methods are used to affix the dried plant specimen to the herbarium sheet. In the "spot welding" technique, the specimen is inverted and drops of glue are placed on its lower side, then it is carefully turned back over and placed onto the herbarium sheet and weighted down with metal weights (e.g., large washers, rebar segments) until dry. In the glass-plate method, a sheet of glass or a plastic tray is coated with a thin layer of glue using a paintbrush; the specimen is placed on the layer of glue and carefully lifted out with forceps and placed on the herbarium sheet. To prevent unwanted sticking after application of the glue, a sheet of wax paper is temporarily placed on top of the specimen between it and a piece of cardboard, then pressure is applied through the cardboard until the glue dries. Specimens may also be strapped to the herbarium sheet using strips of archival-quality adhesive-linen tape or strands of glue extruded from a plastic applicator bottle. Archer's adhesive, and modifications (Croat 1978), dry to form clear plastic straps. These polystyrene polymers have been used extensively in herbaria in the past, but because their use requires exposure to volatile organic solvents, they have fallen into disfavor. Water-soluble glues are best because they are usually nontoxic and can be loosened or removed if needed. Whatever the mounting technique, care must be taken to avoid obscuring plant structures, encasing small fruits or flowers in the adhesive, or rehydrating tissues thorough excessive application of water-based adhesives. Plastic tape and staples should never be used to attach specimens to the paper.

Sorting and Filing Specimens. Once mounted, the finished voucher specimens are given serial accession numbers, sorted by taxonomic group, and filed sequentially in herbarium cases using archival-quality genus folders.

Storing, Handling, and Shipping Voucher Specimens

Storing and Handling Specimens. Dried voucher specimens, both before and after mounting, are properly stored in a dry, pest-free environment. Generally, they should be kept in tight herbarium cases at a temperature below 21 C with relative humidity below 50% (Lull and Moore 1999). Unprocessed or partially processed specimens should be isolated from the herbarium collection, and all incoming specimens should be frozen to eliminate pests before transfer into the herbarium collection. As an additional precaution, repellents or insecticides, such as naphthalene or dichlorvos (DDVP), are kept in the herbarium cases (Hall 1988), although health concerns about exposure to any such compound should always be taken into consideration. If facilities are not available for proper storage, voucher specimens should be sent to an herbarium as soon as possible. Metsger and Byers (1999) provide additional recommendations for proper storage of herbarium specimens.

Freezing Specimens to Control Pests. Freezing is a safe and effective means of controlling insect pests in herbarium specimens. Rapid freezing is essential to prevent acclimation of pests (Hall 1988). To ensure rapid freezing, specimens are frozen in packets no more than 15 cm (about 6 inches) thick, and to reduce condensation problems, the specimen packet is placed in a plastic bag before freezing. In a conventional domestic freezer, the specimens should be held at a temperature of −18 C or lower for at least 48 h. For control of resistant dermestids, refreezing is recommended after rapidly bringing the packet to 15–20 C. If available, an ultracold (−40 to −80 C) freezer is most effective. Herbarium pest-control methods are reviewed by Hall (1988) and Strang (1999).

Shipping Voucher Specimens. Unmounted, dried voucher specimens are easily mailed. Even international shipment generally does not require a permit, although some types of plants may be restricted under certain conditions. The dried specimens in newspaper folds are sandwiched between reinforcing pasteboards and secured with tape before posting. Additional pasteboards should be used as necessary for reinforcement. Depending on the number of specimens being sent, suitably sized cardboard cartons are useful for shipping.

If drying facilities are not available, it is possible to ship a "fresh" specimen. The specimen is first placed within a folded newspaper section (e.g., section A, sports section, arts section) and then flattened by placing books or other heavy objects on the newspaper section for several days. The specimen still in the newspaper section is then sandwiched between reinforcing pasteboards, secured with tape, and mailed. This method should be used only as a last resort, when a plant dryer is not available, and the recipient should always be given prior notice before shipment. Following are some additional precautions that should be observed in preparing voucher specimens.

- Do not tape or staple specimens to paper.
- Do not mail fresh specimens in zip-lock or other plastic bags.
- Do not leave specimens in zip-lock or other plastic bags at room temperature for prolonged periods.

Long-Term Storage of Specimens. Properly prepared voucher specimens can be kept indefinitely in the herbarium if stored under ideal conditions. The oldest European herbaria date to the 16th and 17th centuries (von Reis Altshul 1977, Holmgren et al. 1990). Although valid use of herbarium specimens by researchers is certainly encouraged, special care must be taken in the handling of historically significant and unique specimens. Type specimens, which are especially valuable in taxonomic research (McNeill et al. 2006), or very old or rare specimens are often photographed to minimize unnecessary handling, thereby reducing the risk of damage.

Conclusions

One of the most basic attributes of science is that it be repeatable. The absence of a voucher specimen indicating exactly which species is the subject of a research project presents a dilemma of the most fundamental sort should the research ever be questioned or new information suggest the need for reappraisal. The voucher specimen, permanently preserved in an herbarium, can be critically examined and reexamined, and its identity can be verified, refuted, or disputed by other researchers. Even if shown to be misidentified, the voucher provides tangible supporting evidence for the research and allows for correction by future workers. Thus, voucher specimens and herbarium collections are essential components of any well-designed research project. Additionally, such specimens provide a broader sampling of biological data that may be important in completely unrelated studies.

Much of what we know about the distributions of plant species is based upon label data on voucher specimens in herbarium collections, and there is enormous potential for using herbarium specimens and associated data to elucidate much about distributions, patterns of dispersal, and origins and relationships of weeds. We encourage weed scientists to work more closely with herbarium botanists, to support herbarium collections, and to document their research by depositing properly prepared voucher specimens in publicly accessible herbaria.

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Literature Cited

Baker, M. A., M. W. Mohlenbrock, and D. J. Pinkava. 1985. A comparison of two new methods of preparing cacti and other stem succulents for standard herbarium mounting. Taxon 34:118–120.

Barney, J. N. 2006. North American history of two invasive plant species: phytogeographic distribution, dispersal vectors, and multiple introductions. Biol. Invasions 8:703–717.

Carter, R. 1990. *Cyperus entrerianus* (Cyperaceae), an overlooked species in temperate North America. Sida Contrib. Bot. 14:69–77.

Carter, R. and C. T. Bryson. 2000. *Cyperus sanguinolentus* (Cyperaceae) new to the southeastern United States, and its relationship to the supposed endemic *Cyperus louisianensis*. Sida Contrib. Bot. 19:325–343.

Carter, R. and R. L. Mears. 2000. *Cyperus* (subg. *Queenslandiella*) *hyalinus* (Cyperaceae) new to the United States and the Western Hemisphere. Sida Contrib. Bot. 19:345–350.

Carter, R., R. L. Mears, K. C. Burks, and C. T. Bryson. 1996. A report of four exotic *Cyperus* (Cyperaceae) species new to Florida, U.S.A. Sida Contrib. Bot. 17:275–281.

Croat, T. 1978. Survey of herbarium problems. Taxon 27:203–218.

Croat, T. 1985. Collecting and preparing specimens of Araceae. Ann. Mo. Bot. Gard. 72:252–258.

Drábková, L., J. Kirschner, and C. Vlĉek. 2002. Comparison of seven DNA extraction and amplification protocols in historical herbarium specimens of Juncaceae. Plant Mol. Biol. Rep. 20:161–175.

Dransfield, J. 1986. A guide to collecting palms. Ann. Mo. Bot. Gard. 73:166–176.

Funk, V. A. and N. Morin. 2000. A survey of the herbaria of the southeast United States. Sida Bot. Misc. 18:35–52.

Funk, V. A., P. C. Hoch, L. A. Prather, and W. L. Wagner. 2005. The importance of vouchers. Taxon 54:127–129.

Hall, A. V. 1988. Pest control in herbaria. Taxon 37:885–907.

Haynes, R. R. 1984. Techniques for collecting aquatic and marsh plants. Ann. Mo. Bot. Gard. 71:229–231.

Hicks, A. J. and P. M. Hicks. 1978. A selected bibliography of plant collection and herbarium curation. Taxon 27:63–99.

Holmgren, P. K. and N. H. Holmgren. 1998. Index Herbarium: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih.

Holmgren, P. K., N. H. Holmgren, and L. C. Barnett. 1990. Index Herbariorum, Part I: The Herbaria of the World. 8th ed. Regnum Veg. 120. Bronx, NY: The New York Botanical Garden, 693 p.

Jones, S. B. and A. E. Luchsinger. 1986. Plant Systematics. New York: McGraw-Hill, 512 p.

Lavoie, C. and D. Lachance. 2006. A new herbarium-based method for reconstructing the phenology of plant species across large areas. Am. J. Bot. 93:512–516.

Les, D. H. and R. L. Stuckey. 1985. The introduction and spread of *Veronica beccabunga* (Scrophulariaceae) in eastern North America. Rhodora 87:503–515.

Luken, J. O., J. W. Thieret, and J. R. Kartesz. 1993. *Erucastrum gallicum* (Brassicaceae): invasion and spread in North America. Sida Contrib. Bot. 15:569–582.

Lull, W. P. and B. P. Moore. 1999. Herbarium building design and environmental systems. Chapter 5, Pages 105–118 *in* D. A. Metsger and S. C. Byers, eds. Managing the Modern Herbarium, An Interdisciplinary Approach. Washington, DC: Society for the Preservation of Natural History Collections (SPNHC).

McNeill, J., F. R. Barrie, H. M. Burdet, V. Demoulin, D. L. Hawksworth, K. Marhold, D. H. Nicolson, J. Prado, P. C. Silva, J. E. Skog, J. H. Wiersema, and N. J. Turland, eds. 2006. International Code of Botanical Nomenclature (Vienna Code) adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005. Regnum Veg. 146. Ruggell, Liechtenstein: A.R.G. Gantner, xviii + 568 p.

Metsger, D. A. and S. C. Byers, eds. 1999. Managing the Modern Herbarium, An Interdisciplinary Approach. Washington, D.C.: Society for the Preservation of Natural History Collections (SPNHC). 384 p.

Miller-Rushing, A. J., R. B. Primack, D. Primack, and S. Mukunda. 2006. Photographs and herbarium specimens as tools to document phenological changes in response to global warming. Am. J. Bot. 93:1667–1674.

Muenscher, W. C. 1955. Weeds. Ithaca, NY: Cornell University Press, 586 p.

Petřík, P. 2003. *Cyperus eragrostis*—a new alien species for the Czech flora and the history of its invasion of Europe. Preslia, Praha 75:17–28.

Ribeiro, R. A. and M. B. Lovato. 2007. Comparative analysis of different DNA extraction protocols in fresh and herbarium specimen of the genus *Dalbergia*. Genet. Mol. Res. 6:173–187.

Rosen, D. J., R. Carter, and C. T. Bryson. 2006. The spread of *Cyperus entrerianus* (Cyperaceae) in the southeastern United States and its invasive potential in bottomland hardwood forests. Southeast. Nat. 5:333–344.

Simpson, M. G. 2006. Plant Systematics. San Diego, CA: Elsevier Academic, 590 p.

Šmarda, P. and D. Stančík. 2006. Ploidy level variability in South American fescues (*Festuca* L., Poaceae): use of flow cytometry in up to 5 1/2-year-old caryopses and herbarium specimens. Plant Biol. 8:73–80.

Strang, T.J.K. 1999. A healthy dose of the past: a future direction in herbarium pest control? Chapter 3, Pages 59–80 *in* D. A. Metsger and S. C. Byers, eds. Managing the Modern Herbarium, An Interdisciplinary Approach. Washington, DC: Society for the Preservation of Natural History Collections (SPNHC).

Tasker, A. V. 2007. Federal Weed and Seed Laws. *In* B. L. Harper-Lore, M. Johnson, and M. W. Skinner, eds. Roadside Weed Management. Washington D.C.: Federal Highway Administration, In press.

von Reis Altschul, S. 1977. Exploring the herbarium. Sci. Am. 236:96–104.

Voss, E. G. 1999. Labeling of herbarium specimens. Mich. Bot. 38:57–63.

Zimdahl, R. L. 1999. Fundamentals of Weed Science. 2nd ed. London: Academic. 556 p.

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INFRASPECIFIC TAXONOMY AND NOMENCLATURE OF *ELEOCHARIS ACUTANGULA* (CYPERACEAE)

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ABSTRACT

A taxonomic study of *Eleocharis acutangula* (Roxb.) Schult. was conducted in order to better define this poorly understood and variable pantropical species. Multivariate statistical analysis, and ecological and distributional data of worldwide collections of *E. acutangula* provided the basis for its segregation into *E. acutangula* subsp. *acutangula*, **E. acutangula** subsp. **breviseta** D.J. Rosen, subsp. nov., and **E. acutangula** subsp. **neotropica** D.J. Rosen, subsp. nov. Nomenclatural research necessitated the lectotypification of *E. acutangula* and a heterotypic synonym, *E. fistulosa* Schult. var. *robusta* Boeck. A taxonomic treatment of *E. acutangula* is provided that includes a key to the subspecies, detailed descriptions, illustrations, and notes on habitat and distribution.

RESUMEN

Se realizó un estudio taxonómico de *Eleocharis acutangula* (Roxb.) Schult. para definir mejor esta especie pantropical variable y pobremente conocida. Un análisis estadístico multivariante, y datos ecológicos y de distribución a nivel mundial de *E. acutangula* fueron la base para su segregación en *E. acutangula* subsp. *acutangula*, **E. acutangula** subsp. **breviseta** D.J. Rosen, subsp. nov., y **E. acutangula** subsp. **neotropica** D.J. Rosen, subsp. nov. La investigación nomenclatural precisó la lectotipificación de *E. acutangula* y de un sinónimo heterotípico, *E. fistulosa* Schult. var. *robusta* Boeck. Se aporta un tratamiento taxonómico de *E. acutangula* que incluye una clave de subespecies, descripciones detalladas, ilustraciones, y notas sobre el hábitat y distribución.

Eleocharis R. Br. is a cosmopolitan genus of about 200 species and over 600 published names with a center of diversity in the Neotropics (González-Elizondo & Tena-Flores 2000). *Eleocharis* subg. *Limnochloa* (P. Beauv. ex Lestib.) Torr. (= *Eleocharis* ser. *Mutatae* Svenson) comprises over 35 species occurring in seasonally wet to permanently flooded habitats from principally tropical regions, and is distinguished from other *Eleocharis* by a combination of the following morphological characteristics: (1) cartilaginous, un-keeled (rarely obscurely-keeled), many-veined floral scales; (2) generally large culms that are often as thick as the cylindrical spikelet; and (3) biconvex (rarely trigonous) achenes usually with epidermis of large, conspicuous polygonal cells (Svenson 1929; González-Elizondo & Peterson 1997). Five new species in subg. *Limnochloa* have recently been described from the New World: *E. eglerioides* S. González & Reznicek and *E. liesneri* S. González & Reznicek from Venezuela (S. González-Elizondo & Reznicek 1996), *E. yecorensis* Roalson from Mexico (Roalson 1999), *E. laeviglumis* R. Trevis. & Boldrini from Brazil (Trevisan & Boldrini 2006), and *E. steinbachii* D.J. Rosen from Bolivia (Rosen & Hatch in press). However, no comprehensive study of subg. *Limnochloa* has been published since the seminal work of Svenson (1929, 1939).

Eleocharis acutangula (Roxb.) Schult. is the most widely distributed species of *Eleocharis* subg. *Limnochloa* (Svenson 1939 [as *E. fistulosa* Schult.]). In the New World it is reported from near sea level to elevations over 2200 m from various habitats including cloud forests, forest depressions, savannahs, grasslands, palm swamps, lake margins, borrow pits, and roadside ditches. Old World habitats include swamps, forest depressions, streams, savannahs, grasslands, borrow pits, lake margins, and rice paddies. Several authors have reported considerable variation in *E. acutangula* (Svenson 1929 [as *E. fistulosa*], 1939; Haines & Lye 1983; Browning et al. 1997). Svenson (1929, 1939) indicated *E. planiculmis* Steud. and *E. fistulosa* Schult. var. *robusta* Boeck. were potential segregates of *E. fistulosa*, which is treated herein as a synonym of *E. acutangula*. Hess (1953) described *Heleocharis pseudofistulosa* H. Hess based on plants he collected in Angola, and stated that they differed from *E. fistulosa* in surface characteristics of the achene. Hess (1957) later provisionally reported *H.* cf. *pseudofistulosa* from South America (Brazil), which differed in having terete rather than sharply three-angled culms; this is presumably *E. obtusetrigona* (Lindl. & Nees) Steud.

Svenson (1939) included *Eleocharis fistulosa* among five poorly defined tropical African taxa, and Browning et al. (1997) described variability among specimens of *E. acutangula* from different geographical areas in southern Africa. Our research reported here, including observations of live plants in the field and a study of herbarium specimens from a broad geographical area, shows considerable variability within *E. acutangula,* thus confirming the work of Svenson (1939) and Browning et al. (1997). A critical examination of over 600 specimens of *E. acutangula* suggested sufficient variation existed to warrant recognition of three infraspecific taxa: *E. acutangula* subsp. *acutangula*, *E. acutangula* subsp. *breviseta*, and *E. acutangula* subsp. *neotropica*. The objectives of this research were: (1) to investigate the morphological variation within *E. acutangula* and (2) to review all the apposite nomenclature in order to typify *E. acutangula* and its synonyms.

METHODS

Specimens were borrowed from herbaria that could provide loans yielding broad geographical representation of *Eleocharis acutangula* including types and authentic specimens. Over 600 specimens were examined from the following herbaria (acronyms follow Holmgren et al. 1990): BM, BRI, BRIT, C, CIIDIR, CM, E, F, FTG, GA, GH, IBE, ICN, K, LL, M, MEXU, MICH, MO, NH, NU, NY, P, PH, PRE, RSA, TAES, TEX, US, USF, VSC, WIS, Z, and ZT. Selected for multivariate analysis were 198 mature herbarium specimens (including types) complete for all morphological characters measured. Specimens studied originated from Africa, Australia, Bolivia, Brazil, China, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, Guyana, India, Japan, Madagascar, Malaysia, Mexico, Panama, Peru, United States, Venezuela, and Vietnam. Because of the limited number of specimens complete for all morphological characters, duplicate specimens collected by the same collector were measured. A complete citation of all specimens examined during this research can be found in Rosen (2006).

Quantitative and qualitative vegetative characters (e.g., culm height, width, texture, and cross-sectional shape; leaf sheath texture and structure; rhizome length and diameter) are highly plastic. Although these features are of some use in *Eleocharis* at the infrageneric level, they are of no value in distinguishing infraspecific taxa. In *Eleocharis* subg. *Limnochloa*, significant variation in culm anatomy in response to environmental conditions has been reported (Edwards et al. 2003; Baksh and Richards 2006). Svenson (1929) emphasized achene characters and perianth bristle texture in differentiating species of *Eleocharis*. A review of the literature reveals a tendency of workers investigating closely related species and infraspecific variation in *Eleocharis* to rely primarily on characters associated with the achene (Hines 1975; Larson & Catling 1996; Gregor 2003). Indeed, achene-related characters are important in taxonomic limits in *Eleocharis* at all levels (Menapace 1991).

Twenty morphological characters were selected for initial evaluation (Table 1). For each specimen a mature achene and its subtending scale were selected from near the base of a spikelet. Each specimen measured was complete for all characters so that the data matrix contained no missing values. One measurement per character was taken from each specimen, and 198 specimens (114 of *Eleocharis acutangula* subsp. *acutangula*, 67 of *E. acutangula* subsp. *breviseta*, and 17 of *E. acutangula* subsp. *neotropica*) were analyzed utilizing principal component analysis (PCA). The raw morphometric data were standardized and analyzed using NTSYSpc 2.11Q, and the principal components were generated using a correlation matrix (Rohlf 2000). A final analysis comprising six characters (Table 2) was run, and a scatter plot of the first two principal components was generated in an effort to depict morphological relationships.

RESULTS

The first three principal components represented 87.3% of the total variance (50.3%, 24.3%, and 12.7% for PC1, PC2, and PC3 respectively; Table 2) of 198 specimens scored for six morphological characters. Principal component 1 is most influenced by high positive loadings of LONBRSTL, TBRCL, BRSTLNACHNL

Table 1. Initial 20 morphological characters used to evaluate the infraspecific variation within *Eleocharis acutangula*.

Symbol	Character
ACHNL	achene length (from base to constriction at neck)
ACHNLW	ratio of achene length to width (achene shape)
ACHNMAX	ratio of achene length to distance from achene base to widest point (determines if achene is widest above, at, or below middle)
ACHNSCAL	ratio of achene length to floral scale length
ACHNW	achene width (at widest point)
BRSTACH	number of perianth bristles longer than summit of achene
BRSTLACHNL	ratio of length of longest perianth bristle to achene length
BRSTLNACHNL	ratio of number of perianth bristles longer than summit of achene to total number of perianth bristles
BRSTN	number of perianth bristles
LONBRSTL	length of longest perianth bristle
LONROW	number of longitudinal rows of cells on achene face
NECKWACHNW	ratio of achene neck width to achene width
NECKW	achene neck width
SCALEL	floral scale length
SCALELW	ratio of floral scale length to width
SCALEW	floral scale width
TBRACHW	ratio of tubercle width to achene width
TBRCL	tubercle length
TBRCLW	ratio of tubercle length to width (tubercle outline shape)
TBRCW	tubercle width

(Table 2). Principal component 2 is most influenced by a high positive loading of NECKWACHNW and a high negative loading of TBRClW (Table 2). Although there are varying degrees of overlap among the three taxa, specimens from each subspecies cluster together into distinct groups (Fig. 1). Specimens of *Eleocharis acutangula* subsp. *breviseta* and *E. acutangula* subsp. *neotropica* are almost completely separated along principal component axes 1 and 2 (Fig. 1). Specimens of *E. acutangula* subsp. *acutangula* overlap slightly with *E. acutangula* subsp. *breviseta* along principal component axis 1 and *E. acutangula* subsp. *neotropica* along principal component axis 2. The relatively small area of the graph (Fig. 1) occupied by *E. acutangula* subsp. *breviseta* and *E.* subsp. *neotropica* compared to that occupied by *E. acutangula* subsp. *acutangula* is presumably the result

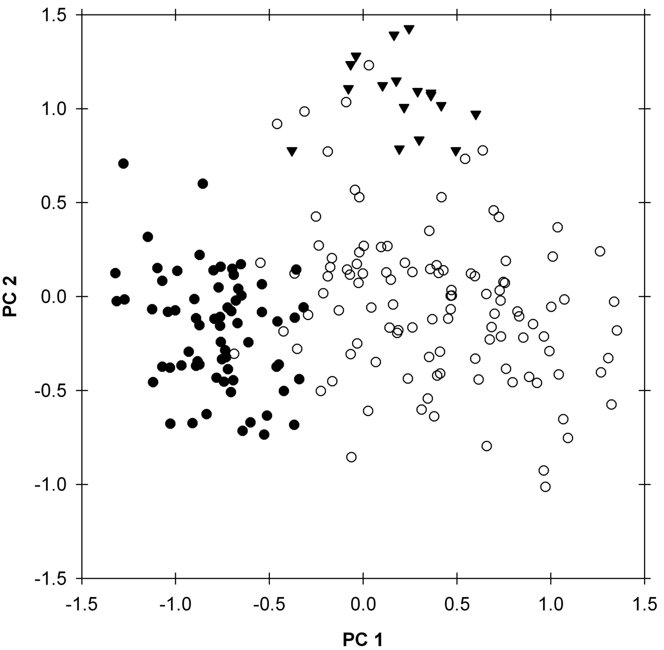

Fig. 1. Scatter plot of first two principal components from PCA for six variables from 198 specimens of *Eleocharis acutangula* subsp. *acutangula* (open circles), *E. acutangula* subsp. *breviseta* (closed circles), and *E. acutangula* subsp. *neotropica* (triangles).

Table 2. Eigenvalues and total percent variance represented by each principle component and loadings onto the first three principle component axes for 6 morphological characters used in PCA of 198 specimens of *Eleocharis acutangula* subsp. *acutangula*, *E. acutangula* subsp. *breviseta*, and *E. acutangula* subsp. *neotropica*.

Character	PC 1	PC 2	PC 3
Eigenvalue	3.018	1.459	0.760
Percent variance	50.302	24.317	12.675
LONBRSTL	0.862	0.365	0.030
TBRCL	0.832	-0.348	-0.290
BRSTLNACHNL	0.828	0.324	0.040
TBRCLW	0.695	-0.643	-0.259
ACHNL	0.644	0.220	0.576
NECKWACHNW	0.015	0.799	-0.524

Table 3. Select character comparisons for *Eleocharis acutangula* subsp. *acutangula*, *E. acutangula* subsp. *breviseta*, and *E. acutangula* subsp. *neotropica*. Means and ranges (mean ± 1 standard deviation) are provided for quantitative characters.

Character	subsp. acutangula	subsp. breviseta	subsp. neotropica
achene length (mm)	1.8(1.6–2)	1.6(1.4–1.7)	1.7(1.6–1.8)
achene width (mm)	1.4(1.2–1.6)	1.3(1.2–1.4)	1.4(1.3–1.5)
achene color at maturity	shiny dark amber (dark brown)	shiny dark brown	shiny yellow-green (tinged with amber)
tubercle width (mm)	0.7(0.6–0.9)	0.7(0.6–0.8)	0.9(0.8–1)
achene neck width (mm)	0.6(0.4–0.7)	0.5(0.4–0.6)	0.8(0.7–0.8)
tubercle length (mm)	0.6(0.5–0.8)	0.4(0.3–0.5)	0.5(0.4–0.5)
ratio of achene neck width to achene width	0.4(0.3–0.5)	0.4(0.3–0.4)	0.5(0.6–0.7)
description of perianth bristles	usually all overtopping summit of achene and sometimes the tubercle; coarsely retrorse nearly to the base or less often completely smooth	usually few-none overtopping summit of achene; only a few short, salient retrorse spinules near the tips	all overtopping tubercle; coarsely retrorse nearly to the base
length of longest perianth bristle (mm)	2.6(2–3.3)	1.2(1–1.5)	3.6(3.2–4)
ratio of length of longest perianth bristle to achene length	1.4(1.1–1.7)	0.8(0.6–0.9)	2(1.9–2.3)
ratio of tubercle length to width	0.8(0.6–1.1)	0.6(0.5–0.8)	0.5(0.4–0.6)

of less morphological variability in *E. acutangula* subsp. *breviseta* and *E.* subsp. *neotropica*, which perhaps stems from their relatively limited geographical distributions when compared with the more morphologically variable and widespread *E. acutangula* subsp. *acutangula*. This could also indicate active speciation (local adaptation) in *E. acutangula* subsp. *acutangula*.

DISCUSSION AND CONCLUSION

Multivariate analysis and thorough examination of ca. 600 specimens, including types, warrants the recognition of three infraspecific taxa within *Eleocharis acutangula*. The presence of several conspicuous morphological differences between the three taxa along with a relatively cohesive geographic distribution of *E. acutangula* subsp. *breviseta* and *E.* subsp. *neotropica* (Fig. 2) suggests subspecies is an appropriate rank for classification (Stuessy 1990). A summary of the characters accounting for most of the variability in the multivariate analysis and our observations of achene color and the length and texture of perianth bristle spinules indicate that features of the mature achene and perianth are essential for identification of the subspecies of *E. acutangula* (Table 3). *Eleocharis acutangula* subsp. *breviseta* is distinguished from *E. acutangula* subsp. *acutangula* by its shorter achenes and tubercles and short perianth bristles with only a few short, retrorse spinules near the tips. *Eleocharis acutangula* subsp. *neotropica* differs from *E. acutangula* subsp. *acutangula* by its long, soft, flexuous perianth bristles, weakly constricted achene apex, and the tubercle being usually as wide to wider than long. Differences between *E. acutangula* subsp. *breviseta* and *E. acutangula* subsp. *neotropica* are summarized in Table 3. Greater variability was observed in specimens referable to *Eleocharis acutangula* subsp. *acutangula* for several of the parameters used in the multivariate analysis (Fig. 1; Table 3). Variation was also observed in achene epidermal cell shape, often in achenes from the same herbarium specimen (Rosen 2006).

Svenson (1929, 1939) suggested that *E. fistulosa* var. *robusta* and *E. planiculmis* may represent taxa distinct from *E. acutangula*. However, a critical examination of the types indicates they are only minor expressions of highly variable *E. acutangula* subsp. *acutangula*. Specimens from Madagascar [*DuPuy 2429* (MO, K, P); *Bathie 17929* (P, US); and *Bathie 2722* (P)], including type material of *E. fistulosa*, exhibited obtusely trigonous culms rather than sharply wing-angled triquetrous culms observed in all other specimens of *E. acutangula* examined. Indeed, the protologue of *S. fistulosus* describes the culms as "subtriquetro". These specimens are otherwise referable to *E. acutangula* subsp. *acutangula* for the characters used in the multivariate analysis. We do not propose segregation on the basis of a single, highly plastic vegetative character and with such a limited number of specimens examined.

TAXONOMIC TREATMENT

KEY TO SUBSPECIES OF *ELEOCHARIS ACUTANGULA*

1. Longest perianth bristle 3.2–4 mm long, soft, flexuous, retrorsely spinulose to below the middle (nearly to the base); achene neck weakly constricted, 0.6–0.7 times achene width; tubercle 0.4–0.6 times long as wide; mature achenes yellow-green (tinged with amber); distribution limited to northwest South America ______ subsp. **neotropica**
1. Longest perianth bristle 3.2 mm long or shorter, stiff, retrorsely spinulose only at the tips to near the base or sometimes smooth; achene neck markedly constricted, 0.6 times achene width or less; tubercle 0.5–1.1 times long as wide; mature achenes dark amber to dark brown; distribution more widespread.
    2. Perianth bristles shorter than achene or rarely few to all reaching its summit or slightly surpassing, spinules restricted to the distal half or more commonly only near the tip; achene 1.4–1.7 mm long, dark brown; tubercle 0.3–0.5 mm long ______ subsp. **breviseta**
    2. Perianth bristles longer than achene (rarely one to few just reaching its summit or slightly shorter), spinules nearly to base or rarely spinules completely absent; achene 1.6–2 mm long, dark amber or rarely dark brown; tubercle 0.5–0.8 mm long ______ subsp. **acutangula**

1. Eleocharis acutangula (Roxb.) Schult. subsp. **acutangula** (**Fig. 3 a–b**). *Scirpus acutangulus* Roxb. Fl. Ind. 1:216. 1820. *Eleocharis acutangula* (Roxb.) Schult. Mant. 2:91. 1824. *Limnochloa acutangula* (Roxb.) Nees. Contr. Bot. India 114. 1834. Type: INDIA, *Roxburgh s.n.* (Lectotype here designated: BM [BM000847992]!).

Scirpus medius Roxb. Fl. Ind. 1:216. 1820. *Limnochloa media* (Roxb.) Nees. Contr. Bot. India 114. 1834. Type: INDIA, *Roxburgh s.n.* (not found).

Scirpus fistulosus Poir. Encyclopédie Méthodique, Botanique 6:749. 1804. nom. illeg., non *Scirpus fistulosus* Forssk. 1775. *Eleocharis fistulosa* Schult. Mant. 2:89. 1824. Type: MADAGASCAR, *Poiret s.n.* (holotype: P [Herbier du Petit-Thouars., P00376392]!; isotype: Herb. Poiret in Herb. Moquin-Tandon [P00370140]!).

Eleocharis fistulosa Schult. var. *robusta* Boeck. Flora 62:563. 1876. *Heleocharis robusta* (Boeck.) H. Hess. Ber. Schweiz. Bot. Ges. 63:331. 1953. cum descr. ampl. Type: AFRICA, Africa centralis, Seriba Ghassas, in Lande der Djur ges, 1 Sep 1869, *Schweinfurth 2326* (lectotype here designated: GH!; isolectotypes: Z [000006263, 000006265]!).

Eleocharis planiculmis Steud. Syn. Pl. Glumac. 2:80. 1855. Type: Java, *Zollinger 281* (holotype: P [P00368895]!; isotypes: P [P00368896, P00368897]!, K [K000290949, K000290950]!).

Heleocharis pseudofistulosa H. Hess. Ber. Schweiz. Bot. Ges. 63:329. 1953. Type: ANGOLA: Provinz Huila, Guanhama, Tümpel, 15 km südlich Cubango an der Strasse nach Cassinga, 14 Jan 1952, *Hess 52/220* (holotype: ZT photo! [based on Hess's designation of "Typus"]; isotype: BOL, K, TAES!, Z).

Fig. 2. Distribution of *Eleocharis acutangula* subsp. *acutangula* (open circles), *E. acutangula* subsp. *breviseta* (closed circles), and *E. acutangula* subsp. *neotropica* (triangles). Each symbol represents one or more specimens.

Plants perennial. **Roots** coarse, fibrous, drab-brown to reddish, small storage structures present in carefully collected plants, cylindrical-reniform, brown; primary rhizomes caudex-like, thick, hard, ascending, concealed by roots and persistent culm bases (occurring only in carefully collected specimens); secondary rhizomes elongated, to 4 mm thick, scales to 17 mm long (few seen). **Culms** triquetrous (a few specimens from Madagascar trigonous) distally, (25–)38–81(–135) cm long × (1.2–)2.1–4.4(–6.5) mm wide, soft, internally spongy, with incomplete transverse septa, smooth, green, finely longitudinally striate when dry. **Leaves** 2, reduced to sheaths, apically oblique, membranous, loose, friable, proximally pinkish to dark maroon (dark purplish), distally drab, apex acute. **Spikelets** cylindric, (11–)21–39(–56) mm long × (2.5–) 3.2–4.8(–6) mm wide, acute; proximal scale with flower, obtuse, amplexicaul-clasping, appearing as a continuation of culm, remaining floral scales conspicuously spirally arranged, appressed to somewhat spreading at maturity, ovate-oblong, (2.5–)3.8–5.3(–6) mm long × (1.7–)2.3–3.4(–4.8) mm wide, cartilaginous, abaxially greenish to stramineous centrally, stramineous marginally, sparsely red-maculate and sometimes the veins or other areas reddish or pinkish (purplish) tinged, usually with a fine dark band near apex, adaxially sparsely to copiously red-maculate, apex acute (rounded), distal 0.1–0.5 mm translucent hyaline-erose, central area nearly flat, coarsely many veined, only mid-vein conspicuous in adaxial view. **Flowers** with 6–7(–8) perianth bristles; bristles sub-equal, usually 1.1–1.8 times the length of the achene (rarely one or few just reaching its summit or slightly shorter), retrorsely spinulose nearly to base or rarely completely smooth (both conditions can occur in same population), stramineous or pinkish to dark maroon; stamens 3; anthers (1.1–)1.3–2.2(–3.2) mm long, stramineous; style 3-fid. **Achenes** biconvex, very broadly obovoid to obovoid, the shoulders and sides near the apex usually straight and forming an obtuse angle, or sometimes rounded, (1.4–)1.6–2.0(–2.2) mm long × (1.0–)1.3–1.6(–1.8) mm wide, with (11–)12–15(–19) longitudinal rows of deeply concave transversely oblong to linear polygonal cells visible through transparent periclinal layer on each achene face, dull yellow-buff maturing to shiny dark amber (dark brown), apex constricted to a distinct neck about 0.3–0.5 times the width of achene. **Tubercle** dorsoventrally compressed, shallowly triangular-deltate (triangular), 0.5–0.8(–1.1) mm long × (0.5–)0.6–0.9(–1.2) mm wide, stramineous, maturing to dark brown.

Lectotypification of *Eleocharis acutangula*

Eleocharis acutangula was described by Roxburgh (1820) as *Scirpus acutangulus* based on plants from India. As is the case with apparently all Roxburgh names, no type specimen was designated (Forman 1997). Schultes transferred *S. acutangulus* to *Eleocharis* without indicating a type. A literature search revealed no reference to a particular type specimen although a number of authors indicate the "type" is from India (e.g., Haines & Lye 1983; Gordon-Gray 1995; Browning et al. 1997). Typifying Roxburgh names can be difficult since his specimens were widely distributed, making locating specimens annotated by him or known to be associated with him challenging (Forman 1997). Almost all of Roxburgh's nearly 2600 species were illustrated by color drawings prepared by local Indian artists; the original set is at CAL, and a duplicate set at K (Sanjappa et al. 1991). Forman (1997) indicated that the *Flora Indica* drawings were often superior to the corresponding Roxburgh specimen (if one can be found), and in some instances make a better choice for a type. From the set of drawings at Kew a high resolution digital photograph was obtained of the front and back of the drawing of *S. acutangulus*. The drawing, a stylized depiction of an immature plant, was annotated in what the first author interprets as Roxburgh's hand.

We made queries to curators at key herbaria indicated by Forman (1997) in an effort to locate an authentic Roxburgh specimen. Mark Spencer (BM) presented a specimen (BM-000847992) that he considers to have been associated with Roxburgh, the most compelling evidence being annotations on the verso and front of the specimen. The verso is annotated "Ind. Orient Roxburgh" in an unknown hand, indicating that the specimen was received from Roxburgh, and the front was annotated "72" in what the first author interprets to be Roxburgh's hand. We selected this specimen as the lectotype of *Scirpus acutangulus* since it fits the description in the protologue and is thought with reasonable certainty to have been used by Roxburgh.

Problems with Typification of *Scirpus medius*

Roxburgh described *Scirpus medius* as being similar to *S. acutangulus* but having shorter culms with smooth, rounded angles. Nees (1842) transferred the name to the genus *Limnochloa*. Roxburgh's description of the culms as having rounded angles is troublesome, as all Asian specimens of *Eleocharis acutangula* examined during this research had triquetrous culms. No specimens annotated as *S. medius* were seen by us, and no specimens were located in herbaria where Roxburgh's specimens were distributed. Thus, we follow Svenson (1929) and others (Blake 1939; Koyama 1985; Gordon-Gray 1995) in placing *S. medius* in synonymy under *E. acutangula*.

Clarification of the Authorship of *Eleocharis fistulosa*

Scirpus fistulosus Poir. is illegitimate because of an earlier homonym, *S. fistulosus* Forsskal. *Eleocharis fistulosa* Link is also invalid because Link failed to associate the specific epithet with the name of the genus or species, or with its abbreviation, as mandated by the Art. 33.1 of the ICBN (McNeill et al. 2006). Thus, *E. fistulosa* Schult. is the correct author citation (See ICBN Articles 58.1; 7.5; and 33, Note 2.). Since the priority of *E. fistulosa* does not date back to the publication of Poiret's illegitimate use, *E. acutangula* (Roxb.) Schult. has priority as the oldest legitimate name for the species.

Lectotypification of *Eleocharis fistulosa* var. *robusta*

Eleocharis fistulosa var. *robusta* was described by Boeckeler based on *Schweinfurth 2326* from Central Africa. Boeckeler's types were at B, and, if the holotype of *E. fistulosa* var. *robusta* was ever extant at B, it was destroyed by the fire of 1943 (Robert Vogt, B, pers. comm.). In this case, *Schweinfurth 2326* from GH is designated as lectotype, and two duplicates from Z become isolectotypes.

Excluded Name

Eleocharis fistulosa var. *micrantha* Chermezon was described from specimens from Senegal (Chermezon 1936). Attempts to locate type specimens cited in the protologue have been unsuccessful thus far. Svenson (1939) relegated this name to synonymy under *E. nupeensis* Hutchinson & Dalziel based on the description, a temporary solution adopted here.

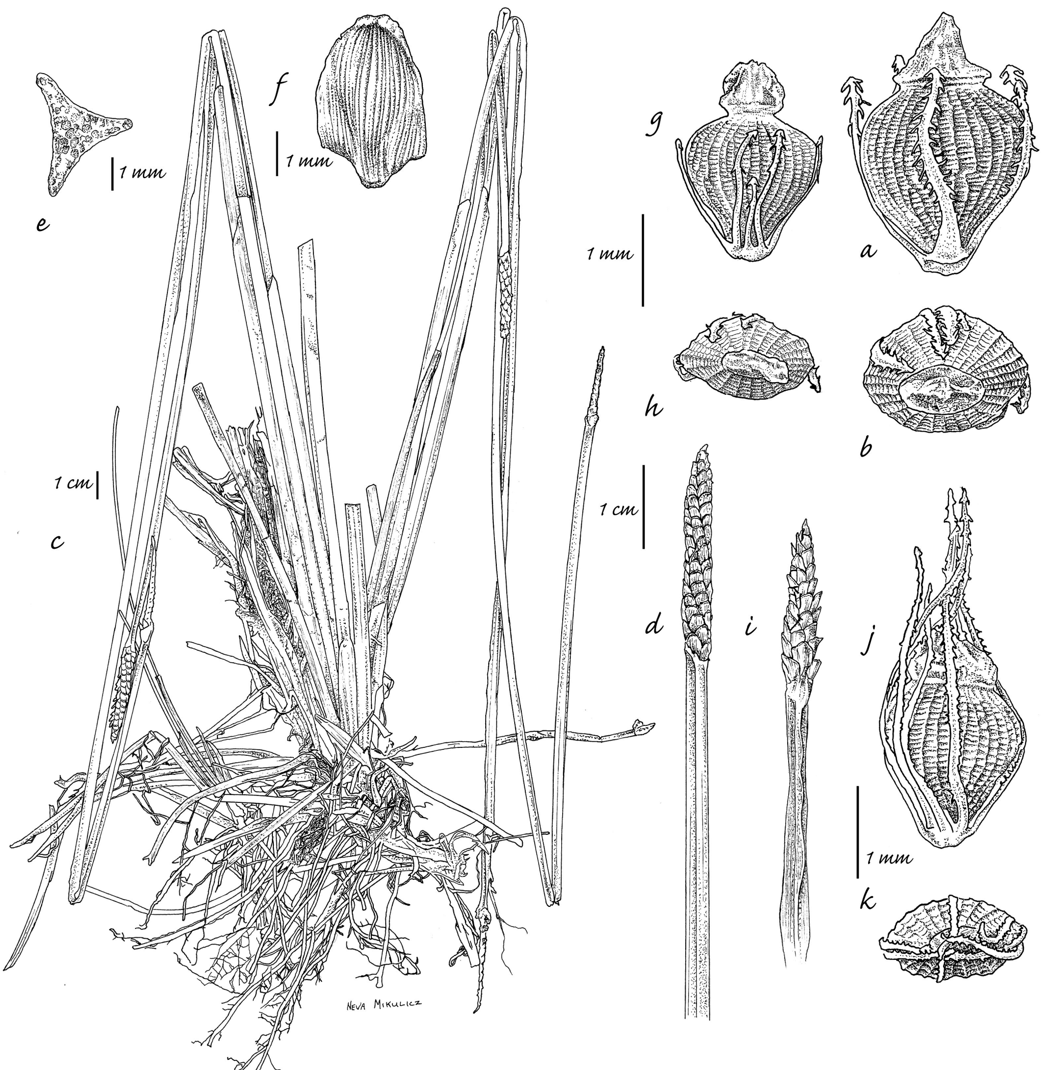

Fig. 3. A–B *Eleocharis acutangula* subsp. *acutangula*: A abaxial view of achene; B apical view of achene. C–H *E. acutangula* subsp. *breviseta*: C habit; D spikelet and distal end of culm; E cross section of culm below spikelet; F floral scale; G abaxial view of achene; and H apical view of achene. I–K *E. acutangula* subsp. *neotropica*: I spikelet and distal end of culm; J abaxial view of achene; and K apical view of achene. A–B from *Hooper & Gandhi* 2373, C–F from *Rosen & Carter* 3206, G–H from *Howard & Howard* 9862, and I–K from *McDaniel & Rimachi 18552*. Drawn by Neva Mikulicz.

Representative Specimens Examined: **NORTH AMERICA. MEXICO: Chiapas:** E side of Pueblo Solistahuacan, Municipio of Pueblo Nuevo Solistahuacan, elev. 1700 m, 26 Oct 1971, *Breedlove 21527* (MO, NY). **Hidalgo:** Lake Atexca below Molango, 09 Nov 1946, *Moore 1938* (GH). **Jalisco:** swamps near Guadalajara, 1888, *Pringle 2061* (NY). **Nayarit:** near Lake Labor, ca 15 mi SE of Tepic, 25 Sep 1960, *McVaugh 19426* (MICH). **Tabasco:** km 64 rumbo de Huimanguillo a Fransisco Rueda, 35 msnm, 06 Nov 1979, *Orozco & Zamudio 2187* (MO). **Veracruz-Llave:** Mpio. Las Choapas, ca 5.4 km S of the town of Las Choapas, along rural road to El Chichon, 13 Jul 2006, *Rosen et al. 3870* (CIIDIR, GH, K, MICH, MO, TAES, TEX, US, VSC, WIS). **CENTRAL AMERICA. GUATEMALA: Alta Verapaz:** E of Tactic, alt 1,300 m, 20 Feb 1942, *Steyermark 43970* (F). **Chiquimula:** between Chiquimula and La Laguna, alt. 500–1000 m, 27 Oct 1939, *Steyermark 30713* (F). **Huehuetenango:** vicinity of Maxbal, ca. 17 mi N of Barillas, Sierra de los Cuchumatanes, alt. 1500 m, 15–16 Jul 1942, *Steyermark 48770* (F). **Izabal:** near Puerto Barrios, sea level, 25 Apr 06 May 1939, *Standley 72862* (F). **Jutiapa:** SE end of Potrero

Carrillo, 13 mi NE of Jalapa, alt. 1500–1700 m, 12 Dec 1939, *Steyermark 33099* (F). **Santa Rosa:** 4 mi N of Barberena, 18 Feb 1951, *Fassett 28844* (F). **BELIZE: Toledo District:** near junction of Southern Highway and Pine Hill, 22 Nov 1998, *Holst et al. 7064* (MO). **HONDURAS: Comayagua:** vicinity of Siguatepeque, ca. 1050 m, 25 Mar 05–Apr 1947, *Standley & Chaco*n 6595 (F). **Copan:** 14 Jul 1971, *Harmon & Fuentes 6445* (MO, NY–2 sheets). **Francisco Morazan:** near Las Mesas, 900 m, 10 Sep 1950, *Standley 26634* (GH). **Olancho:** Santa Maria del Carbon, 23 mi NE of San Esteban along road to Bonito Oriental, 03 Jul 1994, *Davidse et al. 35564* (CIIDIR). **EL SALVADOR: Ahuachapan:** Lagunita las Ninfas, Apaneca, 28 Jan 1951, *Fassett 28721* (GH). **NICARAGUA: Comarca del Cabo:** Bihmona, 7 Jul 1972, *Seymor 5707* (CIIDIR, GH, MO-mixed with *E. interstincta*). **Esteli:** Reserva Natural Miraflor, Municipio de Esteli, Comunidad los Volcancitos, 10 Jul 1999, *Rueda et al. 11643* (MO). **Zelaya:** Cano Manso Awalka Tingni, reached by Geodesia turn on road between Torre 7 and Bismuna Tara, ca. 11.9 km SW of Bismuna Tarra, 19 Apr 1978, *Stevens 7704* (CIIDIR–2 sheets, MO). **COSTA RICA: Isla De Cocos:** Macollas en suelo humedo, a la orilla del par tano, Bahia de Wafer, ca. nivel del mar, 31 Jul 1981, *Gomez-Laurito 6915* (F, MO). **Alajuela:** 6 km W of Venicia, elev. 450 m, 15 Oct 1968, *Davidse & Pohl 1307* (F, MO). **Cartago:** Laguna Dona Anacleta, Canton Paraiso, Lago Crater, 22 Aug 1983, *Novelo 1209* (MO). **Guanacaste:** upper N fork of Rio Sabalito, just N of San Joaquin de Coto Brus, 13 Sep 1985, *Grayum et al. 6011* (MO). **Puntarenas:** San Joachim de Sabosa, just N of San Vito, 22 Feb 1982, *Barringer & Gomez 1688* (F). **PANAMA: Chiriqui:** S of El Boquete, 01 Mar 1918, *Killip 4569* (NY). **Cocle:** El Valle de Anton and vicinity, 500–700 m, 23–27 Jul 1935, *Seibert 476* (MO, NY, US). **Veraguas:** vicinity of La Mesa in sunny muddy bottom in pasture, 28 Dec 1968, *Tyson 6054* (MO). **CARIBBEAN BASIN. JAMAICA: Clarendon Parish:** Mason River Field Station, 4 mi W of Kellitts, 2300 m, 27–29 Jul 1979, *Thomas 2146* (MICH). **Saint Catherine Parish:** Charlton, near Ewarton, 03 Apr 1903, *Harris 8513* (NY). **DOMINICAN REPUBLIC: San Cristóbal Province:** between Duarte Hwy. Kl. 28 and Haina, 11 Oct 1947, *Allard 15976* (GH). **Santa Domingo Province:** 8 km from La Batata on road to Mata de Piedra and La Catalina, 09 Dec 1980, *Mejia & Zanoni 9753* (NY). **DOMINICA:** Lesser Antilles, St. George Parish, vicinity of freshwater lake, NE of Laudat, E side of Morne Macaque, loccaly common, 2500', 20 Mar 1991, *Hill et al. 22119* (GH, NY). **GRENADA:** Nelle Grenade, 1844, *Goudot s.n.* (P). **SOUTH AMERICA. COLOMBIA: Antioquia:** Municipio Valdivia, Corregimiento de Puerto Valdivia, km 11 de Pto Valdivia, mina de Oro "Canarias", colecciones en escombreras de 2 anos, 14 May 1987, *Callejas et al. 3486* (MO–2 sheets, NY). **Risaralda:** hacienda Alejandria km 6 carretera La Virginia-Cerrito, extremo norte de parte ancha del Valle del Rio Cauca, lomas bajas, 22 Aug 1989, *Silverstone-Sopkin 5504* (MO). **Cauca:** Chisquio, Finca Los Derrumbos, alt. c. 1700 m, 11 May 1940, *Asplund 10577* (LL). **Huila:** 3 km W of Garzon, upper basin of Rio Magdalena, 17 Feb 1959, *Mason 13888* (GH, US). **Meta:** ca. 17 km SW of Puerto Lopez, along road between La Balsa and Bocas del Guayuriba, 17 Jan 1970, *Schuyler 4165* (PH). **Valle del Cauca:** Calima, on Rio Calima, 14–15 Sep 1922, *Killip 11247* (GH, NY, PH). **VENEZUELA: Apure:** Guanare, Esteros y pantanos cerca de los diques y el cano Matorral, 25 Oct 1980, *Stergios 2387* (MO). **Aragua:** El Limon, near Maracay, in Morass, 29 Jan 1922, *Pittier 10116* (GH). **Bolivar:** Gran Sabana, Hato Sta. Teresa, Mar 1946, *Tamayo 3211* (F, US). **Guarico:** Orituco, 25 km SW de la Estacion Biologice de la Clanus (sic) Edo Gcarico, 19 Sep 1982, *Montes 1343* (MO). **Portuguesa:** terrenos de la Unellez, 06 Sep 1984, *Stergios 7051* (MO). **GUYANA: Upper Takutu-Upper Essequibo Region:** Rupununi Distr., Shea Village, 09 Feb 1994, *Jansen-Jacobs et al. 3634* (NY, US). **SURINAM:** in Maurisie swamp, W of 4-Gebroeders Mts., 27 Sep 1968, *Oldenberger et al.* 194 (NY). **ECUADOR: Napo:** Amazonica, Archidona, Coca km 9.3 roadside, 15 Apr 1988, *Laegaard & Renvoize 70909* (MO, NY). **Pastaza:** Amazonica, Hacienda San Antonio de Baron von Humboldt, 2 km al Nede Mera, 20 Feb–20 Mar 1985, *Palacios et al. 144* (MO). **BRAZIL: Distrito Federal:** Brasilia, 27 Jun 1979, *Heringer 1652* (NY). **Bahia:** 37 km N from Correntina, on the Inhaumas road, 29 Apr 1980, *Harley 21957* (NY). **Mato Grosso:** 17 Oct 1968, *Harley et al. 10711* (NY). **Minas Gerais:** without location, 1816–1821, *Catal 616* (K, P). **Sao Paulo:** Butantan, S. Paulo, without date, *Gehrt 5403* (GH, NY). **Amazonas:** lagoa permanente, 500 m ao Sul da BR 230 km 4, 15 Aug 1980, *Janssen & Gemtchujnicov 514* (M). **Maranhao:** Brejo, Ets. Ecologica UFMG, 02 Apr 1991, *Neto 461* (CIIDIR). **Parana:** Rolandia, Fazenda Conquista, area alagada, dentro da lagoa, no. 14, 11 Mar 2003, *Vanzela 35.42* (CIIDIR). **Rio de Janeiro:** Goias, Formosa, Bisual, 20 Oct 1965, *Pereira & Duarte 9414* (NY). **Rio Grande do Norte:** near Bento Fernandes, 70 km W from Natal, shallow at pond's edge, 28 Aug 1987, *Tsugaru & Sano B-1273* (GH). **Rio Grande do Sul:** M. Rio Pardo, Riniao Reserva, Feb 1923, *Jurgens s.n.* (US). Without location, 1844, *Weddele 1195* (P). **BOLIVIA: La Paz:** Iturralde, Luisita, sabana humeda, W del rio Beni, Palmar, 12 Sep 1984, *Haase 540* (NY). **Santa Cruz:** Andres Ibanez, NE side of Viru-Viru Pampa and property of Aeropuerto Internacional, along road to Chuchio, 4.5 km E of turnoff from highway from Santa Cruz to Warnes on road to Chuchio, 15 May 1998, *Nee 49365* (CIIDIR, TEX). **PARAGUAY: Departamento Central:** Estero del Ypoa, Villeta, Puerto Guyrati, 4.5 km S of Villeta, 02 Dec 1992, *Zardini & Aquino 34134* (CIIDIR, US). **Caazapa:** Tavai, Enrramadita, 05 Dec 1988, *Mereles 2067, 2069, 2070, 2081* (MO). **la Cordillera:** 1 km E of Nueva Colombia on road to Atyra, 09 Jun 1990, *Zardini & Velazquez 20917* (MO). **Misiones:** Estancia La Soledad, Santiago, 30 Apr 1961, *Pedersen 6029* (US, GH, MO, NY, TEX). **Paraguari:** Estero Ypoa, between Nueva Italia and Yuquyty on a hill, 18 Mar 1992, *Zardini & Aquino 31333* (CIIDIR). **Amambay:** Ao. Estrella, Prop. De Heisecke, 08 May 1989, *Soria 3749* (MO). **ARGENTINA: Corrientes:** Concepcion, Carambola, Estancis "Buena Vista", 19 Feb 1985, *Pedersen 14072* (MO, NY). **Misiones:** Sausta Aira, 1913, *Rodriguez 763* (GH). **Chaco:** Dep 1o de Mayo, Colonia Benitez, embalsado burger, 16 Dec 1943, *Schulz 4118* (F, GH). **AFRICA. ANGOLA: Benguela:** Gebirge sudlich Ganda, Tumpel bei Calusipa, 30 km sudlich Chicuma, 1580 m, 24 Dec 1951, *Hess 51/419* (Z). **Bie Bie:** Baixo Cubango, 28 km nordlich Caiundo in der Umgebung der Missao cat. Capico, flacher sumpf, 31 Jan 1952, *Hess* 52/525 (Z). **BOTSWANA: Ngamiland District:** Moremi Wildlife Reserve, N Okavango swamp, Kwani River floodplain, Jul 1964, *Tinley 1057* (NU). **BURKINA FASO: l' Oudalan:** Mare de Bidi, 20 Sep 1996, *Madsen 5749* (NY). **Boulgou:** some km SE of Tenkodogo, 31 Aug 1996, *Madsen 5455* (NY). **BURUNDI: Bubanza:** Plaine Rusizi km 14, 800 m, 16 Mar 1975, *Reekmans 4390* (MO). **Bujumbura:** Bujumbura, plaine Rusizi km 14, 780 m, 13 Feb 1972, *Reekmans 1539* (MO). **Provense ya Bururi:** Gihofi-Gihara, 20 May 1980, *Reekmans 9205* (MO). **CAMEROON: Nord:** ca. 15 km NE of Maroua, along road to Waza, 12 Sep 1964, *Wilde 3215* (K). **CENTRAL AFRICAN REPUBLIC: Prefecture de la Sangha-Mbaere:** Sangha Economique, Dzanga-Sangha Reserve, 40 km S of

Lidjombo on tributary of Keine, 26 Oct 1988, *Harris & Fay 1488* (MO, PRE). **COMORO ISLANDS:** Mayotte, Grande Terre, Ouangani, Coconi, Valarana, 26 Fev 2002, *Barthelat & Sifari 708* (P). **CONGO:** Vallie Uruanda, 26 Oct 1953, *Liben 852* (K, PRE). **ETHIOPIA: Kaffa Province:** Kochi, ca. 5 km E of Jimma, along the road to Addis Ababa, 02 Nov 1970, *Friis et al. 38* (C, K). **GABON: Nyanga:** a plus ou moins 7km sur la route de Doussala vers Bongo dans la direction Nord-Ouest, Petit etang, 25 Mar 2000, *Sosef 1016* (MO). **Haut-Ogooue:** Bateke Plateau, Mpassa River watershed, 4.2 km N of station of the Project de Protection des Gorilles, 27 Nov 2001, *Walters et al. 982* (MO). **GHANA: Brong-Ahafo Region:** 1 m S of Atebubu, 16 Nov 1970, *Hall & Duodu 42128* (MO). **Guinea-Bissau:** 08 Dec 1944, *unknown 1594* (MO). **Ivory Coast: d' Abidjan:** coast savanna, near the airport of Abidjan, 21 Oct 1963, *Wilde 1109* (Z). **LIBERIA: Grand Bassa County:** Sanokwele Dist., Ganta, 02 Dec 1935, *Harley 781* (NY, US). **Nimba County:** Mt. Nimba, Crete, Marc a', 04 Jul 1974, *Adam 28878* (MO). **MADAGASCAR: Antananarivo Province:** Ankazobe, Jun 1927, *Bathie 17929* (P, US). **Fianarantsoa Province:** Ambatofinandrahana, Itremo, petite vallee a l'ouest du Massif de l'itremo, 1680 m, 26 Nov 1993, *Du Puy & Andriantiana 2429* (MO, K, P). **Mahajanga Province:** 10 km E Antsalova, 20 Mar 1993, *Villiers et al. 4855* (K). Toamasina province, Marais de Didy, voir Joncacee de a a 2m, 21 Feb 1943, *Cours 1758* (P). **Malawi: Central Region:** Kasungu National Park, Angombe Hill, 03 Sep 1970, *Hall-Martin 1712* (PRE). **Nigeria: Kano:** 12 Sep 1973, *Jackson & Apcjoye 10-12973* (MO). **Plateau:** in vicinity of Bukuru, near Jos, 29 Jun 1970, *Blum 2488* (WIS). **Rhodesia: Hartley:** Avondale farm dam, 25 Feb 1969, *Mavi 983* (NU). **S.W.A. (Southwest Africa?):** 8 km S of Makuri vlei on road to Gimsa, 03 Mar 1985, *Hines 361* (PRE). **Senegal: Kaolak Region:** Kaolak, Nov 1824, *Berhaut s.n.* (Z). **Sierra Leone:** *Elliot 4453* (GH). **SOUTH AFRICA: Mpumalanga Province:** Transvaal, Witklip Staatsbos, Nelspruit Dist., in water in Witklipdam, Kruid, 27 Jan 1976, *Kluge 862* (PRE). **KwaZulu-Natal:** North coast, Lake Nhlabane area, W corner of North Lake, 19 Sep 1991, *Ward 11378* (PRE, NU, NH photo). **SUDAN:** Jonglei, Nyany, nr. Maar, 80 km N of Bor, 01 Feb 1981, *Lock 81/10* (K). **Swaziland:** Malolotja Nature Reserve, below Mortimers dam, stream, 17 Dec 1985, *Heath 406* (PRE). **Tanzania: Dar es Salaam Region:** Mbezi, 2km WNW of Dar es Salaam University (by cattle track to Tanzania packers), 12 Jun 1974, *Wingfield 2752* (MO). **Iringa District:** T7, km 13 Ufinda-Sao Hill Rd., E side of road, 10 Jun 1996, *Faden et al. 96/130* (K, US). **Ruvuma Region:** Ruanda, Urundi, Vallie Uruanda, Oct 1953, *Liben 852* (M). **Zaire: l' Equateur:** Bikoro, 01 Oct 1957, *Thonet 7* (M). **Kasai-Occidental:** Kabinda, 26 Jul 1934, *Becquaert 62* (GH). **Katanga:** River Kalule, pres de la ferme Rostenne, Elisabethville, 27 Mar 1963, *Symoens 10155* (K). **Province Orientale:** 1940, *Germain 171* (M). **Zambia: Central Province:** Mkushi Dist., David Moffat's farm, Munchiwemba dambo, 20 Sep 1993, *Bingham & Nkhoma 9711* (PRE). **Luapula Province:** Lake Bangweulu, S part, swamps between Ncheta Island and Chibambo Lagoon, 11 Feb 1996, *Renvoize 5585* (K). **Northern Province:** 8 km N of Kasama, 22 Jan 1961, *Robinson 4296* (K, MO, NU). **Western Province:** ca. 10 mi NE of Mongu, 18 Nov 1959, *Drummond & Cookson 6597* (MO). **Zimbabwe: Manicaland:** Mare Dam, Rhodes Inyanga National Park, 06 Jan 1972, *Gibbs Russell 1210* (M, MO–2 sheets, K). **Matabeleland North:** Wankie National Park, Ngamo Pans 54 mi SE of main camp, 17 Apr 1972, *Russell* 1645 (NU). **Salisbury District:** 6 mi spruit, 4800', 10 Jan 1932. **ASIA. CHINA: Huebi:** Central China, 1885–1888, *Henry 4102* (GH, US–2 sheets). **Yunnan:** 1530 m, May 1936, *Wang 73552* (GH). **INDIA: Bangladesh:** East Bengal, 1863–64, *Griffith 6235* (NY). **Karnataka:** near Station, 10 Nov 1971, *Hooper & Gandhi 2373* (MO, NY). **Kerala:** Malappuram Dist., between Tirurangadi and Parappanangadi, almost sea level, 12 Nov 1993, *Cook & Camenisch 5169* (Z). **Maharashtra:** Pashan, near Poona, lake margin, 30 Dec 1971, *Hooper 112* (K). **Nepaul:** without date, *Hook & Thomson s.n.* (NY). **Tamil Nadu:** Dharmapuri, Denkanikotta taluk to Jowalagiri, to Karareddy pond, 18 Dec 1978, *Matthew & Venugopal 20415* (GH). **INDONESIA: Alor:** 1938, *Jaag? s.n.* (ZT). **Java:** Meester Cornelis, 1991, *unknown 23139* (K). **Jawa:** Barat, Banten, 1936, *Hackenberg 1* (GH). **JAPAN: Hondo:** Shinjo in Kii, 11 Oct 1953, *Koyama 838* (GH). **Honshu:** Shinjo mura, Nagaitani valley, 15 Oct 1953, *Koyama 5885* (MO, NY). **Kyushu-chiho:** Hondo, Shinjo in Kii, 11 Oct 1953, *Koyama 838* (BRIT, NY, US, WIS). **Yoron-jima:** Liukiuensis, 30 Aug 1921, *Uyehara s.n.* (US). **MALAY PENINSULA:** Langkowi, ricefields near Kueh, 14 Nov 1941, *Comes? 37973* (K). **MALAYSIA: Malacca:** Kampong Bukit Piatu, 02 Apr 1955, *Sinclair 40551* (K). **PHILIPPINE ISLANDS: Lanao Mindanao:** in 6" of water pocket in grassland, 04 Sep 1938, *Zwickey 50* (GH, US). **SIAM:** growing in open fields, 13 Jul 1968, *Kerr 15798* (K). **SRI LANKA: North Eastern Province:** Amparai Dist., Helawe Eliya, ca. 7 mi S of Panama, E of Helawe Lagoon, sea level, 08 Feb 1971, *Koyama et al. 14026* (GH, NY). **VIETNAM: Quang Nam-Dà Nang: Tinh (province):** Annam, Mount Bani, in the main coast range ca. 25 km from Tourane (Da Nang), May–Jul 1927, *Clemens & Clemens 4050* (F, K, MO, NY, PH, US, US, Z). **OCEANIA**. **AUSTRALIA: Queensland:** Cook Dist., Abattoir swamp, 4.5 km N of Mount Molloy, 20 May 1995, *Clarkson 10317* (BRI). **PAPUA-NEW GUINEA: Morobe District:** vicinity of Kajabit Mission, elev. 800–2000 ft, Aug–Dec 1939, *Clemens 10600* (GH, US). **National Capitol District:** Hohola Port Moresby, 14 Nov 1973, *White 37815* (BRI, GH, K, M, US).

Distribution.—Pantropical; in México from the states of Chiapas, Hidalgo, Jalisco, Nayarit, Tabasco, and Veracruz-Llave. In Central America known from Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. In the Caribbean Basin known from Dominica, Dominican Republic, Grenada, and Jamaica. In South America known from records in Argentina, Brazil, Colombia, Ecuador, Guyana, Paraguay, Surinam, and Venezuela. Some previous reports of *Eleocharis acutangula* from the Galápagos Archipelago are based on misidentified specimens of *E. obtusetrigona* (Stewart 1911). Other reports were not verified (e.g., Jørgensen & León-Yánez 1999), and no authentic specimens of *E. acutangula* from the Galápagos Archipelago have been seen. Perhaps most widespread and occurring in more variety of habitats in tropical Africa, with records from Angola, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Comoro Islands, Congo, Ethiopia, Gabon, Ghana, Gunea-Bissau, Ivory Coast, Liberia, Madagascar, Malawi, Nigeria, Rhodesia, Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Zaire, Zambia, and Zimbabwe. Of sporadic distribution in Asia and Oceania with records from Australia, China, India, Indonesia, Japan, Malaysia, Papua-New Guinea, Philippine Islands, Siam, Sri Lanka, and Vietnam.

Habitat.—Various disturbed and natural freshwater herbaceous and forested wetlands including marshy open grasslands, coastal savannas, and tropical forests from sea level to 2300 m. Reportedly forms expansive stands on a variety of soil types usually associated with other aquatic plants. Weedy in rice and other crop rotations and aquatic habitats, and used as a fiber crop in Borneo, Brazil, and Sumatra (Simpson & Inglis 2001).

Note.—*Eleocharis acutangula* subsp. *acutangula* as treated here remains a variable taxon and includes forms meriting additional systematic study. Of particular interest are plants reviewed from Madagascar (including the type of *E. fistulosa*) with obtusely trigonous culms.

2. Eleocharis acutangula (Roxb.) Schult. subsp. **breviseta** D.J. Rosen, subsp. nov. (**Fig. 3 c–h**). Type: DOMINICAN REPUBLIC: El Seibo Province, 3–7 Nov 1946, *Howard & Howard* 9862 (holotype: GH!; isotype: NY–2 sheets!, P!, US!).

A *Eleocharis acutangula* (Roxb.) Schult. subsp. *acutangula* perianthii setis brevioribus cum spinulis paucis retrorsis prope apicem, acheniis parvibus et stylopodiis brevioribus recedit.

Plants perennial. **Roots** coarse, fibrous, mostly maroon (a few drab-brown), small storage structures present in carefully collected plants, cylindrical-reniform, white; primary rhizomes caudex-like, thick, hard, ascending, concealed by roots and persistent culm bases (occurring only in carefully collected specimens); secondary rhizomes elongated, to 3 mm thick, scales to 9 mm long (few seen). **Culms** triquetrous, (19–)30–71(–134) cm long × (1.1–)1.5–3.7(–7) mm wide, soft, internally spongy, with incomplete transverse septa, smooth, green when fresh, finely longitudinally striate when dry. **Leaves** 2, reduced to sheaths, apically oblique, membranous, loose, friable (upper distil portion disintegrating when submerged), proximally dark maroon, distally drab, apex acute. **Spikelets** cylindric, (10–)17–34(–49) mm long × (2.2–)2.7–4.1(–5.5) mm wide, acute; proximal scale with flower, obtuse, amplexicaul-clasping, appearing as a continuation of culm; remaining floral scales conspicuously spirally arranged, appressed to somewhat spreading at maturity, ovate-oblong, (3.1–)3.3–4.5(–5.9) mm long × (1.4–)1.8–3(–4.0) mm wide, cartilaginous, abaxially greenish centrally, stramineous marginally and sometimes reddish or pinkish tinged, with a fine dark band near apex, adaxially sparsely to copiously red-maculate, apex acute (rounded), distal 0.1–0.4 mm translucent hyaline-erose, central area nearly flat, coarsely many veined, only mid-vein conspicuous in adaxial view. **Flowers** with (5–)6–7(–8) perianth bristles, bristles sub-equal, (0.4–)0.6–1(–1.2) times the length of achene (rarely few-all bristles overtopping achene summit) with only a few short, salient retrorse spinules near tips (rarely spinules present in distal half), stramineous or pinkish to dark maroon; stamens 3; anthers (0.9–)1.1–1.9(–2.7) mm long, stramineous; style 3-fid. **Achenes** biconvex, broadly obovoid, the shoulders and sides near the apex usually straight and forming an obtuse angle, (1.3–)1.4–1.8(–2.1) mm long × (1.1–)1.2–1.4(–1.6) mm wide, with (9–)11–14(–16) longitudinal rows of deeply concave transversely oblong (linear) polygonal cells visible through transparent periclinal layer on each achene face, dull yellow-green maturing through amber to shiny dark brown, apex constricted to a distinct neck about 0.4 times width of achene, in the field achenes sometimes persistent after the floral scales have shed giving spikelet a beaded appearance. **Tubercle** dorsoventrally compressed, shallowly triangular, (0.2–)0.3–0.5(–0.6) mm long × (0.5–)0.6–0.8(–1) mm wide, light brown tinged with green, maturing to dark brown.

Specimens examined: **NORTH AMERICA. U.S.A: Florida: Lee Co.:** 4 km SW of the intersection of Hwy. 82 and Green Meadows Rd., SE of Fort Myers, 12 Nov 2004, *Rosen 3206 & Carter* (CIIDIR, GH, K, MEXU, MICH, MO, NY, P, TAES, TEX, US, VSC, WIS), S side of Griffin Rd., just S of entrance to Pinewood Lakes in Gateway, 28 Oct 1993, *Orzell and Bridges 22526* (BRIT, FTG, USF). **MEXICO: Campeche:** a aprox. 10 km al sureste de la ciudad de Campeche, Mun. Campeche, alt. 80 m, 10 Nov 1980, *Novelo & Zetina 721* (TEX), 14 km N of Ocozocoautla on road to Mal Paso, Municipio of Ocozocoautla de Espinosa, 07 Oct 1974, *Breedlove 38254* (MEXU, MO). **Chiapas:** 96 km S of Mexican Hwy. 190 on road to Nuevo Concordia, 10 Oct 1974, *Breedlove 38516* (NY). **Guerrero:** 1.5 km al NW del Rincon de la Via, 28 Sep 1988, *Verduzco 389* (MEXU). **CENTRAL AMERICA. PANAMA:** vicinity of El Llano, 7–8 Sep 1962, *Duke 5526* (MO, USF), Near the big swamp east of the Rio Tecumen Province, 11 Dec 1923, *Standley 26509* (MO). **Canal Zone:** Laguna de Portala, near Chepo, province of Panama, Oct 1911, *Pittier 4602* (NY). **Panama:** Sabanas near Chepo, 30 m, 20 Jan 1935, *Hunter & Allen 87* (MO), 1.6 km W of Juan Diaz, 10 Oct 1917, *Killip 4090* (PH, RSA, US), Camino del Boticario, near Chepo, altitude 30 to 50 meters, Oct 1911, *Pittier 4557* (GH, NY, US), near Matias Hernandez, wet field, 30 Dec 1923, *Standley 28909* (US), near Matias Hernandez, wet field, 30 Dec 1923, *Standley 28984* (US). **CARIBBEAN BASIN. CUBA: Ciudad de La Habana:** Vedado-Habana, Sabana de Monasterio, 23 Jun 1920, *Leon 9215* (NY). Without location, 1860–1864, *Wright 3376* (GH, mixed with E. mutata, MO, NY, P). **SOUTH AMERICA. COLOMBIA: Magdalena:** Rincon Hondo, Magdalena Valley, 10 Aug 1924, *Allen 357* (MO). **Vaupes:** Rio Vaupes, Mitu y alrededores, 08 Sep 1951, *Schultes & Cabrera 13977* (GH), Rio Vaupes, Mitu and vicinity, 09 May 1953, *Schultes & Cabrera 19257* (GH–2 sheets). **VENEZUELA: Bolivar:** 27 km SW of Caicara along Hwy. 19 to Ciudad Bolivar, 22 Nov 1973, *Davidse 4355* (MO). **Tachira:** between La Rochela and La Espuma, SW of Santo Domingo, 31 Jul 1979, *Steyermark & Liesner 119299* (MO). **Zulia:** Perija, carretera Calle Larga-San Felipe-Jaguacita, km 25 al SE de San Felipe, 09 Oct 1977, *Bunting 5656* (NY), ca 50 km SSW of Machiques by air, 19 km W of main road, 26 Mar 1982, *Liesner & Gonzalez 13183* (NY). **GUYANA: Upper Takutu-Upper Essequibo Region:** Baboon Hill (Sabrina Tau) 1.5 km S of Sand Creek Village, 21 Jun 1989, *Gillespie et al. 1803* (NY). **ECUADOR: Los Rios:** along road San Juan, Vince, 07 Mar 1988, *Laegaard & Renvoize 70652* (K, NY). **BRAZIL: Mato Grosso do Sul:** Pantanal do Miranda-Abobral, Passo do Lontra, Rodovia MS 122, Fazenda Sao Bento, depois da 2a porteira, 11 Jul 1997, *Rodrigues et al. 3* (K). **Rondonia:** Guapore, Porto Velho, 1952, *Cordeiro & Silva 270* (US). **Amapa:** Rio Macacoari, Municipio de Macapa, 05 Aug 1951, *Froes & Black 27231* (US). **Parana:** Curitiba, Paso do Lontra (mun. Miranda) Mato Grosso, 13 Oct 1972, *Hatschbach & Scherer 30441* (NY, Z). **Rio de Janeiro:** Rio de Janeiro, Jan 1914, *Hoehne 5736* (US). **Rio Grande do Sul:** Jari, estrada do Caracuru, Jari, estrada do Caracuru, campo alagado, 09 Aug 1969, *Silva 2636* (NY). **Roraima:** borrow pit close to road from Furo do Maraca to SEMA research station, 10 Mar 1987, *Edwards 2529* (K). **BOLIVIA: Beni:** Ballivian, la zona de influencia del rio Yacuma, 09 Mar 1980, *Beck 3248* (NY), Ballivian, espiritu en la zona de influencia del rio Yacuma, 13 Apr 1980, *Beck 3354* (NY). **AFRICA. SOUTH AFRICA: KwaZulu-Natal:** Hlabisa, St. Lucia, E shores, 30 Nov 1959, *Feely & Ward 15* (K, M, NU–2 sheets]), Near Howick, 1990, *Taylor 131* (NU), Ingivauvima distr., near Salumhlanga, Ndumu Game Reserve, 22 Dec 1972, *Pooley* 1624 (NU), Greater Durban area, Mlazi Valley, 15 Mar 1992, *Ward 11925* (NU, PRE), Greater Durban area, Mlazi Valley, 15 Mar 1992, *Ward 11926* (NU, NH photo), Transvaal, Waterberg, 13.2 m NW of Warmbaths, 19 Mar 1965, *Acocks 23562* (K, PRE), near Maputa, Tengane near Nyinyani, 29 Oct 1980, *Cunningham s.n.* (NU), Karkloof floodplain near junction with Kusane River, Jan 1977, *Kotze s.n.* (NU). **TANZANIA: Singida Dist.:** T. 5, M. 12.7 from Issuna on the Singida-Manyoni Road, 4,800 ft, 13 Mar 1964, *Greenway & Polhill 11543* (PRE), T4, Sumbawanga Dist., goli Mbuga, 5 km S of Sumbawanga, 19 Jun 1996, *Faden et al. 96/302* (US), T5, Manyoni Dist., Chaya Lake, S of Itigi-Tabora track, 16 km W of Kazikazi, 02 Jul 1996, *Faden et al. 96/522* (US). **ZIMBABWE:** Gokwe, Sengwa Nature Resreve, Jan 1966, *Jacobsen 73* (NU), District Gokwe, Sengwa research station, 09 May 1966, *Jacobsen 3218* (PRE).

Distribution.—In the U.S.A. known only from Lee County, Florida. In México known from the states of Campeche, Chiapas, and Guerrero, and in Central America known only from Panama. In the Caribbean Basin known only from Cuba and the Dominican Republic. Most widespread in South America with records from Bolivia, Brazil, Colombia, Ecuador, Guyana, and Venezuela. In Africa known from South Africa, Tanzania, and Zimbabwe.

Habitat.—Disturbed and natural freshwater wetlands including marshy open grasslands and tropical forests; reported from 0–1400 m.

Etymology.—The subspecific epithet is indicative of the short perianth bristles of this taxon.

3. Eleocharis acutangula (Roxb.) Schult. subsp. **neotropica** D.J. Rosen, subsp. nov. (**Fig. 3 i–k**). Type: PERU. Departamento de Loreto: Maynas, Iquitos, prolongacion Yavari, Versailles-Paina, open annually burned grassland, 23 Mar 1974, *McDaniel & Rimachi 18552* (holotype: MO!; isotypes: IBE–2 sheets [photos!], NY!).

A *Eleocharis acutangula* (Roxb.) Schult. subsp. *acutangula* perianthii setis brevioribus mollibus flexuosis longissimis 1.8–2.4-plo longitudo achenii, achenii apicibus constrictis infirme usque ad 0.6–0.7-plo latitudem achenii et stylopodiis plerumque latioribus quam longioribus recedit.

Plants perennial. **Roots** coarse, fibrous, drab-brown; primary rhizomes caudex-like, thick, hard, ascending, concealed by roots and persistent culm bases; secondary rhizomes elongated, to 3.2 mm thick, scales to 14 mm (few seen). **Culms** triquetrous, (44–)56–86(–106) cm tall × (2–)2.7–3.9(–4.3) mm wide, soft, internally spongy, with incomplete transverse septa, smooth, green to drab gray-green and finely longitudinally striate when dry. **Leaves** 2, reduced to sheaths, apically oblique, membranous, loose, friable, proximally dark maroon, distally drab, apex acute. **Spikelets** cylindric, (1.5–)2–3.1(–3.5) cm long × (3–)3.2–4.2(–4.5) mm wide, acute; proximal scale with flower, obtuse, clasping, appearing as a continuation of culm; remaining floral scales conspicuously spirally arranged, appressed, ovate-widely ovate, (3.9–)4.1–4.8(–5) mm long × (2.3–)2.4–3.2(–3.8) mm wide, cartilaginous, stramineous (faintly greenish centrally), adaxially sparsely red-maculate, apex acute (rounded), the distal 0.2–0.3 mm translucent hyaline-erose, central area nearly flat, abaxially coarsely many veined, the veins raised and visible at 20×, only mid-vein distinguishable in adaxial view. **Flowers** with (5–)6–7 perianth bristles, bristles sub-equal, (1.8–)1.9–2.3(–2.4) times achene length, coarsely retrorsely spinulose nearly to base, stramineous, sometimes becoming reddish-brown distally; stamens 3; anthers 0.9–1.8(–2.3) mm long, stramineous; style trifid. **Achenes** biconvex, broadly obovoid, (1.3–)1.6–1.8 mm long × (1.2–)1.3–1.5(–1.6) mm wide, with 12–14(–16) longitudinal rows of deeply concave transversely oblong polygonal cells visible through transparent periclinal layer on each achene face, dull to shiny yellow-green (sometimes tinged with amber), apex constricted to a distinct neck about 0.6–0.7 times achene width. **Tubercle** dorsoventrally compressed, wider than tall and appearing very shallowly to shallowly triangular, sometimes apex appearing truncate or retuse, (0.3–)0.4–0.5(–0.6) mm long × (0.6–)0.8–1(–1.1) mm wide, light-dark brown.

Specimens examined: **SOUTH AMERICA. ECUADOR: Pastaza:** Villano, Compamento Base de Arco, Pantano al noreste de la pista, 1° 29'S, 77° 27' W, Feb 1994, *Palacios 12171* (CIIDIR, MO). **Napo:** Archidona, Reserva Ecologica Antisana, Comunidad Shamato, Entrada por km 21, Shamato, 00° 43'S, 077° 49'W, 24 Apr 1998, *Clark et al. 5122* (MO). **PERU: Amazonas:** Bagua, along roadside from Chiriaco to Puente Venezuela (3.9 Km NE Chiriaco), elev 600–800 ft, 31 Oct1978, *Barbour 4355* (F, IBE-photo, MO). **Cusco:** Paucar Tawbo, Montaueza Choutachaca, 780–1000 m, 28 Nov 1965, *Vargas 16887* (US). **Loreto:** Puerto Almendras on the Rio Nanay, 30 km N of Iquitos, 600 m, 16 Aug 1981, *Moore & Ruiz 114* (F); Prov. Maynas, hierba de 80 cm, 03 Aug 1967, *Torres 340* (GH–2 sheets); Prov. Maynas, Iquitos, Carretera de Zungaro Cocha, cerca a la quebrada de Shushuna, 12 Aug 1983, *Rimachi 6908* (IBE–photo, VSC); Maynas, Dtto. Punchana, Rio Nanay, varadera de; caserio de Padre Cocha, 07 Jul 1994, *Rimachi 11004* (IBE–photo, MICH–2 sheets, NY, VSC); Maynas, Inmediaciones de la Guarnicion militar de Gueppi, sobre la margen izquierda del Rio Putumayo, borde con Ecuador, 26 May 1978, *Diaz 368* (F, MO); Maynas, Distrito Iquitos, Caserio Nina Rumy, Rio Nanay, 73° 25' W, 03° 48' S, 22 Apr 1988, *Ruiz 1262* (MO); Iquitos Region, 26 Jul 1966, *Martin & Lau-Cam 1164* (GH). **Huanuco:** Leoncio Prado, 3 km SE of Pucayacu, on road from Tingo Maria to Tocache Nuevo, ca 75 km NW of Tingo Maria, 10 Dec 1981, *Plowman & Rury 11288A* (MO, NY). **BOLIVIA: Pando:** Provincia Nicolas Suarez, Cobija 2 km hacia el Sur, 19 Oct 1988, *Beck 17139* (K, US).

Distribution.—Known only from northwest South America from Ecuador, Bolivia, and Peru.

Habitat.—Specimens examined are from various freshwater wetlands including marshy open grasslands, tropical forests, and roadside ditches, reportedly from 0–1000 m.

Etymology.—The specific epithet indicates the decidedly neotropical distribution of this taxon.

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REFERENCES

Baksh, S.I. and J.H. Richards. 2006. An architectural model for *Eleocharis*: morphology and development of *Eleocharis cellulosa* (Cyperaceae). Amer. J. Bot. 93:707–715.

Blake, S.T. 1939. A monograph of the genus *Eleocharis* in Australia and New Zealand. Proc. Roy. Soc. Queensland 50:88–132.

Browning, J., K.D. Gordon-Gray, and C.J. Ward. 1997. Studies in Cyperaceae in Southern Africa 32: *Eleocharis* subgenus *Limnochloa* section *Limnochloa*. S. African J. Bot. 63:172–184.

Chermezon, H. 1936. Contribution à la flore cypérologique du Sénégal: Cypéracées récoltées par M. Trochain. Arch. Bot. Mem. 7:1–32.

Edwards. A.L., D.W. Lee, and J.H. Richards. 2003. Responses to a fluctuating environment: effects of water depth on growth and biomass allocation in *Eleocharis cellulosa* Torr. (Cyperaceae). Canad. J. Bot. 81:964–975.

Forman, L.L. 1997. Notes concerning the typification of names of William Roxburgh's species of phanerogams. Kew Bulletin 52:523–534.

González-Elizondo, M.S. and A.A. Reznicek. 1996. New *Eleocharis* (Cyperaceae) from Venezuela. Novon 6:356–365.

González-Elizondo, M.S. and P.M. Peterson. 1997. A classification of and key to the supraspecific taxa in *Eleocharis* (Cyperaceae). Taxon 46:433–449.

González-Elizondo, M.S. and J.A. Tena-Flores. 2000. *Eleocharis* (Cyperaceae) in the New World. In: K. L. Wilson & D. A. Morrison (eds.), Monocots: systematics and evolution. CSIRO Publishing, Australia. Pp. 637–643.

Gordon-Gray, K.D. 1995. Cyperaceae in Natal. Strelitia 2. National Botanical Institute, Pretoria, South Africa.

Gregor, T. 2003. *Eleocharis mamillata* - Distribution and infraspecific differentiation. Folia Geobot. 38:49–64.

Haines, R.W. and K.A. Lye. 1983. The sedges and rushes of East Africa. East African Natural History Society. Nairobi.

Hess, H. 1953. Über die Gattungen *Heleocharis* und *Carex* aus Angola und dem unteren Kongo. Ber. Schweiz. Bot. Ges. 63:317–359.

Hess, H. 1957. Beiträge zur Kenntnis der Gattung *Heleocharis* in Brasilien. Ber. Schweiz. Bot. Ges. 67:91–94.

Hines, D.M. 1975. A monograph of the *Eleocharis ovata* complex (Cyperaceae) in North America. Ph.D. Dissertation. University of Michigan, Ann Arbor.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett. 1990. Index herbariorum Part I: The herbaria of the world. New York Botanical Garden. New York.

Jørgensen, P.M. and S. León-Yánez. 1999. Catalogue of the vascular plants of Ecuador. Missouri Botanical Garden Press, St. Louis.

Koyama, T. 1985. Cyperaceae. In: M.D. Dassanayake & F.R. Fosberg, eds. Flora of Ceylon, Vol. 5., pp. 125–405. Amerind Publishing Co. Pvt. Ltd., New Delhi.

Larson, B.M.H. and P.M. Catling. 1996. The separation of *Eleocharis obtusa* and *Eleocharis ovata* (Cyperaceae) in Eastern Canada. Canad. J. Bot. 74:238–242.

McNeill, J., F.R. Barrie, H.M. Burdet, V. Demoulin, D.L. Hawksworth, K. Marhold, D.H. Nicolson, J. Prado, P.C. Silva, J.E. Skog, J.H. Wiersema, and N.J. Turland. 2006. International code of botanical nomenclature (Vienna Code). Regnum Veg. 146:1-568.

Menapace, F.J. 1991. A revision of the genus *Eleocharis* (Cyperaceae) section *Maculosae*. Ph.D. Dissertation. Southern Illinois University, Carbondale.

Nees von Esenbeck, C.G.D. 1842. Cyperographia sive descriptio in Brasilia provenientium In: K. F. P. von Martius. Flora Brasiliensis, Vol. II, Part I. Pp. 1–226.

Roalson, E.H. 1999. *Eleocharis yecorensis* (Cyperaceae), a new species of spike-sedge from Mexico. Aliso 18:57–60.

Rohlf, F.J. 2000. NTSYS-pc: numerical taxonomy and multivariate analysis system, version 2.1. Exeter Software: Setauket, NY

Rosen, D.J. 2006. A systematic study of select species complexes of *Eleocharis* subgenus *Limnochloa* (Cyperaceae). Ph.D. Dissertation. Texas A&M University, College Station.

Rosen, D.J. and S.L. Hatch. (in press). A new species of *Eleocharis* subg. *Limnochloa* (Cyperaceae) from Bolivia. Brittonia.

Roxburgh, W. 1820. Flora Indica or descriptions of Indian plants. Serampore.

Sanjappa, M., K. Thothathri, and A.R. Das. 1991. Roxburgh's flora Indica drawings at Calcuta. Bull. Bot. Surv. India 33:1–232.

Simpson, D.A. and C.A. Inglis. 2001. Cyperaceae of economic, ethnobotanical and horticultural importance: a checklist. Kew Bull. 56:257–360.

Stewart, A. 1911. A botanical survey of the Galápagos Islands. Proc. Calif. Acad. Sci. IV, 1:7–288.

Stuessy, T.F. 1990. Plant taxonomy; the systematic evaluation of comparative data. Columbia University Press, NY.

Svenson, H.K. 1929. Monographic studies in the genus *Eleocharis* I. Rhodora 31:121–135, 167–191.

Svenson, H.K. 1939. Monographic studies in the genus *Eleocharis* V. Rhodora 41:1–19, 90–110.

Trevisan, R. and I.I. Boldrini. 2006. A new species of *Eleocharis* R. Brown (Cyperaceae) from Southern Brazil. Novon 16:155–157.

The Gametophyte of *Lycopodiella prostrata*.—As part of an extended study on mycorrhizal and photosynthetic gametophytes of the Lycopodiaceae, spores of *Lycopodiella prostrata* (Harper) Cranfill, a species with an undescribed gametophyte, were cultured. The spores were obtained from plants collected in Cook County, Georgia and a voucher was deposited at VSU (*Carter #14616*). The conditions, techniques, and nutrient medium used were those of Whittier and Renzaglia (Amer. Fern J. 95:153–159. 2005). The system of classification followed in this report is that of Øllgaard (Opera Bot. 92:153–178. 1987).

There are five gametophyte types in *Lycopodium (s.l.)*. Four of the five are mycorrhizal with the following shapes – carrot-shaped, disk-shaped, uniaxial strap-shape, and branched cylindrical. The last type, which has been reported for *Lycopodiella*, is photosynthetic with a solid, more or less cylindrical base topped with photosynthetic lobes. This study was carried out to determine if the gametophyte of *L. prostrata* is this type.

Spore germination was slow. The earliest germination occurred two months after sowing spores in illuminated cultures, and at one year, 61 spores out of 10,000 (0.6%) had germinated. Spores cultured in the dark for one year did not germinate; however, spores from these dark cultures remained viable and 142 of them out of 10,000 (1.4%) germinated after moving them into the light for seven months.

Although spores of the mycorrhizal species of *Huperzia* and *Lycopodium* germinate slowly and at low percentages (Whittier, Amer. Fern J. 88:106–113. 1998), it is generally believed that *Lycopodiella* spores germinate rapidly and at high percentages (Whittier, Amer. Fern J. 88:106–113. 1998). This is not completely true because spores from some *Lycopodiella* species germinate slowly (Whittier, Amer. Fern J. 88:106–113. 1998).

Cell divisions in various planes formed a small mass of gametophyte tissue that remained partially contained by the spore coat. At about six weeks of growth, the young gametophyte escaped from the spore coat. At this time a small, dark green, ellipsoidal mass of cells formed – the young primary tubercle (Fig. 1A). Once the main body of the tubercle had a width of 150 μm or more, the first photosynthetic lobe developed at its apical end (Figs. 1B, 1C). Further enlargement of the tubercle resulted in a larger apical region where additional photosynthetic lobes formed. The lobes were erect, narrow, and strap-shaped with tapering distal ends.

The early mature gametophytes had a short, solid, more or less cylindrical base topped with numerous photosynthetic lobes. As the gametophytes aged, more lobes formed, and the previously formed lobes were displaced to the sides of the larger base. Gametophytes at this stage are illustrated in Figs. 1D and 1E.

The gametangia usually formed at the junction of the photosynthetic lobe and the gametophyte base. Both archegonia and antheridia developed on the

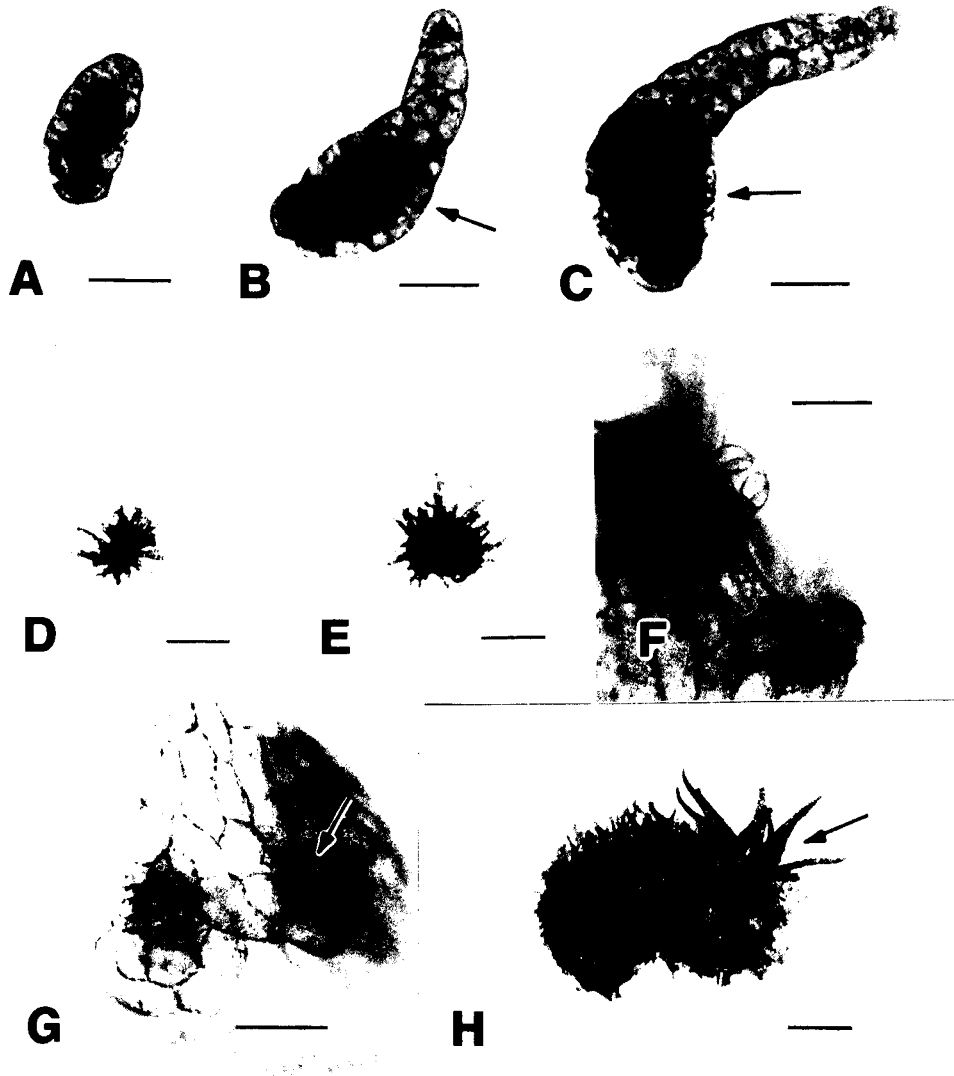

FIG. 1. Gametophytes of *Lycopodiella prostrata*. A. Primary tubercle. B–C. Primary tubercles (arrows) with young photosynthetic lobes (ca. 2 mo old). D. Oblique view of early mature gametophyte (ca. 5 mo old). E. Apical view of gametophyte (ca. 7 mo old). F. Two archegonia with short necks. G. Two antheridia – one with view of opercular cell (arrow). H. Large gametophyte (ca. 18 mo old) with young sporophyte (arrow). Bars = 100 μm for Figs. A–C & F–G, 1 mm for Figs. D–E, and 2 mm for Fig. H.

young mature gametophytes. The archegonia had short necks made up of two tiers of neck cells exposed above the gametophyte surface (Fig. 1F). The length of the archegonial neck was about 70 μm long. The length from the tip of the neck to base of egg was about 110 μm as determined with optical sections. Each antheridium had one opercular cell in the antheridial jacket at the gametophyte surface (Fig. 1G). Optical sections showed the gamete masses of the antheridia to be essentially spherical with diameters of about 70 μm.

The small, young gametophytes with both antheridia and archegonia continued to grow on the nutrient medium without undergoing sexual reproduction. With age these medium-sized gametophytes took on a pincushion shape (Fig. 1D, 1E). After a year or more in culture, large pincushion-shaped gametophytes formed. The solid basal portions of these gametophytes were obscured by the numerous photosynthetic lobes (Fig. 1H).

Mature gametophytes were capable of fertilization if water was added to the cultures. Fifty older gametophytes growing in separate cultures produced 24 sporophytes after flooding with water. The first microphylls, which were larger than the photosynthetic lobes, were evident two weeks after flooding. Within three months the young sporophytes became well established with numerous microphylls growing above the photosynthetic lobes (Fig. 1H).

The development of the primary tubercle is typical for *Lycopodiella* gametophytes and the ellipsoidal or oblong shape is known from other species (Whittier & Renzaglia, Amer. Fern J. 95:153–159. 2005). A growth from the top of the tubercle, the intermediate shaft, which was reported for *Lycopodiella* gametophytes growing on soil (Holloway, Trans. New Zealand Inst. 48:253–303. 1916; Bruce, Amer. J. Bot. 66:1156–1163. 1979), does not develop in *L. prostrata* under these conditions. It appears that the growth of *Lycopodiella* gametophytes in well-illuminated cultures prevents the development of the intermediate shaft (Whittier & Renzaglia, Amer. Fern J. 95:153–159. 2005).

Photosynthetic lobes develop from the top of the tubercle in *L. prostrata* as was observed with the gametophyte of *Lycopodiella lateralis* (R.Br.) B. Øllg. (Whittier & Renzaglia, Amer. Fern J. 95:153–159. 2005). The formation of the pincushion-shaped gametophyte with many green lobes arising from a solid base is typical for *Lycopodiella* (Wagner & Beitel, Flora North America 2:18–37. 1993). The young pincushion-shaped gametophytes with photosynthetic lobes arising from the apex and sides of the solid base appear to have a radial symmetry (Figs. 1D, 1E). The symmetry of the larger pincushion-shaped gametophytes (Fig. 1H) appears dorsiventral as was reported for *Lycopodiella carolinianum* by Bruce (Amer. J. Bot. 66:1156–1163. 1979). The long strap-shaped lobes have been described for *Lycopodiella* gametophytes previously (Whittier & Renzaglia, Amer. Fern J. 95:153–159. 2005).

Both gametangia form on these gametophytes at the base of the photosynthetic lobes. Descriptions of *Lycopodiella* archegonia indicate that they have short necks (Bruce, Amer. J. Bot. 63:919–924. 1976; Wagner & Beitel, Ann. Mo. Bot. Gard. 79:676–686. 1992). The antheridia are smaller than those reported for the terrestrial species of *Huperzia* (Whittier, Pintaud, & Braggins, Amer. Fern J. 95:22–29. 2005) and much smaller than those of *Lycopodium* (Bruce, Amer. J. Bot. 66:1138–1150. 1976; Whittier, Canad. J. Bot. 55:563–567. 1977). The gametangia of *Lycopodiella appressa* (F.Lloyd & L.Under.) Cranfill and *Lycopodiella cernua* (L.) Pichi-Serm. have essentially the same sizes as those of *L. prostrata*. The gametangia of *L. prostrata* are typical for *Lycopodiella*.

The development of the other types of gametophytes of the Lycopodiaceae is quite different from that found in *Lycopodiella*. The mature gametophyte of *Phylloglossum* is photosynthetic but it starts out as a subterranean, mycorrhizal gametophyte that is negatively gravitropic. After its exposure to light at the soil surface it becomes a green, bilaterally symmetrical, tuberous gametophyte lacking photosynthetic lobes (Whittier & Braggins, Amer. J. Bot. 87:920–924. 2000).

The remaining gametophytes of the Lycopodiaceae are subterranean, mycorrhizal, and nonphotosynthetic. Their development is initiated underground by the dark germination of their spores and requires a mycorrhizal association for continued growth. Early growth forms a solid, teardrop-shaped gametophyte that gives rise to the four other gametophyte shapes found in the Lycopodiaceae. Larger teardrop-shaped gametophytes develop ring meristems that form the radially symmetrical disk- and carrot-shaped gametophytes of *Lycopodium* (Whittier, Canad. J. Bot. 55:563–567. 1977; Whittier, Bot. Gaz. 142:519–524. 1981).

The uniaxial, dorsiventral, strap-shaped gametophyte of the terrestrial *Huperzia* species lacks a ring meristem. The meristem arises from a portion of the apical region of a larger teardrop-shaped gametophyte (Bruchmann, Flora 101:220–267. 1910). This meristem occurs in a subterminal groove overarched by young dorsal tissue on these strap-shaped gametophytes. With the epiphytic *Huperzia* species, the teardrop-shaped gametophyte enlarges and grows into the branched, cylindrical, mycorrhizal gametophyte (Whittier unpublished).

The gametophyte of *L. prostrata* has the typical structure and development of *Lycopodiella* gametophytes; thus it is different from the other gametophyte types of the Lycopodiaceae.—DEAN P. WHITTIER, Department of Biological Sciences, Box 1634, Vanderbilt University, Nashville, TN 37235-1634, and RICHARD CARTER, Department of Biology, Valdosta State University, Valdosta, GA 31698-0015.

NOMENCLATURAL NOTES ON *CYPERUS RETRORSUS* CHAPM. AND "*CYPERUS RETROVERSUS* CHAPM." (CYPERACEAE), INCLUDING A LECTOTYPIFICATION

RICHARD CARTER[1]

Abstract. *Cyperus retrorsus* Chapm. is common and widespread in the southeastern United States. Although authors have indicated the existence of types at NY and US, none has ever been specifically designated as such. A lectotype at US and an isolectotype at NY are herein designated, and ambiguity resulting from A.W. Chapman's use of both *C. retrorsus* and "*C. retroversus"* for the same species is discussed.

Keywords: nomenclature, typification, lectotype, *Cyperus retrorsus*, *"Cyperus retroversus"*, A.W. Chapman.

Cyperus retrorsus Chapm. (Cyperaceae) is widespread in the southeastern United States and was first described by A.W. Chapman in 1878. Since no type specimen designated by Chapman has been found and none has been specifically designated as type by subsequent workers, my primary purpose herein is to lectotypify *C. retrorsus* Chapm. Secondarily, an ambiguous reference by Chapman (1883) to "*C. retroversus*" is clarified.

Lectotypification of Cyperus retrorsus *Chapm.*

The application of *C. retrorsus*, which has been consistently used (e.g., Small 1903, 1933; Kükenthal 1935–1936; Horvat 1941; Fernald 1950; Gleason 1963; Gleason & Cronquist 1963, 1991; Radford et al. 1968; Long & Lakela 1971; Godfrey & Wooten 1979; Wunderlin 1982, 1998; Clewell 1985; Diggs et al. 1999; Tucker et al. 2002) for a common, widespread species in the southeastern United States, is not in question. Although no material of *C. retrorsus* bearing Chapman's designation as type has been found, original materials consisting of a specimen (US) and a fragment (NY) from the type locality and from Chapman's herbarium are known. Although improbable, there is always the possibility that other duplicates exist.

Fernald and Griscom (1935) referred to a "fragment of [the] type at [the] New York Bot[anical]. Gard[en]. examined through [the] courtesy of Dr. Gleason." Horvat (1941:84) cited "*Chapman's* specimen from 'Robert's Key, Caximbas Bay, South Florida' in the United States National Herbarium" as the type specimen, a photograph of which she indicated was in the Langlois Herbarium of Catholic University. Except for a few sheets at WIS, the Cyperaceae from the Langlois Herbarium (LCU) are now at US (Tucker et al. 1989). The phototype cited by Horvat has not been located at either US (M.T. Strong, personal communication) or WIS (T.S. Cochrane, personal communication). However, the phototype negatives from LCU were composed of cellulose nitrate, and after acquisition by US those found to be distorted beyond recovery were disposed of as a fire hazard (M.T. Strong, personal communication).

The fragment at NY (Columbia College Herbarium), cited by Fernald and Griscom (1935), has been examined. It consists of a single ray "received from Dr. Chapman, May 13, 1885" with the additional note, "Of Cyperus retrorsus I found only a single plant on a Key in Caximbas Bay." Although no specimen with data matching those cited by Horvat (1941) or one annotated as the type has been located at US, a specimen from Chapman's herbarium has been found at US that can be linked with the NY fragment cited by Fer-

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nald and Griscom (1935). This specimen was probably made during October and November 1875 when Chapman went to southern Florida and the Keys to collect wood samples for the 1876 Centennial Exposition in Philadelphia (K.J. Wurdack, personal communication). The sheet at US bears a single plant from which the two longest rays have been removed and mounted in approximate position above the rest of the inflorescence. A close examination of this specimen reveals three empty primary prophylls. Two of the empty prophylls undoubtedly correspond with the disarticulated and re-positioned rays mounted with the specimen. The third empty prophyll suggests yet a third ray is missing from the specimen. The label data with the US specimen are minimal and, unfortunately, Chapman named the plant "Cyperus retroversus, Chapm."

The fragment at NY matches the spikes and spikelets on the aforementioned specimen from Chapman's herbarium, now at US, and most likely originated from its third empty prophyll. If one assumes the fragment at NY originated from the *Herb. Chapman* specimen at US, then both specimens are clearly tied to the protologue of *C. retrorsus* Chapm. and are parts of a single gathering. In the absence of an unambiguous published reference to a particular type specimen at US or an annotation designating a type by Horvat (1941), it seems prudent to choose a lectotype here. Thus, the US specimen is chosen herein as the lectotype, and the subsidiary fragment at NY an isolectotype.

Cyperus retrorsus Chapm., Bot. Gaz. (Crawfordsville) 3:17. 1878. *Mariscus retrorsus* (Chapm.) C.B. Clarke, Kew Bull. 8:15. 1908.—TYPE: U.S.A. FLORIDA: South Florida, [Robert's] Key, Caximbas Bay, [Oct.–Nov. 1875], *Herb. Chapman s.n.* (LECTOTYPE: US!, **herein designated**; ISOLECTOTYPE: NY!).

***What is* "Cyperus retroversus"?**

Inexplicably, in the second edition of his *Flora of the Southern United States* Chapman (1883) omitted any reference to *C. retrorsus* but, apparently in place of it, did cite (suppl., p. 659) a different name "*C. retroversus* Chapm." with an expanded description essentially similar to the original one he provided for *C. retrorsus* in 1878. Moreover, Chapman (1883:659) cited "Robert's Key, Caximbas Bay, South Florida" as the locality for "*C. retroversus*", which is the type locality of *C. retrorsus* (Chapman 1878). In the third edition (1897) Chapman reverted to *C. retrorsus* without citing "*C. retroversus*"; thus, it seems clear that he mistakenly used "*C. retroversus*" instead of *C. retrorsus* in the second edition (1883) of his *Flora*. Fernald and Griscom (1935:152) and Horvat (1941:83) dismissed "*C. retroversus* Chapman" as an erroneous citation ("*lapsus*") for *C. retrorsus*, and Merrill (1948:67) "suspected that the entry…was due to a *lapsus calami* on the part of Chapman." Such a mistake is correctable as a confusingly similar name under Article 61 of the ICBN (McNeill et al. 2006), and, since the type locality cited for both names is identical and the descriptions are essentially the same, it can be assumed that both *C. retrorsus* and "*C. retroversus*" are based on the same type. Under Art. 61.5, confusingly similar names based on the same type are treated as orthographical variants. Thus, since *C. retrorsus* is the name originally used by Chapman (1878), it is the valid one for the species (McNeill et al. 2006).

LITERATURE CITED

Clewell, A.F. 1985. Guide to the vascular plants of the Florida panhandle. University Presses of Florida, Tallahassee.

Chapman, A.W. 1878. An enumeration of some plants—chiefly from the semi-tropical regions of Florida—which are either new, or which have not hitherto been recorded as belonging to the flora of the southern states. Bot. Gaz. (Crawfordsville) 3:2–6, 9–12, 17–21.

Chapman, A.W. 1883. Flora of the southern United States. 2nd Ed. American Book Company, New York.

Chapman, A.W. 1897. Flora of the southern United States. 3rd Ed. Cambridge Botanical Supply Company, Cambridge.

Diggs, G.M., Jr., B.L. Lipscomb and R.J. O'Kennon. 1999. Shinner's & Mahler's illustrated flora of north central Texas. Sida, Bot. Misc. 16.

Fernald, M.L. and L. Griscom. 1935. Three days of botanizing in southeastern Virginia. Rhodora 37:129–157.

Fernald, M.L. 1950. Gray's manual of botany. 8th Ed. American Book Co., New York.

Gleason, H.A. 1963. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada, Vol. 1. Hafner Publishing Company, Inc., New York.

Gleason, H.A. and A. Cronquist. 1963. Manual of the vascular plants of the northeastern United States and adjacent Canada. D. Van Nostrand Company, New York.

Gleason, H.A. and A. Cronquist. 1991. Manual of the vascular plants of the northeastern United States and adjacent Canada. 2nd Ed. The New York Botanical Garden, New York.

Godfrey, R.K. and J.W. Wooten. 1979. Aquatic and wetland plants of southeastern United States: Monocotyledons. University of Georgia Press, Athens.

Horvat, M.L. 1941. A revision of the subgenus *Mariscus* found in the United States. Catholic Univ. Amer. Biol. Ser. 33:1–147.

Kükenthal, G. 1935–1936. Cyperaceae-Scirpoideae-Cypereae [*Cyperus*]. In: A. Engler and L. Diels, eds. Das Pflanzenreich IV. 20 (Heft 101). Wilhelm Engelmann, Leipzig. Pp. 1–671.

Long, R.W. and O. Lakela. 1971. A flora of tropical Florida. University of Miami Press, Coral Gables.

McNeill, J., F.R. Barrie, H.M. Burdet, V. Demoulin, D.L. Hawksworth, K. Marhold, D.H. Nicolson, J. Prado, P.C. Silva, J.E. Skog, J.H. Wiersema, and N.J. Turland, eds. 2006. International Code of Botanical Nomenclature (Vienna Code). Regnum Vegetabile 146. A.R.G. Gantner Verlag, Ruggell.

Merrill, E.D. 1948. Unlisted binomials in Chapman's Flora of the Southern United States. Castanea 13:61–70.

Radford, A.E., H.E. Ahles and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. The University of North Carolina Press, Chapel Hill.

Small, J.K. 1903. Flora of the southeastern United States. Published by the author, New York.

Small, J.K. 1933. Manual of the southeastern flora. University of North Carolina Press, Chapel Hill.

Tucker, A.O., M.E. Poston and H.H. Iltis. 1989. History of the LCU Herbarium, 1895–1986. Taxon 38:196–203.

Tucker, G.C., B.G. Marcks, and J.R. Carter. 2002. *Cyperus*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J.L. Strother, eds. Flora of North America, vol. 23. Oxford University Press, New York. Pp. 141–191.

Wunderlin, R.P. 1982. Guide to the vascular plants of central Florida. University Presses of Florida, Tampa.

Wunderlin, R.P. 1998. Guide to the vascular plants of Florida. University Press of Florida, Gainesville.

ELEOCHARIS REZNICEKII (CYPERACEAE), A NEW SPECIES FROM THE MEXICAN HIGH PLATEAU

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ABSTRACT

Eleocharis reznicekii (Cyperaceae, subg. *Eleocharis*, series *Eleocharis*), is described and illustrated. It is morphologically intermediate between *E. densa* and two species of *Eleocharis* subseries *Eleocharis* (*E. macrostachya* and *E. palustris*). The new species differs in a combination of characters including conspicuously compressed culms (3 to over 5 times wider than thick) and stylopodium sessile on a thin annular base. *Eleocharis reznicekii* differs additionally from *E. densa* by having relatively lax spikelets, mostly bifid styles, and achenes almost smooth at 30x. From *E. macrostachya* and *E. palustris* it is distinguished in its oblong to linear-oblong spikelets, the proximal floral scale clasping only 1/3 to slightly more than 1/2 of the culm, and the proximal plus 1-2(3) subproximal scales without a flower. *Eleocharis reznicekii* is known only from the state of Durango, in the Mexican high plateau and piedmont of the Sierra Madre Occidental.

Key words: Cyperaceae, Durango, *Eleocharis*, Mexico, taxonomy.

RESUMEN

Se describe e ilustra *Eleocharis reznicekii* (Cyperaceae, subg. *Eleocharis*, serie *Eleocharis*), especie con características morfológicas intermedias entre las de *Eleocharis densa* y las de dos especies de la subserie *Eleocharis* (*E. macrostachya* y *E. palustris*). Se distingue por tener tallos conspicuamente comprimidos (3-5 veces más anchos que gruesos en fresco) y estilopodio sésil sobre una base anular fina. De *E. densa* se distingue además por tener espiguillas menos densas, estilos en su mayoría bífidos y aquenio casi liso a 30x, más redondeado hacia el ápice. De *E. macrostachya* y *E. palustris* lo hace por su hábito más robusto, espiguillas oblongas a linear-oblongas, gluma proximal envolviendo únicamente 1/3 a poco más de 1/2 de la base de la espiga, y por tener la gluma proximal y 1 a 2(3) glumas subproximales sin flor. Hasta ahora, *E. reznicekii* se conoce solamente del estado de Durango, en el Altiplano Mexicano y piedemonte de la Sierra Madre Occidental.

Palabras clave: Cyperaceae, Durango, *Eleocharis*, México, taxonomía.

A field trip in the Mexican state of Durango organized after the symposia The Role of Botany in the Management and Conservation of Ecosystems and the 2nd. Botanical Symposium of Northern Mexico led to the discovery of a conspicuous new species of *Eleocharis* R. Br.:

Eleocharis reznicekii S. González, D.J. Rosen, R. Carter & P.M. Peterson, sp. nov. (Fig. 1). Type: Mexico. Estado Durango, mpio. Durango, W of roadside of MEX Hwy. 23, between Mezquital and Durango, ca. 26 km S of Durango, 16 Sep 2005, D.J. Rosen 3505, R. Guaglianone, A. Torres, S. González, R. Carter, P.M. Peterson (holotype: CIIDIR; isotypes: IEB, K, MEXU, MICH, NY, TAES, TEX, US, VSC, WIS).

Ad *Eleocharitem densam, E. macrostachyam* et *E. palustrem* valde accedit sed a prima differt spiculis laxifloris, stigmatibus plerumque 2 rarius 3 et achaenio fere laeviore; a secunda et tertia differt spiculis oblongis vel lineari-oblongis, squama infima 1/3 ad aliquot plus quam 1/2 spiculae basin amplectenti, squamis inferioribus 2 vel 4 vacuis; et ab omnibus culmis ultra complanatis leviter tortilibus et stylopodiis sessilibus in basi annulari insidentibus differt.

Plants perennial, mat-forming, roots coarse, fibrous, pale brown; rhizomes 3.5-4.5 mm thick, horizontal, conspicuous, firm, cortex persistent, hard, longer internodes to 5.3 cm long, scaly, scales to 16 mm long, persistent, membranous, pale

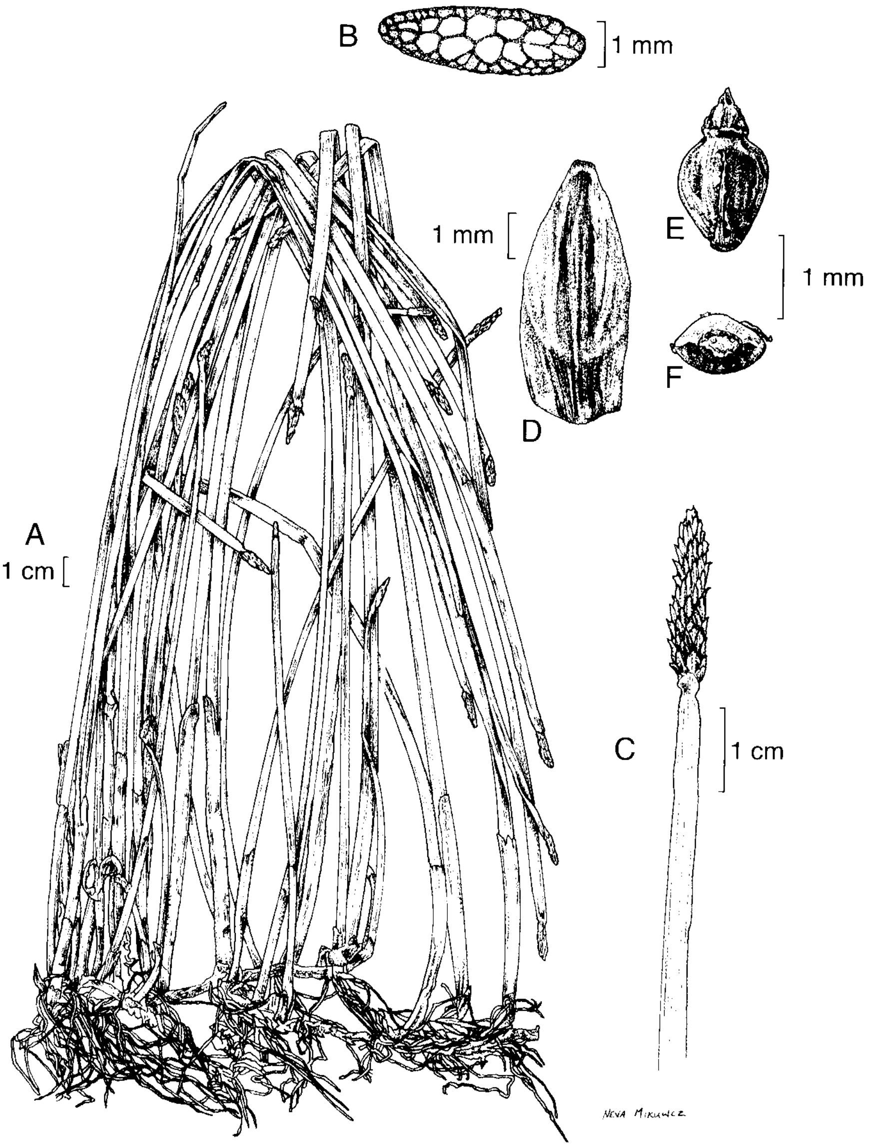

Fig. 1. *Eleocharis reznicekii* S. González, D.J. Rosen, R. Carter & P.M. Peterson, from the type. A. habit; B. transverse section of culm below spikelet; C. spikelet; D. floral scale (abaxial view); E. achene (abaxial view); F. achene (apical view).

chestnut when young, dark grayish brown with age. Fertile culms (30-)50-68 cm tall x 2.6-6 mm wide, markedly compressed distally, broadly ovoid in cross section to ribbon-like, compressed to sub-terete proximally, weakly to conspicuously twisted, 3 to over 5 times wider than thick, pressed flat, longitudinally striate when dry with numerous blunt ridges, soft, internally spongy, bright green. Leaves 2, reduced to tubular sheaths; upper leaf sheath up to 15 cm long, membranous-translucent, loose but not inflated, friable, often splitting adaxially, stramineous to pale grayish brown, apex obtuse to subacute, not callose, tooth-like projection (mucro) absent or very short; lower leaf sheath much shorter than upper, membranous, dark grayish brown to almost black. Spikelets (16-)18-34 mm long x 3-3.7(-4) mm wide, oblong to linear-oblong or but slightly enlarged at base, acute or obtuse; proximal scale 2.1-3.1 mm long, without a flower, clasping 1/3 to slightly more than 1/2 of the culm, slightly constricted basally, of the same color and texture as the culm, apex rounded, the distal, hyaline membranous portion <0.1-0.3 mm long; subproximal 1-2(-3) scales of similar texture and length but narrower and with more evident hyaline apex, without a flower; floral scales (4.1-)4.3-4.7(-4.8) mm long x 1.5-1.9(-2) mm wide, lanceolate, deciduous, often spreading, stramineous or reddish-brown on the midrib region, midrib reddish, stramineous or green. Flowers with perianth of 1-5 slender bristles (sometimes 1 or 2 reduced or rudimentary), shorter than the achene or rarely overtopping the summit, retrorsely spinulose nearly to the base, colorless to pinkish or reddish-brown; stamens 3; anthers (1.4-)2-3.2 mm long, yellow to orange-brown; styles bifid (rarely some trifid in some spikelets). Achene body 1.2-1.5 mm long x 0.9-1.1 mm wide, biconvex, obovate or obpyriform, angles obscure, rounded at summit or with a short constriction about 0.3-0.4 times the width of the achene, smooth at 30 x, yellow, maturing to yellow-brown or brown. Stylopodium (0.3-)0.4-0.6 mm long x (0.3-)0.4-0.5 mm wide, conical to broadly lanceolate, light green to brownish, sessile on a thin, green or brownish annular base which is part of the achene summit.

Eleocharis reznicekii has some morphological features that are intermediate between *E. densa* Benth. and two species of the subseries *Eleocharis*: *E. macrostachya* Britton and *E. palustris* (L.) Roem. & Schult. From the three species *E. reznicekii* differs in a combination of characters including conspicuously compressed culms (3 to over 5 times wider than thick) and stylopodium sessile on a thin annular base which is part of the achenium summit. From *E. densa*, *E. reznicekii* additionally differs by having relatively lax spikelets, mostly bifid styles, and almost smooth achenes at 30x. *Eleocharis densa* is usually represented in herbaria by specimens with very flattened culms, but it has terete culms when fresh; plants of *E. densa* with flattened culms mentioned by McVaugh (1993) could represent specimens of *E. reznicekii*. From *E. macrostachya* and *E. palustris* (as defined by Smith, 2002) it is distinguished by having oblong to linear-oblong spikelets, proximal floral scale clasping only 1/3 to slightly more than 1/2 of the culm, and 1 or 2(3) empty (without a flower) subproximal scales.

Ecology and Distribution. *Eleocharis reznicek*ii grows in almost pure stands or mixed with *Sagittaria*, *Nymphaea*, and other species of *Eleocharis* (e.g., *Eleocharis densa, E. macrostachya, E. ignota, and Eleocharis* sp.) in standing water in deep soils that are sometimes slightly saline, between 1800 and 2530 m above sea level. Known from the Mexican plateau region and adjacent piedmont of the eastern slopes of the Sierra Madre Occidental; thus far *E. reznicekii* is known only from the state of Durango, but it may also exist in Zacatecas. A survey of many sites with suitable habitat during September 2006 yielded the discovery of only one additional locality, which indicates *E. reznicekii* is infrequent, although locally dominant. Two of the five populations known are infected by a sooty mold that gives a dark appearance to the spikelets.

Etymology. The name of the species is dedicated to our colleague and friend Dr. Anton Albert Reznicek, a tireless, sharp-eyed field botanist and specialist in several genera of sedges, who is the Curator of Vascular Plants at the University of Michigan Herbarium.

Additional specimens examined. México: Durango, 9 mi NE of Durango, Route 31, 25 Jul 1958, *D.S. Correll & M.C. Johnston* 20154 (LL); Durango, Granja Don Luis (cercanías), al NW del aeropuerto Guadalupe Victoria y al NE de la Cd. de Durango, por camino vecinal paralelo a las vías del FFCC, 24°08'15" N, 104°32'23" W, 1870 m, humedal en suelo ligeramente salino, abundante en colonias, con *Eleocharis, Nymphaea, Sagittaria* y gramíneas, 20 Sep 2006, *M.S. González 7208, M. Pinedo, F. Sánchez* (ANSM, CHAP, CHAPA, CIIDIR, ENCB, ENEPI, HUAA, IBUG, IEB, MEXU, MO, NY, SI, UAMIZ, US); Durango, al S-SE, por la carretera a El Mezquital, entrada a rancho El Coro, 23°53'14" N, 104°30'03" W, 1800 m, en zona inundada, abundante, en colonia densa; tallos planos 3-4 mm de ancho, 16 Sep 2005, *M.S. González 7105, R. Guaglianone, A. Torres, D. Rosen, R. Carter, P.M. Peterson* (CIIDIR, IEB, MEXU, MICH); Súchil, Reserva de la Biosfera La Michilía, Mesa Larga, a orilla de Chapalita, 5 Sep 1992, 23°23' N, 104°15' W, 2530 m, *A. García 1473* (CIIDIR); Súchil, Reserva de la Biosfera La Michilía, San Juan de Michis, 2 km al S por el camino a El Alemán, orilla de laguna La Virgen, 23°24'58" N, 104°8'16" W, 4 Aug 2000, *S. González 6254, S. Acevedo, A. López* (ANSM, CIIDIR, ENCB, IBUG, IEB, MEXU, MICH, UAMIZ, US).

In the region where *E. reznicekii* occurs, *Eleocharis densa* grows in patches near populations of *E. macrostachya* and *E. palustris*. The intermediate morphological characteristics of *E. reznicekii* and the sympatric occurrence of its putative parents may indicate that this species is of hybrid origin. Hybridization rates are highest in small or peripheral populations (Rieseberg, 1997); *Eleocharis densa* reaches its northern limits of distribution in Durango. However, the fact that *E. reznicekii* is also sympatric with its putative parents makes difficult to accept the hybrid origin hypothesis unless a reproductive isolation mechanism exists. This hypothesis could be tested by a molecular phylogenetic study and/or cytogenetical analysis of this group.

Because of the perennial mat-forming habit, long, horizontal rhizomes with long internodes; mostly bifid styles; and biconvex, blunt angled, yellow to brown achenes almost smooth at 30x, *E. reznicekii* could be placed in *Eleocharis* subg. *Eleocharis*, sect. *Eleocharis*, ser. *Eleocharis*, subser. *Eleocharis* (González Elizondo & Peterson 1997; Smith 2002), which is equivalent to series *Palustriformes* and subseries *Palustres* (invalid names: Svenson 1929, 1932, 1939, 1947, 1957). This group includes the "*Eleocharis palustris* complex", an extremely difficult group according to Svenson (1939), Smith (2001, 2002), and Strandhede (1966). Smith (2001, 2002) recognized seven species in the "*Eleocharis palustris* complex" for North America north of Mexico and discussed four variants of *E. palustris*.

Variation in response to different environmental conditions apparently has led to highly plastic character states making species limits difficult to interpret among members of this complex worldwide. For this reason we have been extremely cautious when considering the taxonomic status of *E. reznicekii*. Field and herbarium observations confirm the distinctive characteristics of this species. During a survey to locate more populations of *E. reznicekii* we found that in the wet season it grows only as an emergent in deep water, and we did not find any plants referable to *E. reznicekii* that have less compressed or more rigid culms out of the water. We also observed that other species of *Eleocharis* (e.g., *E. palustris, E. densa, E. ignota* S. González & Reznicek, *E. montevidensis* Kunth, and *E. parishii* Britton) growing in aquatic or subaquatic habitats in the same region have cylindrical or polygonal culms, with the exception of *E. macrostachya* Britton, which also has compressed culms but differs in several other characters as indicated in the key. A variant of *E. macrostachya* with compressed culms has been called *E. xyridiformis* Fern. & Brack., which additionally differs from typical *E. macrostachya* by having firmer culms, distal leaf sheath apices usually with a tooth to 0.6(-1) mm long on some or all culms, and narrowly lanceoloid spikelets. This variant almost certainly deserves taxonomic recognition, perhaps as a species (Smith, 2002).

Because of the general habit, spikelet shape, proximal scale clasping 1/3 to slightly more than 1/2 of culm and being of the same color and texture as the culm, subproximal 1 or 2(3) scales of similar texture, lacking a flower, and size of the achenes, *E. reznicekii* resembles *E. densa*, a species related to *E. elegans* (Kunth) Roem. & Schult., that has been considered as an intermediate between *Eleocharis* subseries *Truncatae* and subseries *Eleocharis* (González & Peterson, 1997: 439). From the subseries *Truncatae*, *E. densa* differs by having the eventual presence of biconvex achenes, 2 or 3-branched styles, and membranous-translucent to thinly papery distal sheaths that are loose and sometimes disintegrate at the apex. *Eleocharis densa* is restricted to Megamexico 2, the biogeographical area comprising Mexico and northern Central America sensu Rzedowski (1991).

Eleocharis reznicekii has a robust habit and sheaths similar to *E. densa* and *E. elegans*, but its nearly smooth achenes and mostly bifid styles resemble those of species of subseries *Eleocharis*. The need to revise the supraspecific classification in section *Eleocharis* has also been pointed out by Roalson & Friar (2000). In Mexico, both subseries, *Eleocharis* and *Truncatae*, are in need of a revision. A key to the Mexican species of *Eleocharis* subseries *Eleocharis* and to the robust, aquatic species of *Truncatae* is presented below:

1. Styles trifid or some bifid in the same spikelet; achenes plano-convex, slightly trigonous or biconvex, minutely reticulate 2
  2. Culms without complete transverse septa; stylopodium lanceolate .... *E. densa*
  2. Culms with complete transverse septa (sometimes only evident by dissection of the culm in *E. montana*); stylopodium conic, deltoid to lanceolate 3
    3. Culms (0.7-)1-2.5(-3.1) mm wide; septa separated less than 6(-10) mm; stylopodium 0.2-0.35 mm long, conic to deltoid, mostly depressed .... *E. montana*
    3. Culms (1.2-)3-10 mm wide; septa separated more than (7-)10 mm; stylopodium (0.3-)0.4-0.7 mm long, lanceolate .... *E. elegans*

1. Styles bifid (rarely a few trifid in the same spikelet); achenes biconvex, smooth (at 30x) to finely rugulose 4
   4. Culms 2.6-6 mm wide, strongly compressed (3 to over 5 times wider than thick); proximal floral scale clasping 1/3 to slightly more than 1/2 of the culm; achenes smooth at 30x; stylopodium conic to broadly lanceolate, sessile on a thin disc which is part of the summit of the achene .... *E. reznicekii*
   4. Culms 0.7-3(-5) mm wide, terete to compressed (to 3 times wider than thick); proximal floral scale clasping 2/3 to more than 3/4 of the culm; achenes smooth or finely rugulose; stylopodium conic to deltoid, constricted at the base, not sessile on a thin disc 5
      5. Proximal floral scale clasping 2/3(-3/4) of the culm, subproximal scale without a flower; apex of upper sheath obtuse to acute, without a mucro .... *E. palustris*
      5. Proximal floral scale clasping 3/4 or more of the culm, subproximal scale without or with a flower; apex of upper sheath obtuse to subtruncate, with or without a mucro .... *E. macrostachya*

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LITERATURE CITED

González-Elizondo, M. S. & P. M. Peterson. 1997. A classification of and key to the supraspecific taxa in *Eleocharis* (Cyperaceae). Taxon 46: 433-449.

McVaugh, R. 1993. Cyperaceae. Flora Novo-Galiciana 13: 225-440.

Rieseberg, L. H. 1997. Hybrid origins of plant species. Annu. Rev. Ecol. Syst. 28: 359-389.

Roalson, E. H. & E. A. Friar. 2000. Infrageneric classification of *Eleocharis* (Cyperaceae) revisited: Evidence from the internal transcribed spacer (ITS) region of nuclear ribosomal DNA. Syst. Bot. 25: 323-336.

Rzedowski, J. 1991. El endemismo en la flora fanerogámica mexicana: una apreciación analítica preliminar. Acta Bot. Mex. 15: 47-64.

Smith, S. G. 2001. Taxonomic innovations in North American *Eleocharis* (Cyperaceae). Novon 11: 241-257.

Smith, S. G. 2002. *Eleocharis* subg. *Eleocharis* sect. *Eleocharis* ser. *Eleocharis*. Flora of North America North of Mexico 23: 71-89.

Strandhede, S. O. 1966. Morphologic variation and taxonomy in *Eleocharis* subser. *Palustres*. Opera Bot. 10(2): 1-183.

Svenson, H. K. 1929. Monographic studies in the genus *Eleocharis*. Rhodora 31: 121-135, 152-163, 167-191, 199-219, 224-242.

Svenson, H. K. 1932. Monographic studies in the genus *Eleocharis*. Rhodora 34: 193-203, 215-227.

Svenson, H. K. 1939. Monographic studies in the genus *Eleocharis* V. Series 6: *Palustriformes,* subseries *Palustres*. Rhodora 41: 55-73.

Svenson, H. K. 1947. The group of *Eleocharis palustris* in North America. Rhodora 49: 61-67.

Svenson, H. K. 1957. *Eleocharis* (Cyperaceae). North American Flora 18: 509-540

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A NOVEL DESIGN FOR A LIGHT WEIGHT AND DURABLE FIELD PRESS

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ABSTRACT

The development of a light weight, washable, durable, and inexpensive field press is described and illustrated. A pattern and protocol for construction of the field press are provided as well as instructions for its use.

RESUMEN

Se describe e ilustra un aparato portátil para prensar especímenes vegetales en el campo, hecho de material ligero, resistente y barato. Se aporta un patrón y el protocolo para construir la prensa junto con una guía para su uso.

As long as Botanists have collected plants, new and innovative methods have been developed to dry and preserve specimens that retain as much of the natural integrity of the living plant as possible (cf. Smith et al. 1886). Results of the progress in pressing, drying, and preserving methods are readily apparent upon viewing a series of herbarium specimens covering several generations of botanical collectors. The standard methodology employing newsprint, blotters, corrugated cardboard, and heat has been used for several decades to dry specimens, and details about composition, construction, and procedures for drying specimens are provided by a number of authors (e.g., Fosberg & Sachet 1965; Simpson 2006; Carter et al. 2007).

Various materials and methods including metal tubes or cans (vascula), cloth sacks, Styrofoam ice chests, and paper and plastic bags have been used to transport specimens from the field to drying presses, Alternatively, heavy and cumbersome drying presses may be taken directly to the field; however, their use is often prohibited by terrain, distances traversed, and adverse weather conditions. Several field press (portfolio) designs have been used over the years, including that of Fosberg and Sachet (1965). Haynes (2006) described a field press made from several pieces of cardboard corrugate cinched with a press strap. In the early 1990s, Dr. Anton A. Reznicek, curator of vascular plants at the University of Michigan, constructed a field press of cardboard and duct tape and secured with a cord, which was light weight and easy to use under most field conditions. During a field trip to central Arkansas in 1993 with Dr. Reznicek, Dr. Paul Rothrock, and Philip Hyatt, Dr. Reznicek was observed using a cardboard and rope press. Immediately after this field trip, the senior author constructed a prototype of the press described herein out of heavy cloth and rope. Over the years this cloth press has been modified to increase the ease of use and to perfect the overall dimensions. The second author has successfully improvised a variation on Dr. Reznicek's field press by cutting down corners of a cardboard carton and using the sides and top flaps, still attached, to hold specimens enfolded in newsprint.

MATERIALS AND METHODS

Instructions and materials for making the Bryson Field Press (Fig. 1)

1. Cut out two pieces of cotton canvas or similar weight cotton cloth, one piece 1 to 1.5 m long and 0.35 m wide and one piece 0.9 to 1.0 m long and 0.5 m wide.
2. Place cloth right side down.
3. To create hem, turn edges over 1.5 cm and fold over again, then pin hems to hold in place (Fig. 1, hem inset).
4. Clip small triangle at end of each piece of cloth, then fold the miter corners with double folds and pin (Fig. 1, corner insets).

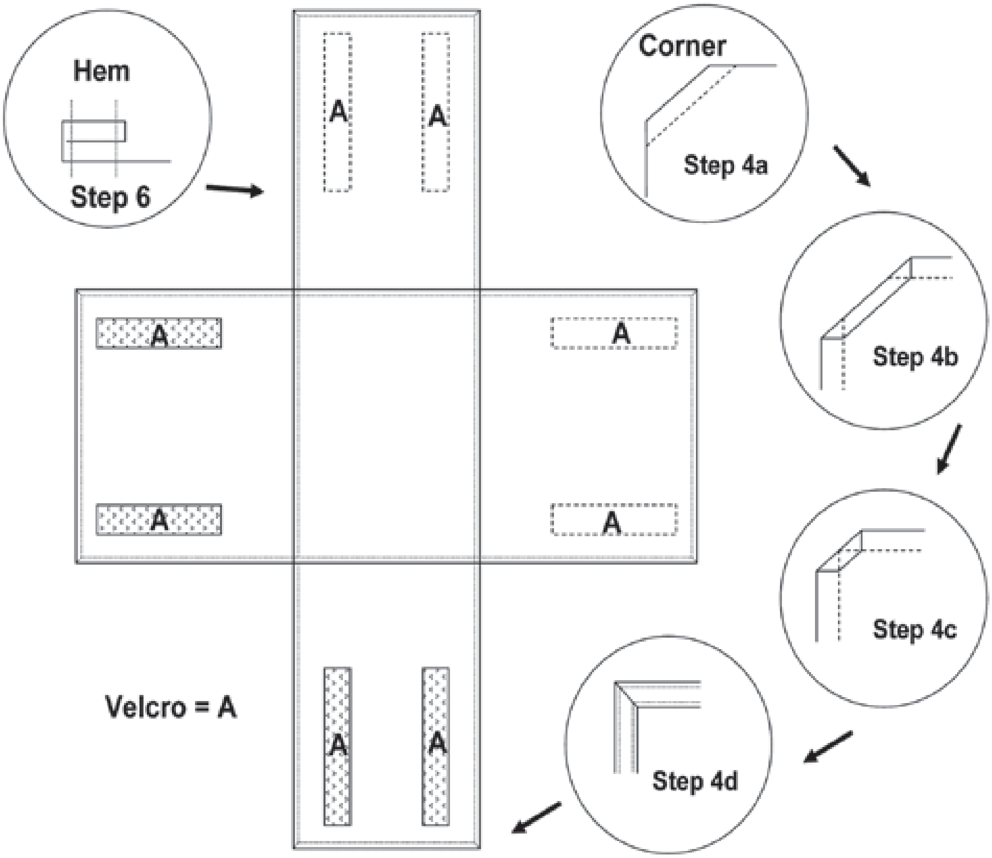

Fig. 1. Diagram of the Bryson Field Press.

5. Iron hem and corners prior to sewing.
6. Stitch around each hem and corner twice on the inside and twice near the outside edge and tie thread ends.
7. Cross pieces with hem side up and cloth right side down forming equal size opposing flaps.
8. Pin the two pieces together.
9. Sew the two pieces together by stitching over previous hem stitches where the pieces overlap and tie thread ends. One side can be left open to create a pocket for a record book, piece of sturdy corrugated cardboard, plywood, or other field supplies.
10. Pin Velcro to the cloth using care to align corresponding pieces on each side. Note that Velcro strips are attached to opposite sides of the cloth on opposing flaps.
11. Stitch around the edge of each piece of Velcro twice and tie thread ends. Strips of Velcro at least 5 cm wide provide better field press closure than narrower strips.
12. Remove all pins and the field press is ready to use.

DISCUSSION

The field press described herein (Fig. 1) is the result of over 15 years of field testing by the authors and except for its size and more permanent materials is based on Dr. Reznicek's initial concept. Durable, light weight, and washable, it is easy to use in a variety of field situations (Fig. 2). The press can be carried under the arm or attached to a back pack, an all terrain vehicle (ATV), or a saddle. It is also convenient for press-

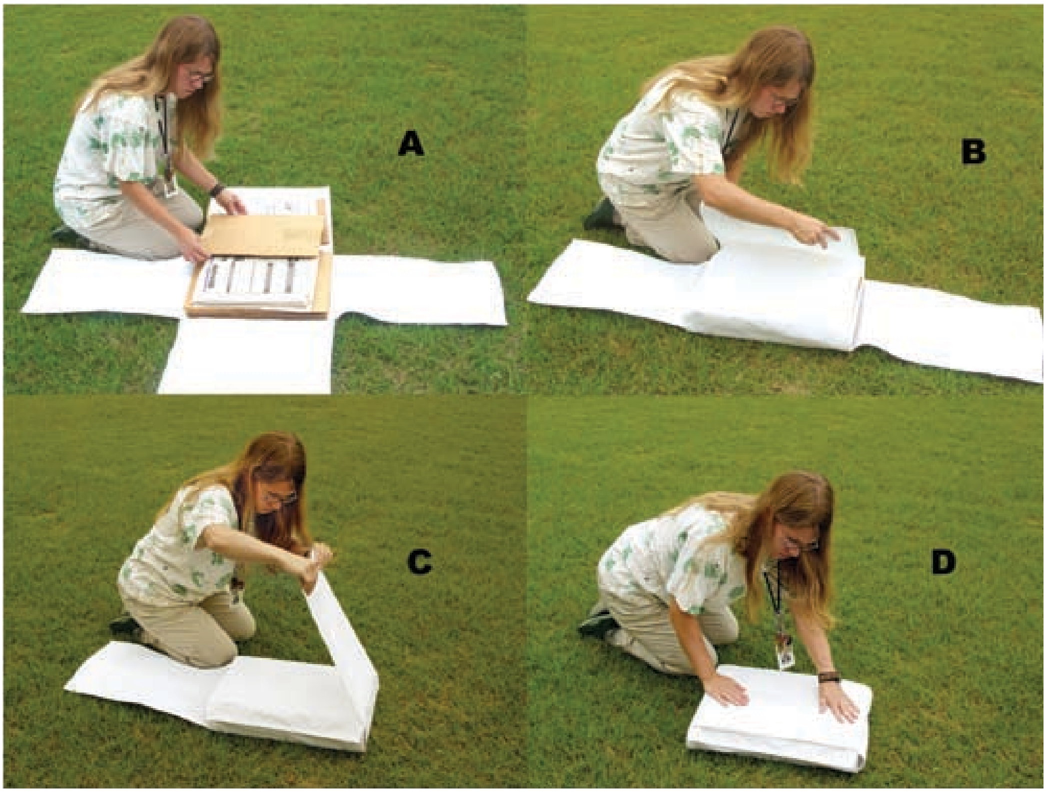

Fig. 2. Photos illustrating the Bryson Field Press (A, loading the field press; B, closing the first set of flaps; C, closing the second set of flaps; and D, closed field press).

ing and transporting plants in a boat or canoe where a conventional press is too heavy or bulky. It is useful for pressing large numbers of specimens rapidly and for pressing plants that wilt rapidly or lose floral parts upon harvesting. The capacity of the press varies depending on the length of the press flaps and thickness of plant specimens and materials used to divide the specimens; however, we have stacked more than 100 specimens in a single field press. The porous cotton fabric allows the press to "breathe" and the drying process to begin. Whereas other materials, such as treated canvas, plastic lined cloth, or heavy plastic were tried in several prototypes, these materials proved to be unacceptable, because they prevented drying and increased condensation, promoted mold and mildew growth, and caused discoloration of specimens. However, heavy weight polyester or other synthetic fabric may be substituted for cotton to make the field press suitable for field work in tropical areas or environments with constant moisture. Although extra cardboard corrugates, plywood, or felt blotters add weight and bulk, they can be used in the field press. Three heavy pieces of corrugated cardboard (one on top, one on bottom, and one between newsprint and the pressed specimens) provide the lightest weight, while allowing for adequate handling of specimens. Additional corrugates can be used to separate specimens from different collection sites or to separate pre-numbered and unnumbered newsprint. We developed a system of pressing the first specimen in pre-numbered newsprint and the duplicates in unnumbered newsprint. When these are placed into a conventional drying press from the top to bottom of each stack from the field press, the numbered newsprint is removed first from the conventional drying press. Thus, the duplicates can be easily tucked into the folded numbered sheet. Unknown to us, Dr. John Thieret and his students used a similar numbering technique (Haynes 2006).

A reasonably skilled seamstress can cut out, pin, and sew a field press in about two hours. The major expenses in constructing one of these presses are the fabric and Velcro. Blemished and seconds fabric can be purchased to save in the overall cost. Also, we have noted that lighter colored fabrics absorb less heat from sunlight than darker colored fabrics. Although wider Velcro strips are substantially more expensive, Velcro strips at least 5 cm wide provide better closure than narrower strips. The estimated cost of fabric, Velcro, and thread is $20.00 to $35.00 per press, but may vary depending on the price and weight of the fabric and amount and width of Velcro. The first author experimented with addition of expandable pockets for temporarily storing woody stems and fruit and straps or handles for carrying the press in the field similar to commercially available presses. Each of these modifications may provide better utility for specific situations, but add cost and bulk to the simple design described herewith.

Specimens are pressed between newsprint and stacked on top of one another with one piece of corrugated cardboard on the top and another piece on the bottom of the stack. The press is closed and secured by pressing the Velcro strips on the first set of flaps against those on the opposing set. Next the second set of opposing flaps is closed and secured. Two sets of opposing flaps allow for greater pressure on the stacked specimens, hold specimens in place within the newsprint, and provide pressure on plant parts that were folded over in fitting the specimen to newsprint sheets. With this field press, unlike vascula, cloth sacks, Styrofoam ice chests, and paper or plastic bags, specimens are in the exact order in which they were collected, facilitating correlation with field notes. When field work is completed, the newsprint folds containing specimens are removed and placed into a standard drying press. While placing the specimens in the drying press, they can easily be repositioned as needed, e.g. refolding leaves or other plant parts to expose flowers, fruits or other structures. Precautions should be taken to keep loaded field presses as cool as possible and out of direct sunlight. For optimal results, plants should be taken from the field press and placed in drying presses as soon as possible, e.g. at the end of each day. However, the time in the field press can be extended depending upon environmental conditions and the kinds of plants being pressed. Plants such as grasses and sedges may remain in the field press longer than plants that are subject to discoloration or contain high water content, and specimens may be kept in the field press under refrigeration overnight with no discernable ill effects. Although not recommended, in unusual circumstances of exigency, we have kept specimens in a field press for almost a week.

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REFERENCES

Carter, R., C.T. Bryson, and S. Darbyshire. 2007. The importance of voucher specimens in documenting research in weed science with notes on their preparation, handling, and storage. Weed Technol. 21:1101–1108.

Fosberg, F.R. and M.-H. Sachet. 1965. Manual for tropical herbaria. Regnum Veg. 39:1–132.

Haynes, R.R. 2006. John W. Thieret, a student's perspective (1967–2005). Sida 22:25–31.

Simpson, M.G. 2006. Plant systematics. Elsevier Academic Press, San Diego, California.

Smith, J.D., I.C. Martindale, J.W. Chickering, Jr., C.E. Bessey, A.W. Chapman, R.I. Cratty, J.J. Davis, C.F. Johnson, C.E. Smith, and G. McCarthy. 1886. Specimens and specimen making. Bot. Gaz. 11:129–134.

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Invasion Alert

Spread of Cuban Club-Rush (*Oxycaryum cubense*) in the Southeastern United States

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Cuban club-rush is an invasive aquatic weed that is spreading northward in the southeastern United States. It is reported for the first time from Mississippi and from significantly farther northward in Alabama than was previously known. Cuban club-rush dissemination and rapid population growth are attributed to two types of reproduction: corky floating achenes and asexual reproduction by fragmentation. An illustration of Cuban club-rush and photos of its habit and habitat are provided.

Nomenclature: Cuban club-rush, *Oxycaryum cubense* (Poepp. & Kunth) Palla.
Key words: Aquatic, invasive, weed dispersal.

Oxycaryum is a monotypic genus widely distributed in the tropics and subtropics of Africa and the Americas (Bruhl 2002). *Oxycaryum cubense* (Poepp. & Kunth) Palla, Cuban club-rush, is known from the West Indies (Kunth 1837), South and Central America (Adams 1994; Nees von Esenbeck 1842; Tur 1971), the southeastern United States (Bryson et al. 1996; Chapman 1889; Clewell 1985; Correll and Johnston 1970; Godfrey and Wooten 1979; Hatch et al. 1990; Jones et al. 1997; Lelong 1988; Mallison et al. 2001; Mohr 1901; Small 1933; Thomas and Allen 1993; Tucker 1987; Turner et al. 2003; Wunderlin 1998), and tropical Africa (Haines and Lye 1983; Hooper and Napper 1972; Lye 1971; Okali and Hall 1974). In the southeastern United States, *O. cubense* is found sporadically in Florida (Anderson 2000, 2007; Chapman 1889; Clewell 1985; Mallison et al. 2001; Wunderlin 1998), southern Georgia (Bryson et al. 1996), southern Alabama (Lelong 1988; Mohr 1901), Louisiana (Thomas and Allen 1993), and coastal Texas (Correll and Johnston 1970; Hatch et al. 1990; Jones et al. 1997; Turner et al. 2003).

The taxonomic placement of *O. cubense* has been disputed. It possesses spirally arranged scales and thus has been treated as *Scirpus cubensis* Poepp. & Kunth (e.g., Correll and Johnston 1970; Godfrey and Wooten 1979; Wunderlin 1998). Molecular analysis by Muasya et al. (2002) supports classification of *Oxycaryum* in tribe Cypereae. Two forms of *O. cubense* are recognized and they differ from one another by inflorescence features (Figure 1). Plants with umbellate inflorescences are *O. cubense* forma *cubense*, while those with monocephalous inflorescences are *O. cubense* forma *paraguayense* (Maury) Pedersen (Barros 1960; Pedersen 1995).

Each of the *O. cubense* collections reported herewith possess monocephalous inflorescences and is *O. cubense* forma *paraguayense* (Figure 2). The Alabama record cited below is only the third collection from Alabama and circa (ca.) 310 km (190 mi) north of previously reported sites in Mobile County, Alabama (Bryson et al. 1996; LeLong 1988; Mohr 1901). The Mississippi records cited below are the first from the state, represent the most northern collections of *O. cubense* in the United States, and expand the range north from the initial Alabama collections by ca. 380 km. Surveys north of Monroe County, Mississippi, have not yielded *O. cubense* populations. Large floating rafts (in excess of 50 m long and 20 m wide [ca. 165 ft long and 65 ft wide]) of *O. cubense* in association with *Eichhornia crassipes* (Mart.) Solms and *Salvinia minima* Baker were observed in each of the counties reported below from 2004 to 2008. *Hydrilla verticillata* (L.f.) Royle, *Hydrocotyle ranunculoides* L.f., *Ludwigia leptocarpa* (Nutt.) H. Harra, *Myriophyllum aquaticum* (Vell.) Verdc., *M. spicatum* L., *Potamogeton nodosus* Poir., *Proserpinaca palustris* L., and *Utricularia gibba* L. were recorded in association with one or more populations of *O. cubense*.

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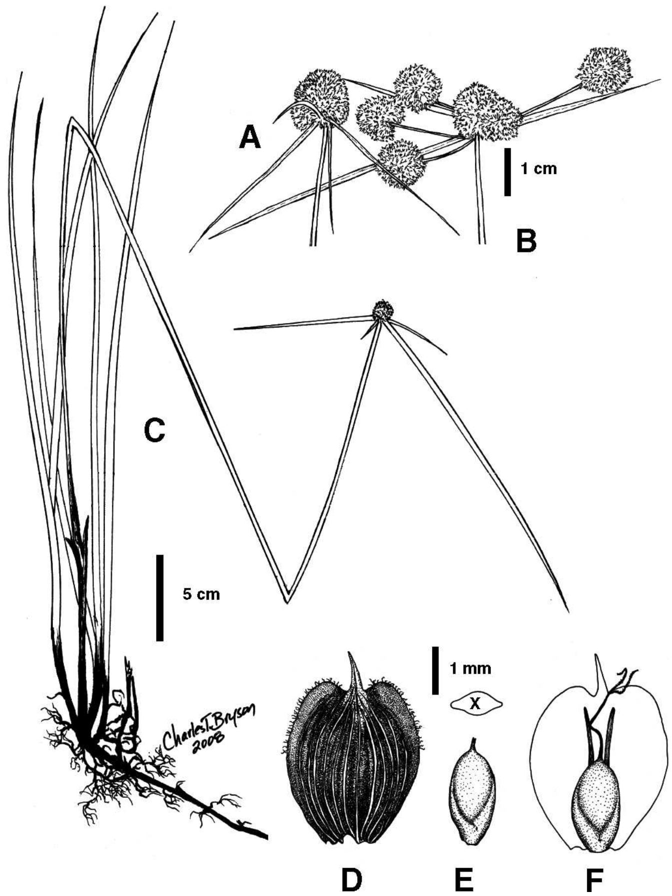

Figure 1. Illustration of *Oxycaryum cubense* (Poepp. & Kunth) Palla: (A) inflorescence of *O. cubense* (Poepp. & Kunth) Palla forma *cubense*; (B) inflorescence of *O. cubense* (Poepp. & Kunth) Palla forma *paraguayense* (Maury) Pedersen; (C) plant habit (culm folded); (D) abaxial view of scale; (E) abaxial and cross section view of achene; and (F) adaxial view of achene with stigma, style, and anthers attached within scale. (B) drawn from *Rosen 2362 & Lange* (herb. Bryson) and (A) and (C)–(F) drawn from *Bryson 20462 & Maddox* (herb. Bryson).

Voucher specimens. *United States, Alabama.*

Pickens County. Aliceville Lake adjacent to boat access off Hwy 86, E side of Tennessee-Tombigbee Waterway, 22 Oct 2004, *Maddox 3489* (herb. Maddox); W side of Pickensville Lock and Dam on Aliceville Lake along Tennessee-Tombigbee Waterway, 2 Nov 2004, *Bryson 20,462 & Maddox* (DAV, DOV, JSU, MISS, MISSA, MMNS, MO, SWSL, USMH, VDB, VSC, herb. Bryson); *Maddox 3495 & Bryson* (herb. Maddox).

United States, Mississippi.

Clay Co. Just N of Waverly Ferry boat ramp S of Hwy MS 50, 8 Nov 2004, *Maddox* 3517 (herb. Maddox); *Maddox* 3518 (SWSL); *Maddox 3519* (herb. Bryson).

Lowndes County. Ca. 5.5 mi. NW of Columbus; just E of Hwy MS 50 bridge over Tennessee-Tombigbee Waterway, 15 Oct 2004, *Maddox 3476* (herb. Maddox); 2 Nov 2004, *Bryson 20,453 & Maddox* (DAV, DOV, JSU, MISS, MISSA, MMNS, MO, SWSL, USMH, VDB, VSC, herb. Bryson).

Monroe County. Aberdeen Lake on Tennessee-Tombigbee Waterway just past lock and dam E bank access in pond, 8 Nov 2004, Maddox 3526 (herb. Maddox); *Maddox* 3527 (SWSL); *Maddox 3528* (herb. Bryson).

O. cubense is a vigorous invasive aquatic plant similar in vegetative reproductive capability to *Salvinia molesta*, *Pistia stratiotes* L., and other invasive aquatic weeds (Tur 1971). It forms transient floating mats and rafts in lakes in Africa (Holm et al. 1977; Okali and Hall 1974), Argentina (Tur 1971), and the United States (Mallison et al. 2001). Although not stated directly (Tur 1971), there are some implications of aquatic succession in mat or raft formation since *O. cubense* depends upon the preexistence of other aquatic species, such as *E. crassipes*, for establishment. These floating mats and rafts impede navigation and displace native organisms. In the southeastern United States and elsewhere, *O. cubense* appears to be extremely invasive, with extensive floating mats and rafts covering large areas in ditches, lakes, ponds, rivers, and impounded swamps to the exclusion of other aquatic vegetation (Bryson et al. 1996; Haines and Lye 1983; Mallison et al. 2001). It is reportedly highly competitive with other floating aquatic species including *Azolla* spp., *E. crassipes*, and *P. stratiotes* (Tur 1971). As suggested by Bryson and Carter (2008), the species is either in the lag phase, or the sporadic distribution of *O. cubense* in the United States suggests low fertility of achenes. Seed placement may be important in establishment. For example, seed germination has been observed in the leaf axils of other aquatic species such as *E. crassipes* (Tur 1971). This characteristic identified *O. cubense* as an aquatic epiphyte by Tur (1971). The corky, buoyant achenes of *O. cubense* are adapted to dispersal by moving water. Its mat-forming, floating habit facilitates asexual reproduction and transport of vegetative fragments by moving water (Haines and Lye 1983).

O. cubense has been in the southeastern United States for more than a century (Chapman 1889; Mohr 1901), and was possibly dispersed into North America from the West Indies or South America by migratory birds or with ship ballast (Bryson et al. 1996). In order to better understand its dispersal and potential to invade wetland habitats, additional research is needed on both its reproductive biology, to determine the extent to which *O. cubense* reproduces sexually and spreads from achenes, and its association with other aquatic weeds.

Acknowledgment

We thank Robert F. C. Naczi for valuable suggestions for improving the manuscript.

Figure 2. *Oxycaryum cubense* (Poepp. & Kunth) Palla forma *paraguayense* (Maury) Pedersen, Cuban club-rush, from the Tennessee-Tombigbee Waterway near Columbus, Mississippi (A) inflorescence; (B) a raft of *O. cubense* growing with *Eichhornia crassipes*; and (C) large floating rafts of *O. cubense* alone or mixed with *E. crassipes* and other floating aquatic plants.

Literature Cited

Adams, C. D. 1994. Cyperaceae. Pages 262–485 *in* G. Davidse, M. S. Sousa, and A. O. Chater, eds. Flora Mesoamericana, Vol. 6: Alismataceae a Cyperaceae. Coyoacán, Mexico: Universidad Nacional Autónoma de México, Ciudad Universitaria,

Anderson, L. C. 2000. Noteworthy plants from North Florida. VII. Sida 19:211–216.

Anderson, L. C. 2007. Noteworthy plants from North Florida. VIII. J. Bot. Res. Inst. Texas 1:741–751.

Barros, M. 1960. Las Cyperaceas del estado de Santa Catalina. Sellowia 12:181–450.

Bruhl, J. J. 2002. *Oxycaryum*. Pages 140 *in* P. W. Ball, K. Gandhi, R. W. Kiger, D. Murray, J. L. Zarucchi, A. A. Reznicek, and J. L. Strother, eds. Flora North America. Volume 23. New York: Oxford University Press.

Bryson, C. T. and R. Carter. 2008. The significance of Cyperaceae as weeds. *In:* R. F. C. Naczi and B. A. Ford, eds. Sedges: Uses, Diversity, and Systematics of the Cyperaceae. Monographs in Systematic Botany from the Missouri Botanical Garden. In press.

Bryson, C. T., J. R. MacDonald, R. Carter, and S. D. Jones. 1996. Noteworthy *Carex*, *Cyperus*, *Eleocharis*, *Kyllinga*, and *Oxycaryum* (Cyperaceae) from Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, Tennessee, and Texas. Sida 17:501–518.

Chapman, A. W. 1889. Flora of the Southern States. 2nd ed. New York: Ivison, Blakeman and Company. 621 p.

Clewell, A. F. 1985. Guide to the Vascular Plants of the Florida Panhandle. Tallahassee: University Presses of Florida. 605 p.

Correll, D. S. and M. C. Johnston. 1970. Manual of the Vascular Plants of Texas. Renner, TX: Texas Research Foundation. 1881 p.

Godfrey, R. K. and J. W. Wooten. 1979. Aquatic and Wetland Plants of Southeastern United States: Monocotyledons. Athens, GA: University of Georgia Press. 712 p.

Haines, R. W. and K. A. Lye. 1983. The Sedges and Rushes of East Africa. Nairobi, Kenya: East African Natural History Society. 404 p.

Hatch, S. L., K. N. Gandhi, and L. E. Brown. 1990. Checklist of the Vascular Plants of Texas. College Station: Texas Agricultural Experiment Station, MP-1655. 158 p.

Holm, L. G., D. Plucknett, J. V. Pancho, and J. P. Herberger. 1977. The World's Worst Weed: Distribution, and Biology. Honolulu: University Press of Hawaii. 391 p.

Hooper, S. S. and D. M. Napper. 1972. Cyperaceae. Pages 278–349 *in* F. N. Hepper, ed. Flora of West Tropical Africa. London: Crown Agents for Oversea Governments and Administrations.

Jones, S. D., J. K. Wipff, and P. M. Montgomery. 1997. Vascular Plants of Texas. Austin: University of Texas Press. 404 p.

Kunth, C. S. 1837. Enumeratio plantarum. 2. Stutgardiae and Tubingae. p. 172.

Lelong, M. G. 1988. Noteworthy monocots of Mobile and Baldwin counties, Alabama. Sida 13:101–113.

Lye, K. A. 1971. Studies in African Cyperaceae II. The genus *Oxycaryum* Nees. Bot. Notiser 124:280–286.

Mallison, C. T., R. K. Stocker, and C. E. Cichra. 2001. Physical and vegetative characteristics of floating islands. J. Aquat. Plant Manage. 39:107–111.

Mohr, C. 1901. Plant Life of Alabama. Contr. U.S. National Herb. 6. Washington, DC: Government Printing Office. 921 p.

Muasya, A. M., D. A. Simpson, and M. W. Chase. 2002. Phylogenetic relationships in *Cyperus* L. *s.l.* (Cyperaceae) inferred from plastid DNA sequence data. Bot. J. Linn. Soc. 138:145–153.

Nees von Esenbeck, C. G. 1842. Cyperaceae. *in* C. F. P. Martius, ed. Flora Brasiliensis 2(1). Lipsiae.

Okali, D. U. U. and J. B. Hall. 1974. Colonization of *Pistia stratiotes* L. mats by *Scirpus cubensis* Poeppig & Kunth on the Volta Lake. Ghana J. Agric. Sci. 7:31–36.

Pedersen, T. M. 1995. Nueva combinacion in Cyperaceae. Hickenia 2: 138.

Small, J. K. 1933. Manual of the Southeastern Flora. Chapel Hill: University of North Carolina Press. 1554 p.

Thomas, R. D. and C. M. Allen. 1993. Atlas of the Vascular Flora of Louisiana, Volume I: Ferns and Fern Allies, Conifers, and Monocotyledons. Baton Rouge, LA: Moran Colorgraphic Printing, 218 p.

Tucker, G. C. 1987. The genera of Cyperaceae in the southeastern United States. J. Arnold Arbor. 68:361–445.

Tur, N. M. 1971. Nuevos casos de epifitismo aquatico. Bol. Soc. Argent Bot. 13(4):243–249.

Turner, B. L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of the Vascular Plants of Texas. Volume 2. Sida Botanical Missellany 24. Fort Worth: Botanical Research Institute of Texas. 888 p.

Wunderlin, R. P. 1998. Guide to the Vascular Plants of Florida. Gainesville: University of Press Florida. 472 p.

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TAXONOMY AND NOMENCLATURE OF THREE CLOSELY RELATED SPECIES OF ELEOCHARIS SUBGENUS LIMNOCHLOA (CYPERACEAE)

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SUMMARY

A taxonomic synopsis and review of nomenclature is provided for *Eleocharis cellulosa*, *E. mutata,* and *E. spiralis*, three closely related species belonging to subgenus *Limnochloa*. One heterotypic synonym of *E. mutata* and the basionym and a heterotypic synonym of *E. spiralis* are lectotypified. The taxonomic treatment includes a key, detailed descriptions and synonymy for each species, notes on distribution and habitat, and illustrations prepared from selected specimens.

Key words: Cyperaceae, *Eleocharis*, *Limnochloa*, lectotypification, nomenclature.

INTRODUCTION

Eleocharis R.Br. is a cosmopolitan genus of ± 200 species and over 600 published names with the major centre of diversity in the Neotropics (González-Elizondo & Tena-Flores 2000). *Eleocharis* subg. *Limnochloa* (P.Beauv. ex T.Lestib.) Torr. (= *Eleocharis* ser. *Mutatae* Svenson) consists of over 35 aquatic or wetland species distributed throughout tropical and subtropical regions worldwide and are distinguished from other *Eleocharis* by a combination of the following morphological characters: indurate to cartilaginous floral scales marginally and distally translucent hyaline-erose and with numerous adaxial cellular-lineate to prominently raised longitudinal veins; proximal scale appearing as a continuation of the culm; coarse culms variously sharply angled to terete and often as thick as the cylindrical spikelet; and biconvex (rarely trigonous) achenes usually with large polygonal epidermal cells arranged in longitudinal rows (González-Elizondo & Peterson 1997). The subgenus has received little attention since the formative work of Svenson (1929, 1939) aside from the description of several new species (González-Elizondo & Reznicek 1996, Roalson 1999, Trevisan & Boldrini 2006, Rosen & Hatch 2007) and a few geographically limited studies (Klimko 1988, Browning et al. 1997), and is in need of worldwide revision.

Recent research by Rosen (2006) supports Svenson's (1939) view that *Eleocharis cellulosa* Torr., *E. mutata* (L.) Roem. & Schult., and *E. spiralis* (Rottb.) Roem. & Schult. form a closely related group sharing the following morphological characters and ecological affinity: floral scales indurate, adaxially many cellular-lineate veined; achene

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apex slightly constricted at the summit into a hard annular thickening or gradually narrowed spongy beak of the same texture and colour as the achene; distal leaf sheath apices that are prolonged into slender, soft awns; achene epidermal cells with concave and distinctly and deeply undulating inner periclinal walls and usually numerous lumen pits; and a distribution in coastal, usually brackish or saline wetlands. The purpose of this paper is to provide an updated taxonomic treatment of these three species based on data from field work in México and the south-eastern United States and on a study of over 700 herbarium specimens (including types) from BM, BRI, BRIT, C, CIIDIR, CM, E, F, GA, GH, K, LIV, LL, M, MEXU, MICH, MO, NU, NY, P, PH, PRE, RSA, SBSC, SMU, SWT, TAES, TEX, US, USF, VSC, WIS, Z, and ZT (acronyms follow Holmgren et al. 1990). Complete citations of all specimens studied can be found in Rosen (2006).

TAXONOMIC TREATMENT

KEY TO SEPARATE ELEOCHARIS CELLULOSA, E. MUTATA, AND E. SPIRALIS

1a. Culms more or less terete to obscurely 3-angled (never triquetrous) distally; floral scales (3.6–)4.2–4.9(–5.3) mm long; achene apex gradually narrowed into a stout spongy region; perianth bristles usually smooth or rarely finely to coarsely retrorsely spinulose . . . . **1. E. cellulosa**

b. Culms triquetrous to trigonous (rarely obscurely 3-angled or terete) distally; floral scales (2.3–)2.8–4(–4.8) mm long; achene apex slightly constricted at the summit into a hard annular thickening; perianth bristles retrorsely spinulose (sometimes smooth in *E. spiralis*) 2

2a. Achenes with c. 20 longitudinal rows of transversely oblong cells; perianth bristles coarse-retrorsely spinulose, most exceeding the tubercle; floral scales ovate to broadly ovate, apex broadly rounded. — New World tropics and Sub-Saharan Africa . . . . **2. E. mutata**

b. Achenes with c. 17 longitudinal rows of transversely linear cells; perianth bristles irregularly spinulose or sometimes smooth, usually few surpassing the achene; floral scales obovate to very widely obovate, apex truncate to broadly rounded. — Oceania, Southeast Asia, Madagascar . . . . **3. E. spiralis**

1. Eleocharis cellulosa Torr. — Fig. 1; Map 1

Eleocharis cellulosa Torr. (1836) 298. — Type: *Ingalls s.n.* (holo NY; iso GH), USA, Mississippi, Bay St. Louis.

Scirpus dictyospermus Wright in Sauvalle (1871) 79. — Type: *Wright 3763* (holo GH; iso K, NY, P), Cuba.

Plants perennial. *Roots* coarse, fibrous, dark grey-brown to maroon, tubers rarely seen except in carefully collected plants; rhizomes long, 1–4 mm thick, scales to 6 mm long. *Culms* terete or rarely obscurely 3-angled to subtrigonous distally (especially when emergent), (39–)46–81(–97) cm by (0.9–)1.4–2.7(–3.5) mm, soft to hard, internally spongy, with incomplete transverse septa, longitudinally striate when dry, shiny and smooth when fresh, light green. *Leaves* 2, reduced to sheaths, apically oblique, apex

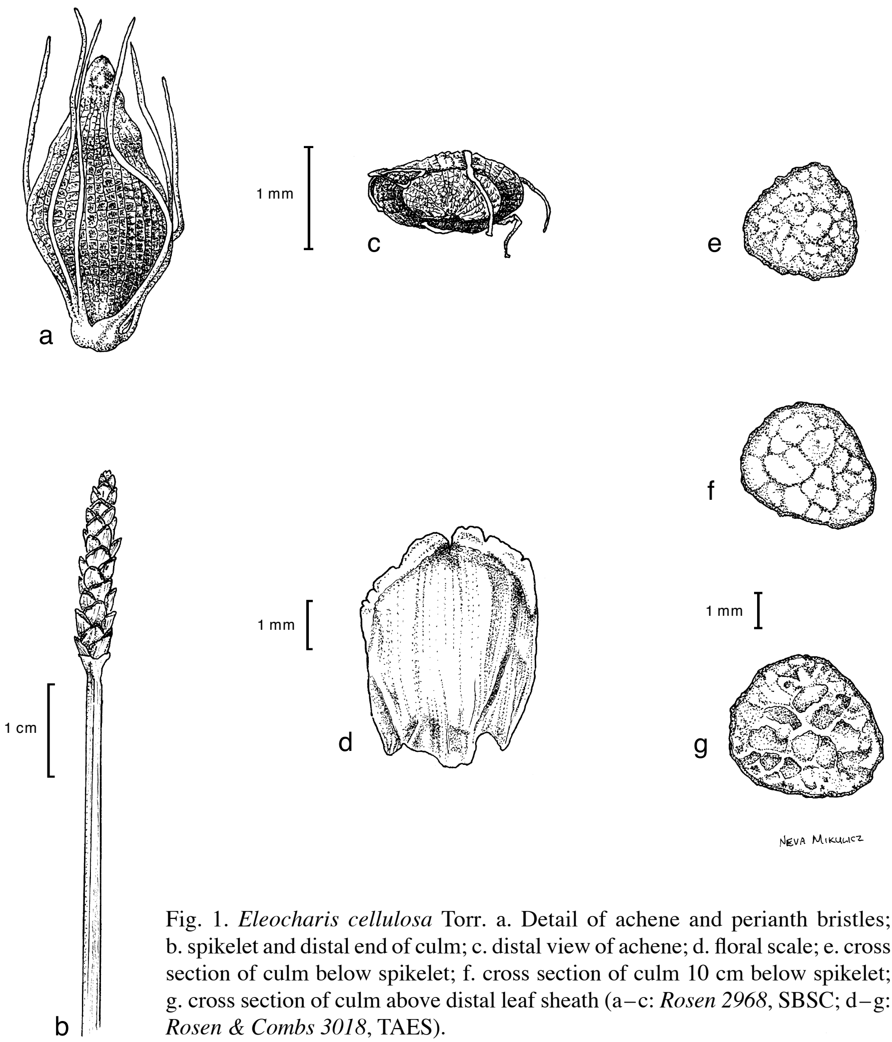
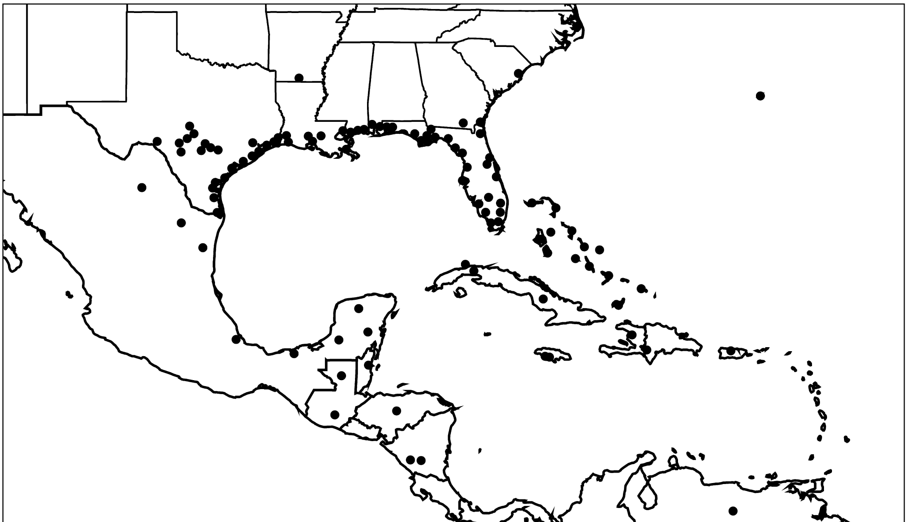


Fig. 1. *Eleocharis cellulosa* Torr. a. Detail of achene and perianth bristles; b. spikelet and distal end of culm; c. distal view of achene; d. floral scale; e. cross section of culm below spikelet; f. cross section of culm 10 cm below spikelet; g. cross section of culm above distal leaf sheath (a–c: *Rosen 2968*, SBSC; d–g: *Rosen & Combs 3018*, TAES).

acute to acuminate, membranous, loose, friable, maroon-chestnut to cinnamon (orangish) basally, brownish distally, apex of upper sheath usually extended into a soft awn to 6 mm long. *Spikelets* cylindric, obtuse, proximal (1–)2–9(–10) scales empty, first scale amplexicaul and appearing as continuation of culm, (13–)24.4–43(–52) by (2.5–)3.5–4.6(–5.5) mm; floral scales appressed to loosely ascending upon drying, ovate to broadly ovate, apex broadly rounded, distal 0.1–0.4 mm hyaline-erose, central area broadly keeled from base to near middle, (3.6–)4.2–4.9(–5.3) by (2.2–)2.8–3.5(–4) mm, with many fine cellular-lineate veins, midvein evident only in adaxial view, centrally indurate, stramineous, adaxially sparsely to densely red-maculate, abaxially sparsely red-maculate with a dark reddish brown band near apex. *Flowers* with (5–)6–7(–8) perianth bristles; bristles straight-tortuous, narrow to somewhat broad and strap-shaped proximally (rarely a bristle present abaxially that is variously forked only near the tip to nearly to the base), smooth or infrequently minutely nodulose (dark brown nodules seen only at high magnification), or bristles retrorsely spinulose nearly to base in some Caribbean plants, bristles 0.6–1.4 times achene length, stramineous, spinules when present colourless, 0.03–0.08 mm long; stamens 3; anthers 1.4–2 mm long, yellow to reddish brown; style 3-fid. *Achenes* biconvex, more or less obpyriform, obovate to very widely obovate, the apex constricted to ± 0.6 times achene width, broadening again into a spongy beak of same texture and colour as the achene, (1.5–)1.6–2(–2.3) by (1.2–)1.4–1.6(–1.8) mm, with (13–)16–19(–23) longitudinal rows of deeply pitted transversely oblong cells visible through transparent periclinal layer on each achene face, dull, cream coloured, maturing to lustrous amber or occasionally light brown; beak usually tapering apically or sometimes the central region spongy and the sides compressed (rarely appearing annulate as in *E. mutata*), (0.2–)0.4–0.8(–1.1) mm high; tubercle usually distinct at high magnification or sometimes so gradually merging with beak as to be scarcely distinguishable from it, (0.1–)0.2–0.4(–0.6) mm tall, dark brown.

Distribution — *Eleocharis cellulosa* is a strictly American species. In the United States, currently known from Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas. In México from the states of Campeche, Coahuila, Nayarit, Nuevo Leon, Quintana Roo, Tabasco, Tamaulipas, Veracruz, and Yucatan. In Central America from Guatemala, Belize, Honduras, and Nicaragua. Widespread in the Caribbean Basin with records from Bahama Archipelago, Bermuda, Cuba, Cayman Islands (Proctor 1984), Jamaica, Haiti, Dominican Republic, and Puerto Rico. In South America known only from Venezuela.

Phenology & Ecology — Flowering from early June through early November in the south-eastern United States. In the tropics, *E. cellulosa* probably flowers year round. In



Map. 1. Distribution of *Eleocharis cellulosa* Torr. Each dot represents the general geographic location of one or more specimens.

the south-eastern United States forming extensive stands in wetlands of the coastal plain, particularly near the coast although a few records occur from inland sites in Texas (the Edwards Plateau) and southern Arkansas. *Eleocharis cellulosa* is a dominant species of some wet-prairie vegetation types in the Florida Everglades (Loveless 1959). In the Caribbean, it occurs in mangrove swamps, fresh to salty marshes, and other coastal wetland habitats.

2. Eleocharis mutata (L.) Roem. & Schult. — Fig. 2a–g; Map 2

Eleocharis mutata (L.) Roem. & Schult. (1817) 155. — *Scirpus mutatus* L. (1759) 867. — *Limnochloa mutata* (L.) Nees (1842) 101. — Type: *Elmgren s.n.* (lecto LINN), Jamaica.

Eleocharis scariosa Steud. (1855) 80. — Lectotype (designated here): *Martius Herb. Fl. Bras. 229* (lecto P, barcode P00217667; isolecto E, GH, M, MO, NY, P), Brasil, Sebastiana.

Plants perennial. *Roots* coarse, fibrous, grey-brown to maroon, tubers rarely seen; rhizomes long, 2–5 mm thick, scales to 8 mm long. *Culms* triquetrous to trigonous, usually conspicuously so distally (rarely obscurely 3-angled to terete), sometimes twisted in plants growing in desiccated wetlands, (31–)53.8–93(–116) cm by (2.2–) 2.6–5.1(–8.5) mm, soft to hard, internally spongy, with incomplete transverse septa, longitudinally striate when dry, shiny and smooth when fresh, dark green. *Leaves* 2, reduced to sheaths, apically oblique, apex acute to acuminate, membranous, loose, friable, maroon-chestnut to cinnamon brown, apex of upper sheath usually extended into a soft awn to 5 mm long. *Spikelets* cylindric, obtuse (acute), at least proximal 2 or 3 (or 4) scales empty, first scale amplexicaul and appearing as a continuation of the culm, (12–)23–44(–66) by (3–)3.8–5.4(–8) mm; floral scales appressed to weakly spreading upon drying, ovate to broadly ovate, apex broadly rounded, distal 0.2–0.3 mm hyaline-erose, central area broadly keeled from base for 0.3–0.5 the scale length, (2.8–)3.2–4(–4.8) by (1.9–)2.5–3.4(–4.8) mm, with many fine cellular-lineate veins, midvein evident only in adaxial view, indurate, stramineous, abaxially red-maculate or more frequently with a dark band near apex, adaxially red-maculate. *Flowers* with (5–)6–8 perianth bristles; bristles straight-tortuous, narrow to somewhat broad and strap-shaped proximally, retrorsely spinulose nearly to the base, mostly exceeding achene, stramineous, margins and spinules sometimes dark reddish; stamens 3; anthers 1.3–2 mm long, reddish brown; style 3-fid. *Achenes* biconvex, more or less obpyriform, obovate, or sometimes broadly elliptic, the apex constricted to ± 0.6 times achene width, broadening again into a hard annulus of same texture and colour as the achene, (1.2–)1.3–1.6(–1.9) (not including annulus or tubercle) by (1–)1.1–1.4(–1.8) mm, with c. 20 longitudinal rows of deeply pitted transversely oblong cells visible through transparent periclinal layer on each achene face, dull, cream coloured, maturing to lustrous olive-yellow (amber); annulus transversely oblong and sometimes tapering apically, transversely rhombic when viewed distally, (0.05–)0.09–0.18(–0.3) mm high; tubercle dorsiventrally compressed, triangular (very shallowly triangular), well formed to withered, distinct or sometimes appearing to merge with annulus or shouldered by it, (0.15–)0.3–0.5(–0.9) by 0.4–0.8 mm, dark brown.

Distribution — In the United States known only from south-eastern Texas. In México from Campeche, Chiapas, Coahuila, Colima (Revillagigedo Islands), Guerrero, Jalisco, Quintana Roo, Tabasco, Tamaulipas, Veracruz, and Yucatan. In Central America from

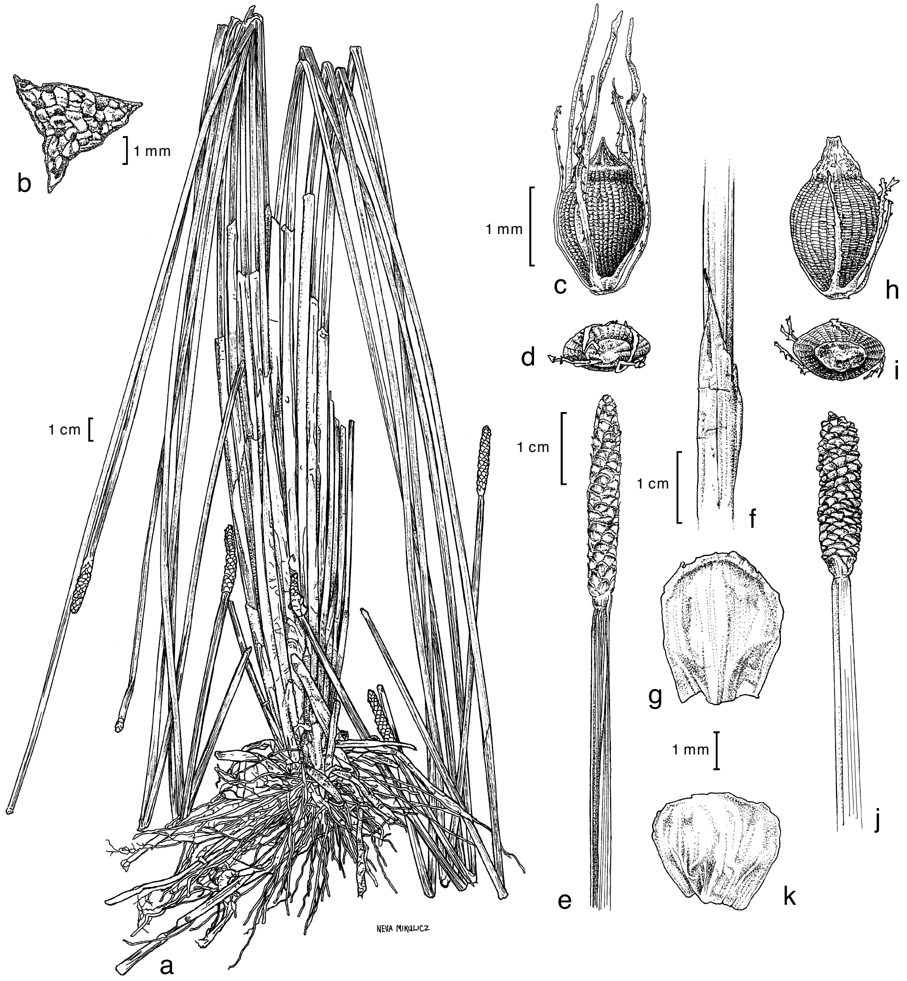
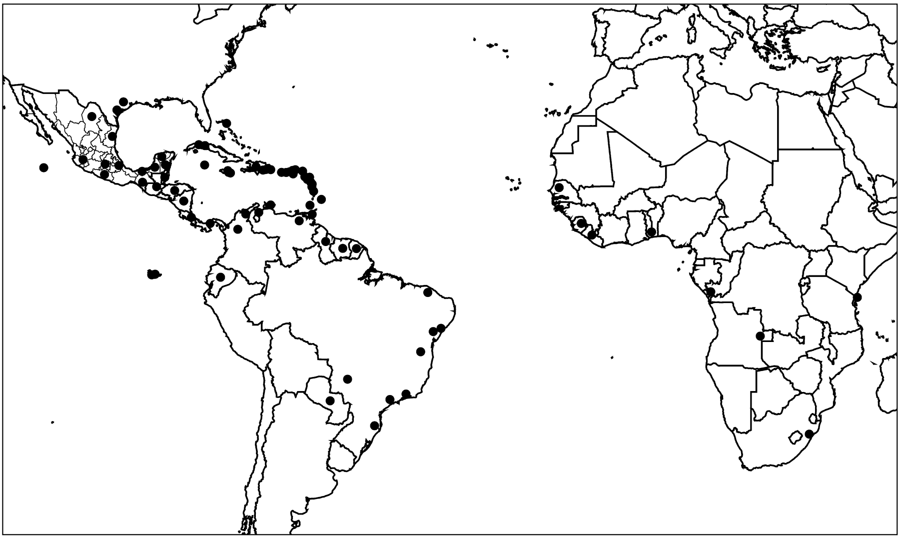


Fig. 2. a–g: *Eleocharis mutata* (L.) Roem. & Schult. a. Habit; b. cross section at distal end of culm below spikelet; c. detail of achene and perianth bristles; d. distal view of achene; e. spikelet and distal end of culm; f. detail of apex of upper sheath; g. floral scale. — h–k: *E. spiralis* (Rottb.) Roem. & Schult. h. Detail of achene and perianth bristles; i. distal view of achene; j. spikelet and distal end of culm; k. floral scale (a–g: *Rosen 2614*, MICH; h–k: *Clemens 9716*, K).

Guatemala, Belize, Honduras, Nicaragua, Costa Rica, Panama, and Clipperton Island. In the Caribbean Basin known from Bahama Archipelago, Cuba, Cayman Islands, Jamaica, Haiti, Dominican Republic, Puerto Rico, Virgin Islands, Leeward Islands, Windward Islands, and southern Netherlands Antilles. In South America known from Brazil, Colombia, Ecuador (including the Galápagos Archipelago), French Guiana, Guyana, Paraguay, Surinam, Tobago, Trinidad, and Venezuela. In Tropical Africa from Angola, Congo, Liberia, Pemba, Senegal, Sierra Leone, South Africa, and Togo. Some Puerto Rican specimens with perianth bristles thin and spinulose only near the tips and



Map. 2. Distribution of *Eleocharis mutata* (L.) Roem. & Schult. Each dot represents the general geographic location of one or more specimens.

the culms terete may be influenced by *E. cellulosa*, or may represent an undescribed species. Two specimens from southern México with terete culms, floral scales with distinctly raised veins, perianth bristles that are stiff (not tortuous) and very coarsely retrorsely spinulose, and achene epidermal cells that are elongated may represent an undescribed species. Formal recognition of these forms is best delayed until more material can be studied.

Phenology & Ecology — Flowering year round and occurring in openings in mangrove swamps, fresh to salty marshes, brackish lagoons and inlets, inter-dune ponds, riverine wetlands, wet clear-cuts, and other coastal wetland habitats reportedly from 0–1200 m.

Uses — Reported as a forage and fibre crop and rice field weed by Simpson & Inglis (2001) and observed as forage for horses and cattle in southern México (Rosen, pers. obs. 2006). Dried culms used for pack-saddle pads and sleeping mats in Galápagos Archipelago (Stewart 1911).

Notes on typification of *Scirpus mutatus* and lectotypification of *Eleocharis scariosa*

Browning et al. (1997) reported the 'type' of *Eleocharis mutata* as being at LINN, but cited no specific specimen. This raises the issue of whether the name has been validly lectotypified according to current procedures outlined in the International Code of Botanical Nomenclature (McNeill et al. 2006). Cafferty & Jarvis (2004) handled identical predicaments for several species of sedges by ascribing lectotype to a specific specimen. However, Mark Spencer (BM, pers. com.) suggested that since there is only one specimen of *E. mutata* at LINN known to have been associated with Linnaeus

('71.2'), it seems prudent and conservative to accept the citation by Browning et al. (1997) as lectotypification for the time being. The inscription 'mutatus' on the specimen was written by Linnaeus, and the plant fits his description.

Eleocharis scariosa was first described by Steudel based on 'Nees in Mart. hrbr. Nr. 229'. Both Nees and Martius are often cited as the collector (e.g., Svenson 1929). Nees could not be the collector because the famous German botanist (and friend of Martius) never left Europe (Hajo Esser, M, pers. com.). Most collections made by Martius are unnumbered, and if numbered by him only go up to 3320 and are always located at M (Hajo Esser, M, pers. comm.). Low numbers (1–500, as is the case with *E. scariosa*) often refer to Martii Herbarium Florae Brasiliensis, a set of Brazilian plants that Martius received from other collectors and distributed widely, usually with many duplicates. Since one can never be certain who the collector was, the type collections of *E. scariosa* should be cited as Martius Herb. Fl. Bras. 229, with Martius as the editor, not the collector (Hajo Esser, M, pers. comm.). The Herb. Fl. Bras. has two meanings: It is the set of plants that Martius distributed, and also a publication of several parts in Flora (Beibl.) in c. 1840–1841, and is the publication on the herbarium specimens of the same name. One can assume that Steudel was referring to this publication and probably to the parts on *Eleocharis* in this publication written by Nees. Presumably, Nees was not cited as collector, but as author. Photos of two duplicates of Martius Herb. Fl. Bras. 229 at P were provided by Caroline Cloup. Specimen #P00217667 is considered by the staff at P to be most reliably associated with Steudel, and is selected as lectotype.

3. **Eleocharis spiralis** (Rottb.) Roem. & Schult. — Fig. 2h–k; Map 3

Eleocharis spiralis (Rottb.) Roem. & Schult. (1817) 155. — *Scirpus spiralis* Rottb. (1773) 45. — *Limnochloa spiralis* (Rottb.) Nees. (1834) 114. — Lectotype (designated here): *Koenig s.n. 1834* (lecto C, barcode L 56/2004 No 55; iso-lecto C), India, Malabaria.

Eleocharis compacta R.Br. (1810) 224. — *Scirpus compactus* (R.Br.) Poir. (1817) 102. — Lectotype (designated here): *Brown 5934* (lecto BM, barcode BM000901117; iso-lecto BM, K), Australia, Northern Territory.

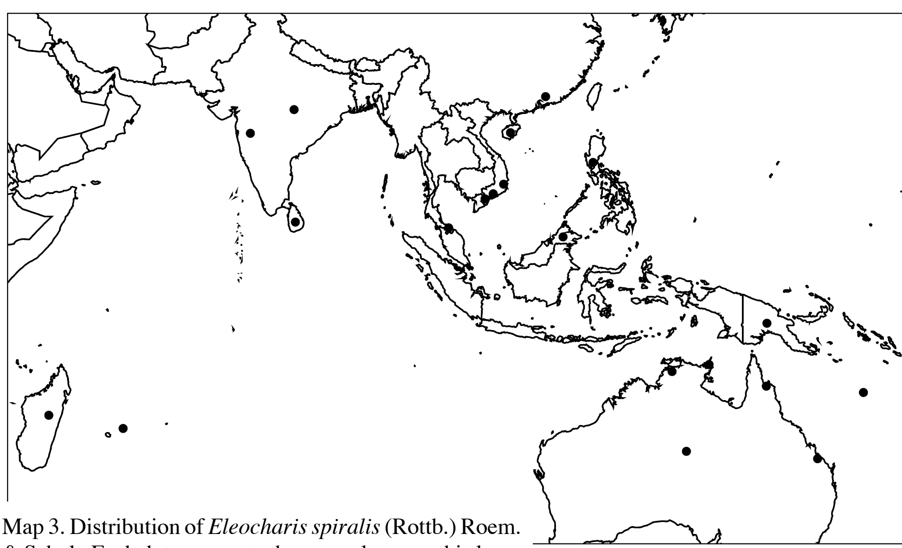
Eleocharis austro-caledonica auct. non Vieillard (1862) xvi: Svenson (1939) 41.

Plants perennial. *Roots* coarse, fibrous, grey-brown, tubers absent; rhizomes long, 2–3 mm thick, scales to 7 mm long. *Culms* trigonous to nearly triquetrous, conspicuously so to near base in some specimens, or only distally or sometimes obtusely trigonous to terete, coarse, (29–)43.9–71(–91.5) cm by (1.4–)1.8–2.8(–3.6) mm, soft to hard, internally spongy, with incomplete transverse septa, longitudinally striate when dry. *Leaves* 2, reduced to sheaths, apically oblique, apex acute to acuminate, membranous, loose, friable, often conspicuously and variably blotched from maroon, pink, to cinnamon brown, apex of upper sheath usually extended into a soft awn to 6 mm long. *Spikelets* cylindric, obtuse (acute), proximal 2 or 3 scales empty, first scale obtuse, amplexicaul, appearing as continuation of culm, (11–)18.7–32.6(–41) by (3–)3.8–5.2(–6) mm; floral scales appressed, obovate to very widely obovate, apex truncate to broadly rounded, distal 0.2–0.3 mm hyaline-erose, central area distinctly broadly keeled from base to near middle, (2.3–)2.8–3.8(–4.2) by (2–)2.4–3.3(–3.7) mm, with many very fine cellular-lineate veins, midvein evident only in adaxial view, a central obtriangular region indurate, cartilaginous to hyaline along sides, stramineous, scarcely abaxially red-maculate and sometimes with a dark band near apex, conspicuously adaxially red-maculate. *Flowers* with (4–)5–7(–8) perianth bristles; bristles straight-tortuous, narrow, irregularly spinulose to smooth, usually half or fewer exceeding achene, stramineous, margins and spinules sometimes dark reddish; stamens 3; anthers (1.1–)1.3–1.7(–1.8) mm long, reddish brown; style 3-fid. *Achenes* biconvex or with (abaxial?) central bulge, obovate, or sometimes broadly obovate, apex constricted to ± 0.6 times achene width, broadening again into hard annulus of same texture and colour as achene, (1.2–)1.3–2.1 by (0.93–)1.04–1.3(–1.4) mm, with c. 17 longitudinal rows of transversely linear cells with inconspicuous longitudinal interstitial ridges visible through transparent periclinal layer on each achene face, dull buff or cream coloured, maturing through amber to lustrous dark brown; annulus narrowly oblong (indistinct) or prolonged and tapered, merging into a short conical tubercle, sometimes very similar in aspect to *E. cellulosa*, 0.1–0.2(–0.3) mm high; tubercle dorsiventrally compressed, triangular, well formed to withered, distinct or sometimes appearing to merge with prolonged and tapered annulus, (0.3–)0.4–0.6(–0.7) by (0.4–)0.5–0.6(–0.8) mm, dark brown.

Distribution — In Southeast Asia, known from China, India, Malaysia, Philippines, Sri Lanka, Thailand, and Vietnam. In Oceania known from tropical and subtropical regions of Australia (Northern Territory and Queensland), New Caledonia, and Papua New Guinea. In Africa known from the Island of Mauritius, and reported by Svenson (1939) from Madagascar. Reports of *E. spiralis* for the New World (e.g., Koyama 1985, Simpson & Koyama 1998) appear to be based on misidentified specimens of *E. mutata*. We have seen no authentic specimens of *E. spiralis* from the New World.

Phenology & Ecology — *Eleocharis spiralis* flowers year round and usually occurs at low elevations in extensive stands on clayey to peaty soils in *Melaleuca* and mangrove swamps, saline flats, brackish to saline marshes, riverine wetlands, and other coastal wetland habitats (Cowie et al. 2000).

Uses — In Indramaju, Java, reportedly used for making mats (Kern 1974).



Map 3. Distribution of *Eleocharis spiralis* (Rottb.) Roem. & Schult. Each dot represents the general geographic location of one or more specimens.

Notes on lectotypification of *Eleocharis spiralis* and *Eleocharis compacta*

Eleocharis spiralis was first described and illustrated under *Scirpus* by Rottboell based on plants sent to him by Koenig from India. The protologue designates no type and the description is accompanied by a detailed illustration of a sterile specimen. Roemer & Schultes (1817) transferred the name to *Eleocharis* without indicating a type. Although Brown is sometimes recognized as author of this combination, he merely indicated the correct placement of *S. spiralis* in *Eleocharis*. The Koenig Herbarium is housed at C, from which five specimens of *Eleocharis spiralis* collected by Koenig were received. Accession # L56/2004 No 55 is traditionally thought to have been associated with the protologue of *Scirpus spiralis* Rottb. (Ib Friis, C, pers. comm.). Since it critically matches the various elements of the protologue, it is herein designated as lectotype.

Eleocharis compacta is based on *Brown 5934* from Australia. Upon Brown's death in 1858, his personal herbarium was acquired by the British Museum and duplicates were distributed to Kew, Edinburgh, Melbourne, and Sydney (Stearn 1960). Stearn (1960) suggested lectotypes for species described by Brown be sought at BM. We have examined photos of two specimens of *Brown 5934* from BM. A sheet (BM000901117) inscribed on the back "Nova Hollandia Ora Septentrionalis Mr. Brown" is herein designate as lectotype as recommended by Stearn (1960), since it is likely the specimen Brown selected for the public collection. A second sheet from BM bears a blue printed label typical of Brown's duplicates distributed by the Bennett bequest (Stearn 1960). Two specimens of *Brown 5934* on loan from K, although immature, are otherwise referable to *E. spiralis* and are isolectotypes.

Confusion surrounding *Eleocharis austro-caledonica*

Svenson (1929) treated *Eleocharis austro-caledonica* Vieill. (based on *Vieillard 1453*) as a synonym of *E. dulcis*, and then later under *E. spiralis* without explanation (Svenson 1939). Our research has resolved the confusion surrounding *Vieillard 1453* and how *E. austro-caledonica* relates to *E. dulcis* and *E. spiralis*. A duplicate of *Vieillard 1453* was received on loan from BM. Photographs of three sheets of *Vieillard 1453* (one mixed with *1455*) were also sent from P (where Vieillard's types are located). All of the specimens at P are annotated by Guillaumin as *E. dulcis*. An examination of the photographs shows the culms are conspicuously septate, and the spikelet characteristics are of *E. dulcis*, not *E. spiralis*. However, the duplicate of *Vieillard 1453* from BM is immature, but is without a doubt *E. spiralis*. Thus, the elements of *Veillard 1453* cited as type of *E. austro-caledonica*, comprise a mixed collection. In the absence of an annotation as type of a particular specimen by Veillard, it is currently not possible to determine exactly to which element he intended to apply the name. However, the protologue describes plants a meter or more high, which is probably too tall for *E. spiralis*. Since the three specimens at P are referable to *E. dulcis,* it is prudent to select one of these as type and to treat *E. austro-caledonica* as a synonym of *E. dulcis*.

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REFERENCES

Brown, R. 1810. Prodromus florae Novae Hollandiae. Hafner Pub. Co., New York.

Browning, J., K.D. Gordon-Gray & C.J. Ward. 1997. Studies in Cyperaceae in Southern Africa 32: Eleocharis subgenus Limnochloa section Limnochloa. S. African J. Bot. 63, 4: 172–184.

Cafferty, S. & C.E. Jarvis. 2004. Typification of Linnaean plant names in Cyperaceae. Taxon 53: 177–181.

Cowie, I.D., P.S. Short & M. Osterkamp Madsen. 2000. Floodplain flora: A flora of the coastal floodplains of the Northern Territory, Australia. ABRS, Canberra.

González-Elizondo, M.S. & P.M. Peterson. 1997. A classification of and key to the supraspecific taxa in Eleocharis (Cyperaceae). Taxon 46: 433–449.

González-Elizondo, M.S. & A.A. Reznicek. 1996. New Eleocharis (Cyperaceae) from Venezuela. Novon 6: 356–365.

González-Elizondo, M.S. & J.A. Tena-Flores. 2000. Eleocharis (Cyperaceae) in the New World. In: K.L. Wilson & D.A. Morrison (eds.), Monocots: systematics and evolution: 637–643. CSIRO Publishing, Australia.

Holmgren, P.K., N.H. Holmgren & L.C. Barnett. 1990. Index herbariorum Part I: The herbaria of the world. New York Botanical Garden, New York.

Kern, J.H. 1974. Cyperaceae. Flora Malesiana, Ser. I, Vol. 7, 3: 435–753. Noordhoff, Leyden.

Klimko, M. 1988. Systematic studies on Eleocharis acutangula (Roxb.) Schult. and Eleocharis variegata (Poir.) Presl. Bull. Soc. Amis Sci. Lett. Poznan 27: 69–79.

Koyama, T. 1985. Cyperaceae. In: M.D. Dassanayake & F.R. Fosberg (eds.), Flora of Ceylon, Vol. 5: 125–405. Amerind Publishing Co. Pvt. Ltd., New Delhi.

Linnaeus, C. 1759. Systema Naturae, Tomus II, editio decima, reformata. Laurentii Salvii, Stockholm.

Loveless, C.M. 1959. A study of the vegetation in the Florida Everglades. Ecology 40: 1–9.

McNeill, J., F.R. Barrie, H.M. Burdet, V. Demolin, D.L. Hawksworth, K. Marhold, D.H. Nicolson, J. Prado, P.C. Silva, J.E. Skog, J.H. Wiersema & N.J. Turland. 2006. International code of botanical nomenclature (Vienna Code). Regnum Veg. 146.

Nees von Esenbeck, C.G.D. 1842. Cyperographia sive descriptio in Brasilia provenientium. In: K.F.P. von Martius (ed.), Flora Brasiliensis, Vol. II, Part I: 1–226. Stuttgartiae & Tubingae, sumptibus J.G. Cottae.

Nees von Esenbeck, C.G.D. 1834. No. III. Cyperaceae indicae. Praecipue juxta herbaria Wrightii, Wallichii, Roylei et Lindleyi. In: R. Wright (ed.), Contributions to the botany of India: 69–129. London.

Poiret, J.L.M. 1817. Scirpus. In: J.B.A.P. de Monnet de Lamarck et al., Encyclopédie Méthodique. Botanique. Suppl. 5: 90–106. Paris.

Proctor, G.R. 1984. Flora of the Cayman Islands. Her Majesty's Stationary Office, London.

Roalson, E.H. 1999. Eleocharis yecorensis (Cyperaceae), a new species of spike-sedge from México. Aliso 18: 57–60.

Roemer, J.J. & J.A. Schultes. 1817. Systema Vegetabilium. Vol. 2. Stuttgart.

Rosen, D.J. 2006. A systematic study of select species complexes of Eleocharis subgenus Limnochloa (Cyperaceae). PhD thesis. Texas A&M University, College Station, USA.

Rosen, D.J. & S.L. Hatch. 2007. A new species of Eleocharis subg. Limnochloa (Cyperaceae) from Bolivia. Brittonia 59: 377–379.
Rottboell, C.F. 1773. Descriptionum et iconum rariores et pro maxima parte novas plantas illustrantium liber primus. Hafniae, Sumptibus Societatis Typographicae.
Sauvalle, F.A. 1871. Flora Cubana. Anales Acad. Ci. Med. Habana.
Simpson, D.A. & C.A. Inglis. 2001. Cyperaceae of economic, ethnobotanical and horticultural importance: a checklist. Kew Bull. 56: 257–360.
Simpson, D.A. & T. Koyama. 1998. Cyperaceae. In: T. Santisuk & K. Larsen (eds.), Flora of Thailand, Vol. 6, part 4: 284–292. Diamond Printing Co., Thailand.
Stearn, W.T. 1960. An introduction to Robert Brown's Prodromus Florae Novae Hollandiae. In: R. Brown, Prodromus florae Novae Hollandiae et Insulae van-Diemen, facsimile edition: v–lii. Cramer, Weinheim.
Steudel, E.G. 1855. Synopsis plantarum Cyperacearum. Stuttgart.
Stewart, A. 1911. A botanical survey of the Galápagos Islands. Proc. Calif. Acad. Sci. IV, 1: 7–288.
Svenson, H.K. 1929. Monographic studies in the genus Eleocharis I. Rhodora 31: 121–135, 152–163, 167–191, 199–219, 224–242.
Svenson, H.K. 1939. Monographic studies in the genus Eleocharis V. Rhodora 41: 1–19, 43–77, 90–110.
Torrey, J. 1836. Monograph of North American Cyperaceae. Ann. Lyceum Nat. Hist. New York 3: 239–448.
Trevisan, R. & I.I. Boldrini. 2006. A new species of Eleocharis R. Brown (Cyperaceae) from Southern Brazil. Novon 16: 155–157.
Vieillard, E. 1862. Plantes utiles de la Nouvelle-Calédonie. Ann. Sci. Nat., Bot. sér. 4, 16: 28–76.

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Host-tree Selection by an Epiphytic Orchid, *Epidendrum magnoliae* Muhl. (Green Fly Orchid), in an Inland Hardwood Hammock in Georgia

Bradley J. Bergstrom[1,*] and Richard Carter[1]

Abstract - We characterized the tree community of a mesic hardwood hammock in south-central Georgia as an oak-pine-hickory forest, with *Liquidambar styraciflua* (Sweetgum), *Magnolia grandiflora* (Southern Magnolia), and *Ilex opaca* Ait. (American Holly) as subdominants. We surveyed this forest for colonies of the most northerly distributed epiphytic orchid in the Western Hemisphere, *Epidendrum magnoliae* (Green Fly Orchid), and recorded the species and trunk diameter of 112 host trees (phorophytes) as well as the height and size of each orchid colony. We calculated a selectivity index (SI) to compare phorophyte frequency with availability, based on a point-transect survey. Green Fly Orchid occurred on 8 species of hardwood trees, but had a strong preference for Southern Magnolia as a host and a moderately strong preference for *Quercus virginiana* (Live Oak). Host trees were much larger (presumably older) than the average of available trees, and that effect was strongest for the most preferred host. Orchid colonies also occupied significantly greater areas on individual Southern Magnolia than on other phorophytes. It is likely that old-growth Southern Magnolia and Live Oak trees are critical to the viability of this population of Green Fly Orchid, which is rare in inland forests in Georgia. In addition to being the most persistent epiphyte substrates in this environment, their broadleaf evergreen canopies—which would be especially true of Southern Magnolia —may provide the most favorable microclimates in terms of shade, humidity, and frost protection.

Introduction

It has been estimated that epiphytic vascular plants comprise 10% of all vascular plant species (Madison 1977) and 70% of all orchid species (Gentry and Dodson 1987). Further, 60% of all epiphyte species are members of the Orchidaceae (Kress 1986). Vascular epiphytes in general and epiphytic orchids in particular attain their peak species diversities in tropical forests, especially in the Neotropics (Gentry and Dodson 1987), but they also occur in subtropical forests, with many species found in southern Florida (Luer 1972). There are 7 species of *Epidendrum* found in the continental US, all of which are epiphytic; 6 of these are limited to subtropical hammocks of peninsular Florida (Hágsater 2002). *Epidendrum magnoliae* Muhl. (= *E. conopseum* W.T. Aiton) (Green Fly Orchid) is found in widely scattered patches of humid coastal plain forest in 7 southeastern states from North Carolina southward through central penisular Florida and westward into southern Louisiana. Populations in eastern Mexico in the states of Nuevo León, San Luis Potosí, and Tamaulipas have been treated as *E. conopseum*

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var. *mexicana* L.O. Williams (Hágsater 2002, Luer 1972). Green Fly Orchid is the only species of epiphytic orchid found in the continental US outside of Florida and has the northernmost distribution of any epiphytic orchid in the Western Hemisphere (Correll 1950).

In some studies in Neotropical forests (e.g., Frei 1973), certain epiphyte species showed marked preferences for host tree (phorophyte) species, whereas in other studies little or no host specificity was seen (Trapnell and Hamrick 2006, Zimmerman and Olmstead 1992). Generally, epiphytes occur on a number of different phorophytes, but with variable frequency (Benzing 1990). Possible mechanisms for host-tree or phorophyte specificity in epiphytic orchids involve microclimate (see Callaway et al. 2002), propensity for exfoliation (bark sloughing), presence of certain bark chemicals (Frei and Dodson 1972), other bark characteristics (Benzing 1981), and distribution of mycorrhizal fungal symbionts. Epiphytic orchids have mycotrophic nutrition (carbon, other nutrients, and possibly water are supplied to the plant by mycorrhizal fungi) and have been shown to require a mycorrhizal symbiont for seed germination (McKendrick et al. 2000, Otero et al. 2005).

Green Fly Orchid shares its geographic range in the southeastern coastal plain with the "atmospheric" epiphyte *Tillandsia usneoides* (L.) L. (Spanish Moss) and the rooted, epiphytic fern *Pleopeltis polypodioides* (L.) E.G. Andrews and Windham (Resurrection Fern), although the latter two are far more common within that range. These species also commonly attach to branches, whereas Green Fly Orchid frequently grows on the main trunk of its host. Outside of Florida, Green Fly Orchid is limited to near climax hardwood forests and swamp forests within the most humid microclimates available, which means hammocks primarily found along the coastal strip and rarely found inland (Wharton 1989).

Correll (1950) reported that *Epidendrum magnoliae* (as *E. conopseum*) grew primarily on *Magnolia grandiflora* L. (Southern Magnolia), and *Quercus virginiana* Mill. (Live Oak), but that it had also been collected on *Acer rubrum* L. (Red Maple), *Carpinus caroliniana* Walter (Hornbeam), *Fagus grandifolia* Ehrh. (American Beech), *Juniperus virginiana* L. (Eastern Red Cedar), *Liquidambar styraciflua* L. (Sweetgum), *Nyssa* spp. (Black Gum or Tupelo), and *Taxodium distichum* (L.) Rich (Baldcypress). We have also observed Green Fly Orchid on *Tilia americana* L. (Basswood) in a bluff forest community along the Withlacoochee River in western Lowndes County, GA, and epilithic on sandstone cliff faces ("Altamaha Grit" formation) at "Broxton Rocks" in Coffee County, GA (Patrick et al. 1995; R. Carter, unpubl. data).

In this study, we attempt to characterize the tree community of a rare inland hardwood hammock in Georgia (Wharton 1989), which hosts a sizable population of Green Fly Orchid, and examine the host-tree distribution and specificity of this epiphytic orchid within this community. We are not aware of any other similar studies of host-tree selection for this species.

Field-site Description

Dudley's Hammock, owned by Moody Air Force Base, is a relatively undisturbed, elevated area, ca. 61 ha in size, within the Grand Bay wetland complex, which comprises ca. 7000 ha of shallow Carolina bays or pocosins and headwater streams in northeastern Lowndes and southwestern Lanier counties in extreme south-central Georgia. It is located 17.6 km NE of Valdosta at 30°57'02"N, 83°09'49"W (NAD27). The hammock rises 2–3 m above the surrounding cypress-gum swamps and pine flatwoods and is noted as a rare inland example in Georgia of undisturbed mesic hardwood hammock, which is also characterized as lowland broadleaf evergreen forest (Quarterman and Keever 1962, Wharton 1989). In the classification scheme of The Nature Conservancy, the vegetation of Dudley's Hammock appears to be most closely related to the Southern Coastal Plain Oak Dome and Hammock (CES203.494), with characteristics of the Southern Coastal Plain Hydric Hammock (CES203.501), but lacking *Sabal palmetto* (Walter) Lodd. ex Schult. & Schult. f. (Cabbage Palm; cf. NatureServe 2008).

Dudley's Hammock is roughly bisected by an east–west 2-track access road, and there has been some recent and historic disturbance (partial clearing, burning) resulting from military activities on the northern half (Bergstrom et al. 1994). Therefore, we limited our survey to the portion of the hammock south of the road, which is relatively undisturbed and where Green Fly Orchids had been observed.

Dominant trees in this less disturbed portion of the hammock include Southern Magnolia, Live Oak, *Q. nigra* L. (Water Oak), *Q. alba* L. (White Oak), *Q. michauxii* Nutt. (Swamp Chestnut Oak), *Ilex opaca* Ait. (American Holly), *Carya glabra* (Mill.) Sweet (Pignut Hickory), Sweetgum, *Nyssa sylvatica* Marshall (Black Gum), *Pinus glabra* Walter. (Spruce Pine) and *P. taeda* L. (Loblolly Pine). Owing either to the small size and isolation of Dudley's Hammock, or to soil properties, American Beech is not found at this site (Bergstrom et al. 1994), whereas it is a dominant tree of similar hammocks in northern Florida (Monk 1968).

Arboreal vascular epiphytes commonly found in Dudley's Hammock include Spanish Moss, Resurrection Fern, and Green Fly Orchid. Green Fly Orchid is protected in Georgia; its legal status is Unusual and its rank is S3 among Special Concern Plant Species (Georgia Department of Natural Resources 2007, Patrick et al. 1995).

Methods

In August 1994, working in a three-person team, we intensively surveyed trees in the southern portion of the hammock for presence of the epiphyte along a series of north–south overlapping compass transects. One team member monitored the compass bearing, while the other two members scanned trees using Pentax® 7×50 6.2° binoculars. The presence of Green Fly Orchid was confirmed by two team members, and species and diameter at breast height (DBH; cm) of phorophyte plus estimates of area of phorophyte surface colonized by *Epidendrum* and mean height above ground of epiphyte colony were recorded. At the time of the survey, fronds of Resurrection Fern were in a relatively dehydrated state, which increased the visibility of Green Fly Orchid plants.

In August 2006, we censused tree-species composition of the southern portion of the hammock by point-quarter sampling every 20 m along three 180-m transects, yielding 10 sampling stations per transect for a total of 120 quadrants (and point-quarter trees). The transects were placed by a stratified random method designed to traverse the area where Green Fly Orchid was most commonly found, and they were at oblique angles to each other (compass bearings 20º, 140º, and 240º). All observations were independent. The nearest tree (up to 15 m) to each point in each of 4 quadrants (NW, NE, SE, SW) that was at least 5 cm in DBH was chosen as the point-quarter tree, and its species and DBH were recorded.

Basal area for each tree was determined by the formula πr^2 where r = DBH/2. Tree community profiles were constructed both by relative stem frequencies and by species importance values (ln basal area per species). A selectivity index (SI) modified from Ivlev (1961) was used to determine host-species selectivity of the orchid, based on that host-tree's availability in the habitat, as follows:

$$SI = (Hs - As) / (Hs + As),$$

where Hs was the relative frequency of the host species among the sample of actual host trees, and As was the relative frequency of that tree species among the 119 trees from the point-quarter survey. For the pool of available host-tree species for this index and to calculate As, we did not include pines (which are not known to be hosts of *Epidendrum*), and we included only species belonging to genera which actually were recorded as host trees in this study. We did a separate calculation of SI using relative basal areas of trees, by species, that were actual host trees (Hs) and relative basal areas, by species, of trees from the point-quarter transect (As), again including or not including species in the latter pool as per the above criteria. We present these two indices for each species as SI_S for stems and SI_B for basal area. This SI index can range from -1.0 for perfect avoidance to 1.0 for perfect selectivity, or total preference. An SI of 0.0 indicates the tree species serves as a host tree in the exact proportion that it is available in the habitat with neither preference nor avoidance.

Results

In only one of the 120 point-transect quadrants did we fail to identify a point-quarter tree (because none of sufficient size occurred within 15 m of the point); therefore our random sample of trees to estimate host-tree availability and to characterize species composition of the hammock consisted of 119. Twelve species of trees were included among these, which accounts for nearly all of the tree-sized woody species that occur on the hammock, except for Black Gum. Of these 119 trees, 19 were pines and 85 belonged to genera that were found to be host trees in this study. The latter formed the pool of available hosts and, by the criteria for inclusion, included 1 tree —of a species (*Q. hemisphaerica* Bartr. ex Willd. [Darlington Oak]) that did not serve as a host tree. Aside from the 2 pines, American Holly (n = 14; mean DBH = 10.1 cm) was the only other species that had substantial representation in the point transects, but was not included in the pool of available hosts.

By stem count, Water Oak was the most abundant tree along the survey transects, followed by Pignut Hickory (Fig. 1a). Live Oak and Southern

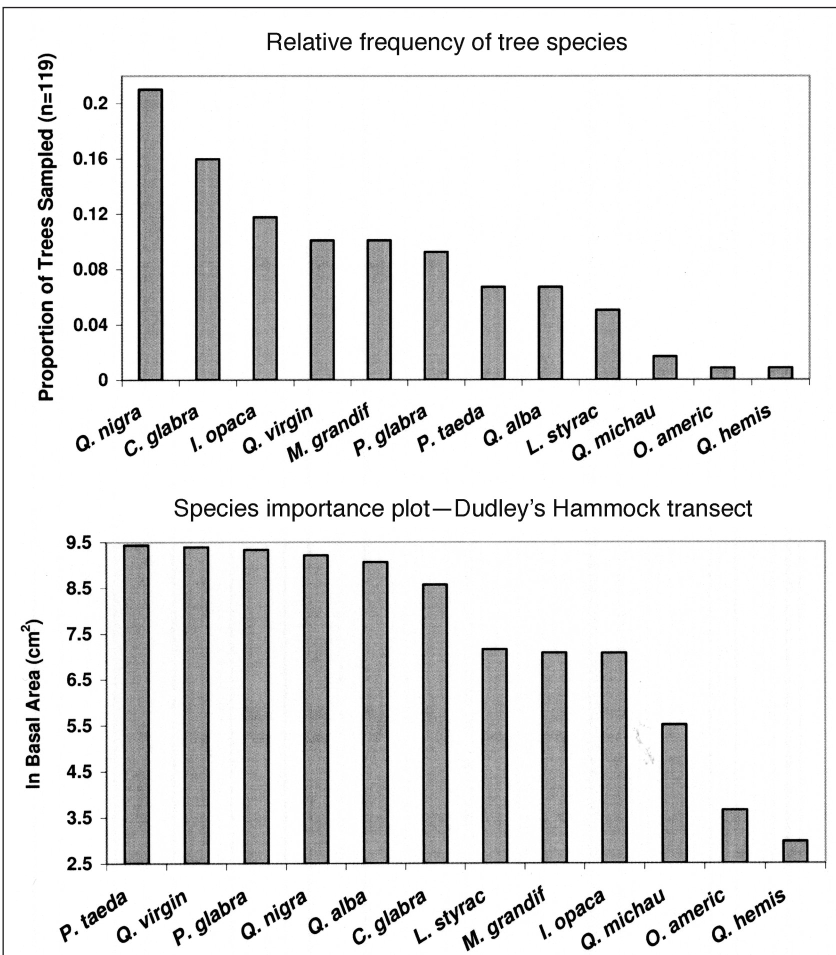

Figure 1. a (top): Most abundant tree species on Dudley's Hammock by stem count, based on 119 point-transect trees. b (bottom): Species importance plot for Dudley's Hammock trees based on ln basal area of 119 point-transect trees. See Methods for more details.

Magnolia were 4th and 5th most abundant, respectively. By ln basal area, a top tier of dominant species was apparent, including both pine species, three oaks (Live Oak, Water Oak, and White Oak), and Pignut Hickory (Fig. 1b). Sweetgum, Southern Magnolia, and American Holly formed a second tier of subdominant species (Fig. 1b).

The orchid survey identified 112 host trees of 8 species; 60 (54%) of these were Southern Magnolia, 35 (31%) were Live Oak, 7 (6.2%) were Sweetgum, 3 each (2.7%) were Pignut Hickory and White Oak, 2 (1.8%) were Swamp Chestnut Oak, and 1 each (0.9%) was Water Oak and Black Gum. Three of the host trees had recently died (2 Southern Magnolia, 1 Swamp Chestnut Oak).

Both SI indices indicated that Green Fly Orchid showed a strong preference for Southern Magnolia as a host and a moderately strong preference for Live Oak, but the difference between these two preferred hosts and the strength of selectivity for Southern Magnolia were greater for the SI_B (Table 1). SI_S indicated that Sweetgum and Swamp Chestnut Oak were nearly random with respect to selection by the epiphyte and that the remaining 4 species were strongly avoided (Black Gum is not included here, because 1 tree served as a host, but 0 trees were found on the point-quarter survey). A similar pattern was shown for these 4 less-preferred host trees by the SI_B, except none was as close to random (all were avoided to some degree).

Host trees were much larger than available trees, being nearly twice the DBH for the entire sample, three times the DBH for Southern Magnolia, and 67% larger for Live Oak; there was no size difference between host and available trees for Sweetgum (Table 2). Among the 3 most common host trees, Green Fly Orchid covered a significantly larger area per host tree on Southern Magnolia (mean = 11.61 cm^2, $F_{2,99}$ = 8.71, P < 0.0001) than on the other two hosts. The range of mean heights above ground where orchid colonies grew was also significantly greater (mean = 5.52 m, $F_{2,99}$ = 13.74, P < 0.001), and the minimum mean-height was significantly lower (mean = 4.37 m, $F_{2,99}$ = 9.30, P < 0.001) for Southern Magnolia than for the other two hosts.

Table 1. Selectivity indices (SI) based on relative frequencies of occurrence (SI_S) and relative basal areas (SI_B) for the 8 Dudley's Hammock tree species that hosted *Epidendrum magnoliae* (Green Fly Orchid). SI ranges from -1.0 for perfect avoidance to 1.0 for perfect selection, with SI = 0.0 signifying neutral or random selection. Note: *N. sylvatica* was not encountered as a potentially available host tree on the point-transect survey. See Methods for more details.

Host-tree species	*n*	SI_S	SI_B
Magnolia grandiflora (Southern Magnolia)	60	0.583	0.863
Quercus virginiana (Live Oak)	35	0.378	0.275
Liquidambar styraciflua (Sweetgum)	7	-0.061	-0.678
Carya glabra (Pignut Hickory)	3	-0.786	-0.942
Quercus alba (White Oak)	3	-0.557	-0.961
Quercus michauxii (Swamp Chesnut Oak)	2	-0.136	-0.232
Quercus nigra (Water Oak)	1	-0.941	-0.883
Nyssa sylvatica (Black Gum)	1	n/a	n/a

Discussion

From our survey, Dudley's Hammock can be characterized as a pine-oak-hickory dominated forest, with Southern Magnolia, Sweetgum and American Holly as subdominants. Excepting American Beech, most of the elements of the climax forest overstory of the southern mixed hardwood forest (sensu Quarterman and Keever 1962) were present, but the co-dominance of Loblolly Pine and Water Oak may indicate some recent disturbance, which means the hammock is in a subclimax state at present. Nevertheless, it is a densely shaded and humid microclimate with abundant growth of epiphytes and as such provides one of the few habitats in the region for Green Fly Orchid.

Although occurring on 8 different hardwood tree species in Dudley's Hammock, Green Fly Orchid had a very strong preference for Southern Magnolia as a host and a moderately strong preference for Live Oak. The stong host preferences yet lack of strict phorophyte specificity of Green Fly Orchid observed at Dudley's Hammock is not surprising given earlier reports of this species (Correll 1950) and other epiphytic orchids (Zimmerman and Olmsted 1992) occurring on a range of host species. Laube and Zotz (2006) showed the distribution of 103 vascular epiphyte species in a lowland tropical forest to be neither host-specific nor random.

At Dudley's Hammock, both Loblolly Pine and Spruce Pine have high importance values (Fig. 2) and bark with markedly different physical characteristics. The bark of Spruce Pine is distinctively ridged and furrowed and perhaps structurally more similar to Live Oak than to its congener

Table 2. Comparison of mean tree sizes (DBH in cm) of tree species hosting *Epidendrum magnoliae* (Green Fly Orchid) ($n \geq 3$) and the pool of "available" trees from the point transect. See Methods for more details.

Species	*n*	Mean DBH	S.D.	*t*	*P*
All Hosts	112	39.8	13.0		
All Available	85	20.3	18.8	8.59	<0.0001
Magnolia grandiflora (Southern Magnolia)					
Host	60	37.7	9.8		
Available	12	10.6	4.0	15.84	<0.0001
Quercus virginiana (Live Oak)					
Host	35	53.9	22.1		
Available	12	32.2	16.0	3.65	0.0012
Liquidambar styraciflua (Sweetgum)					
Host	7	13.6	3.8		
Available	6	14.5	6.7	-0.32	0.82
Carya glabra (Pignut Hickory)					
Host	3	17.2	0.72		
Available	19	16.8	8.82	0.23	0.82
Quercus alba (White Oak)					
Host	3	17.0	6.7		
Available	8	33.7	16.4	-2.39	0.044

Loblolly Pine. However, Green Fly Orchid is absent from both species. Presumably, chemical incompatibility between epiphyte and phorophyte accounts for the complete absence of Green Fly Orchid from Loblolly Pine and Spruce Pine. Laboratory studies have shown chemical attributes of bark may affect germination and early development by epiphytic orchids (Frei and Dodson 1972).

Southern Magnolia and Live Oak have very different bark characteristics, growth habits, and patterns of branching and leaf abscission. The low, broad crown of Live Oak with its massive spreading branches presents a greater horizontal (or near-horizontal) surface for colonization by epiphytes than Southern Magnolia with its more upright habit, more cylindrical form, and absence of massive spreading branches. The bark of Live Oak is thick and rough with prominent ridges and furrows, whereas that of Southern Magnolia is smooth and relatively thin. It is presumed that bark development in Southern Magnolia is slower than in Live Oak and that diminished exfoliation would result in reduced shedding and thus greater persistence of epiphytes. The predominance of Green Fly Orchid on phorophytes with such markedly different physical bark characteristics suggests other factors more strongly influence host selection. Unlike the other, less-preferred phorophyte species observed, both Southern Magnolia and Live Oak have a dense evergreen canopy that would provide deep shade and decrease evaporative water loss year-round, including winter when ambient humidity is lower.

Southern Magnolia and Live Oak differ in their patterns of leaf abscission. Southern Magnolia is distinctly evergreen, and Live Oak is barely evergreen with its leaves gradually falling during late winter, especially just prior to the initiation of new growth in early spring. The absence of full-canopy protection in Live Oak could make Green Fly Orchid more vulnerable to desiccation and frost effects during late winter and early spring. This lack of canopy protection may be partly compensated, as we observed, by orchid colonies often growing under the horizontal limbs of large live oaks. Inland populations of Green Fly Orchid near the northern limit of its range are presumably all the more vulnerable to freezing temperatures, most likely making frost protection an even more critical factor at Dudley's Hammock.

Other studies have shown a positive correlation between the occurrence of vascular epiphyte species and large host-tree size, presumably resulting from greater available surface area and longer time for colonization provided by larger, older phorophytes (Catling and Lefkovitch 1989, Clement et al. 2001, Dunn 2000, Migenis and Ackerman 1993, Muñoz et al. 2003). Given that no host trees were encountered among the 119 randomly chosen point-quarter trees and that host trees were much larger than the average for those randomly encountered, it was also apparent that Green Fly Orchid generally selected (and/or persisted on) only the largest host trees. Thus, the largest and oldest Southern Magnolia and Live Oak trees are vital to this population of Green Fly Orchid. A study of diversity and host-tree preference in a temperate rainforest in southern Chile suggests combinations of particular tree species and sizes promote epiphyte diversity (Muñoz et al. 2003). While the vascular epiphyte diversity, actual and potential, for Dudley's Hammock is much lower than reported by Muñoz et al. (2003), the results of our study nevertheless suggest habitat with a mixture of mature trees of Southern Magnolia and Live Oak is essential for the conservation of large, viable populations of Green Fly Orchid.

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Literature Cited

Benzing, D.H. 1981. Bark surfaces and the origin and maintenance of diversity among angiosperm epiphytes: A hypothesis. Selbyana 5:248–255.

Benzing, D.H. 1990. Vascular Epiphytes: General Biology and Related Biota. Cambridge University Press, New York, NY. 354 pp.

Bergstrom, B.J., J.R. Carter, A. Davis, and K.A. Lutz. 1994. Natural heritage inventory of Moody Air Force Base, Georgia. The Nature Conservancy. Savannah, GA. 262 pp.

Callaway, R., K. Reinhart, G. Moore, D. Moore, and S. Pennings. 2002. Epiphyte host preferences and host traits: Mechanisms for species-specific interactions. Oecologia 132:221–230.

Catling, P.M., and L.O. Lefkovitch. 1989. Associations of vascular epiphytes in a Guatemalan cloud forest. Biotropica 21:35–40.

Clement, J.P., M.W. Moffett, D.C. Shaw, A. Lara, D. Alarçon and O.L. Larrain. 2001. Crown structure and biodiversity in *Fitzroya cupressoides*, the giant conifers of Alerce Andino National Park, Chile. Selbyana 22:76–88.

Correll, D.S. 1950. Native Orchids of North America. Chronica Botanica Company. Waltham, MA. 399 pp.

Dunn, R.R. 2000. Bromeliad communities in isolated trees and three successional stages of an Andean cloud forest. Selbyana 21:25–29.

Frei, J.K. 1973. Orchid ecology in a cloud forest in the mountains of Oaxaca, Mexico. Bulletin of the American Orchid Society 42:307–314.

Frei, J.K., and C.H. Dodson. 1972. The chemical effect of certain bark substrates on the germination and early growth of epiphytic orchids. Bulletin of the Torrey Botanical Club 99:301–307.

Gentry, A.H., and C.H. Dodson. 1987. Diversity and biogeography of Neotropical vascular epiphytes. Annals of the Missouri Botanical Gardens 74:205–233.

Georgia Department of Natural Resources. 2007. Georgia Rare Species and Natural Community Information—Special Concern Plants. Georgia Department of Natural Resources, Natural Heritage Program. Available online at http://georgiawildlife.dnr.state.ga.us/content/specialconcernplants.asp. Last updated July 2, 2007. Accessed March 28, 2008.

Hágsater, E. 2002. *Epidendrum*. Pp. 609–613, *In* G.W. Argus, K. Gandhi, P. Goldblatt, W.J. Hess, R.W. Kiger, J.L. Strother, F.H. Utech, and J.L. Zarucchi (Eds.) Flora of North America, Volume 26, Oxford University Press, New York, NY.

Ivlev, V.S. 1961. Experimental Ecology of the Feeding of Fishes. Yale University Press, New Haven, CT.

Kress, W.J. 1986. The systematic distribution of vascular epiphytes: An update. Selbyana 9:2–22.

Laube, S., and G. Zotz. 2006. Neither host-specific nor random: Vascular epiphytes on three tree species in a Panamanian lowland forest. Annals of Botany 97:1103–1114.

Luer, C.A. 1972. The Native Orchids of Florida. New York Botanical Garden. Bronx, NY. 293 pp.

Madison, M. 1977. Vascular epiphytes: Their systematic occurrence and salient features. Selbyana 2:1–13.

McKendrick, S.L., J.R. Leake, D.L. Taylor, and D.J. Read. 2000. Symbiotic germination and development of myco-heterotrophic plants in nature: Ontogeny of *Corallorhiza trifida* and characterization of its mycorrhizal fungi. New Phytologist 145:523–537.

Migenis, L.E., and J.D. Ackerman. 1993. Orchid-phorophyte relationships in a forest watershed in Puerto Rico. Journal of Tropical Ecology 9:231–240.

Monk, C.D. 1968. Successional and environmental relationships between of the forest vegetation of north central Florida. American Midland Naturalist 79:441–457.

Muñoz, A.A., P. Chacón, F. Pérez, E.S. Barnert, and J.J. Armesto. 2003. Diversity and host-tree preferences of vascular epiphytes and vines in a temperate rainforest in southern Chile. Australian Journal of Botany 51:381–391.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available online at http://www.natureserve.org/explorer. Accessed April 1, 2008.

Otero, J.T., P. Bayman, and J.D. Ackerman. 2005. Variation in mycorrhizal performance in the epiphytic orchid *Tolumnia variegata* in vitro: The potential for natural selection. Evolutionary Ecology 19:29–43.

Patrick, T.S., J.R. Allison, and G.A. Krakow. 1995. Protected plants of Georgia: An information manual on plants designated by the State of Georgia as endangered, threatened, rare, or unusual. Georgia Department of Natural Resources, Wildlife Resources Division, Georgia Natural Heritage Program, Social Circle, GA.

Quarterman, E., and C. Keever. 1962. Southern mixed hardwood forest: Climax in the southeastern coastal plain. Ecological Monographs 32:167–185.

Trapnell, D.W., and J.L. Hamrick. 2006. Variety of phorophyte species colonized by the Neotropical epiphyte, *Laelia rubescens* (Orchidaceae). Selbyana 27:60–64.

Wharton, C.H. 1989. The Natural Environments of Georgia. Georgia Department of Natural Resources, Atlanta, GA. 227 pp.

Zimmerman, J.K., and I.C. Olmsted. 1992. Host-tree utilization by vascular epiphytes in a seasonally inundated forest (tintal) in Mexico. Biotropica 24:402–407.

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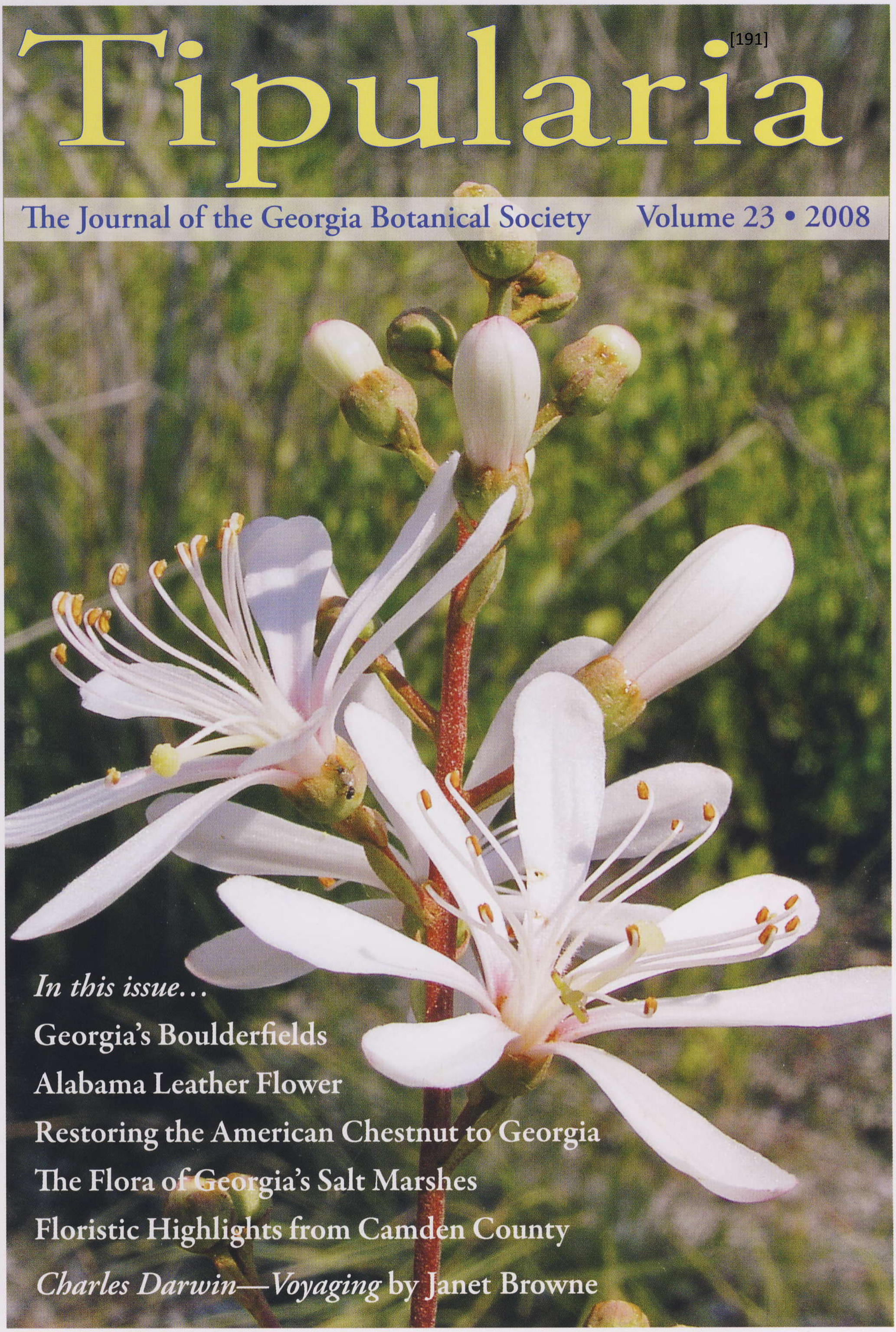


In this issue…

Tillandsia bartramii (Bartram's air-plant) Richard Carter

Table 1. Species found during survey of Camden County flora and their status on the list of Protected Plants of Georgia (Patrick et al. 1995).

Scientific Name	Common Name	Status
Carex dasycarpa	Velvet Sedge	Rare
Coreopsis integrifolia	Floodplain Tickseed	Threatened
Epidendrum magnoliae [=*E. conopseum*]	Green-fly Orchid	Unusual
Litsea aestivalis	Pond Spice	Rare
Pteroglossaspis ecristata	Crestless Plume Orchid	Threatened
Sageretia minutiflora	Climbing Buckthorn	Threatened
Sapindus marginatus	Soapberry	Rare
Sarracenia minor	Hooded Pitcherplant	Unusual

Floristic Highlights from Camden County

Richard Carter

This project began in 1996 when I was contracted by the Georgia Department of Natural Resources to inventory the rare flora and plant communities of Kings Bay Submarine Base. Until that time I had only sporadically botanized Camden County. Subsequent to the Kings Bay project, I made trips to Camden County whenever possible but never on a regular, sustained basis. In 2006, through the generosity of a Georgia Botanical Society Marie Mellinger Field Botany Research Grant, floristic work in Camden County was revitalized.

Closeup, *Tillandsia bartramii* (Bartram's air-plant)
Richard Carter

The survey has resulted in a vouchered list of approximately 1,200 vascular plant species for Camden County, including populations of eight species on Georgia's list of Protected Plants (Table 1) and 49 taxa on the lists of Special Concern and Watched Plants (Table 2). The results of this field research will provide the basis for recommendations to the Georgia Department of Natural Resources Natural Heritage Program about the status of certain species on the lists of Special Concern and Watched Plants. Additionally, numerous new state records and other significant range extensions have been documented (Table 3). The sedge genus *Carex* is notable in yielding more than 30 species in the county, including a number of rarities (Tables 1-3) and range extensions. Notable among rare and unusual *Carex* species are velvet sedge (*C. dasycarpa*), cypress-knee sedge (*C. decomposita*), and Godfrey's sedge (*C. godfreyi*), and significant range extensions include yellow-fruit sedge (*C. annectens*), Chapman's sedge (*C. chapmanii*), and Gholson's sedge (*C. gholsonii*). Following are brief descriptions of selected plant communities in Camden County with emphasis on rare flora. The community classification system of NatureServe (2008) is used.

The Southern Coastal Plain Mesic Slope Forest along the Satilla River bluffs in western Camden County harbors populations of the epiphytic green-fly orchid (*Epidendrum magnoliae*) and Bartram's air-plant (*Tillandsia bartramii*), as well as the rare three-birds orchid (*Triphora trianthophora*), and the inconspicuous nodding nixie (*Apteria aphylla*). Populations of the rare service-berry holly (*Ilex amelanchier*) and cypress-knee sedge (*Carex decomposita*) were found in the Satilla River floodplain at the edges of these bluffs. Several pockets of American beech (*Fagus grandifolia*), previously not reported from the southeastern sector of Geor-

Table 2. Species found during survey of Camden County flora and their status on the lists of Special Concern and Watched plants of Georgia (Anonymous 2008).

Scientific Name	Common Name	Status
Aeschynomene viscidula	Sticky Joint-vetch	S(S?)
Agalinis filifolia	Seminole Purple Foxglove	S(S1S2)
Amaranthus cannabinus	Tidalmarsh Pigweed	W(SU)
Amphicarpum mühlenbergianum	Blue Maidencane	W(S3?)
Apteria aphylla	Nodding Nixie	W(S3)
Asclepias cinerea	Lavender Milkweed	W(S3?)
Asclepias connivens	Large-flower Milkweed	W(S3?)
Asimina pygmaea	Dwarf Pawpaw	S(S1?)
Baptisia lecontei	Leconte Wild Indigo	S(S1)
Befaria racemosa	Tarflower	W(S3)
Carex debilis	Weak Sedge	W(SU)
Carex decomposita	Cypress-knee Sedge	S(S2?)
Carex fissa var. aristata	Hammock Sedge	S(S1)
Carex floridana	Florida Sedge	S(S3)
Carex godfreyi	Godfrey's Sedge	W(S3?)
Carex lonchocarpa	Sedge	W(S3)
Ctenium floridanum	Florida Orange-grass	S(S1)
Cyperus polystachyos var. filicinus	Fern-like Flatsedge	W(SU)
Cyperus polystachyos var. polystachyos	Texas Flatsedge	W(SU)
Cyperus tetragonus	Four-angled Flatsedge	W(S3?)
Cyperus virens var. drummondii	Drummond's Flatsedge	W(S3?)
Cyperus virens var. virens	Green Flatsedge	W(S3?)
Eleocharis albida	White Spikerush	S(S2S3)
Eleocharis cellulosa	Gulf Coast Spikerush	W(SNR)
Eleocharis melanocarpa	Black-fruit Spikerush	W(S3)
Eleocharis montana	Nodose Spikerush	S(SH)
Eleocharis montevidensis	Sand Spikerush	S(S1)
Eupatorium jucundum	Hammock Boneset	W(SU)
Forestiera segregata	Florida Wild Privet	S(S2)
Fuirena scirpoidea	Southern Umbrella Sedge	S(S1?)
Ilex amelanchier	Serviceberry Holly	S(S2)
Iris tridentata	Savanna Iris	S(S2?)

Palafoxia integrifolia	Palafoxia	S(S2?)
Physostegia leptophylla	Narrowleaf Obedient Plant	S(S2S3)
Plantago sparsiflora	Pineland Plantain	S(S2)
Platanthera nivea	Snowy Orchid	S(S2S3)
Quercus austrina	Bluff White Oak	S(S3?)
Quercus chapmanii	Chapman's Oak	S(S2)
Rhexia nuttallii	Nuttall's Meadowbeauty	S(S1?)
Sagittaria graminea subsp. chapmanii	Chapman's Arrowhead	W(S3?)
Schizachyrium stoloniferum	Creeping Bluestem	W(S2S3)
Sida elliottii	Elliott's Fanpetals	S(S2?)
Thalia dealbata	Powdery Alligator-flag	S(S1)
Tillandsia bartramii	Bartram's Air-plant	S(S2)
Tillandsia recurvata	Ball-moss	S(S1)
Triphora trianthophora	Three-birds Orchid	S(S2?)
Vicia minutiflora	Pygmy-flower Vetch	S(S1?)
Vigna luteola	Wild Yellow Cowpea	S(S2?)
Zephyranthes simpsonii	Simpson's Rain Lily	S(S1)

Key to status abbreviations: S=listed among Georgia's Special Concern plant species; W=listed among Georgia's Watched plant species; S1=critically imperiled in state because of extreme rarity (5 or fewer occurrences); S2=imperiled in state because of rarity (6 to 20 occurrences); S3=rare or uncommon in state (21 to 100 occurrences); SH=of historical occurrence in the state, perhaps not verified in past 20 years, but suspected to be extant; SU=possibly in peril in state but status uncertain, need more information on threats or distribution; SNR=state not ranked.

gia, were observed along the Satilla River bluffs and, in one case, in a remnant mixed pine and hardwood forest surrounded by pine plantation on a gently sloping, expansive flat some distance away from the river. Efforts to locate beechdrops (*Epifagus virginiana*), parasitic on American beech, were futile.

Several small, isolated remnants of the fire-dependent *Pinus palustris / Ilex glabra / Aristida stricta* Woodland were identified in the county. These areas unfortunately had not been subject to fire for years. Nevertheless, specialties such as green silky scale (*Anthaenantia villosa*), Florida orange grass (*Ctenium floridanum*), large-flower milkweed (*Asclepias connivens*), and Nuttall's meadowbeauty (*Rhexia nuttallii*) were found. Searching these areas for other plants of special interest, after they have been burned, is eagerly anticipated.

The Southern Atlantic Coastal Plain Maritime Forest, found mostly along the coastal fringe, is dominated by live oak (*Quercus virginiana*), water oak (*Q. nigra*), laurel oak (*Q. hemisphaerica*), bullbay magnolia (*Magnolia grandiflora*), pignut hickory (*Carya glabra*), loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), southern basswood (*Tilia americana* var. *caroliniana*), cabbage palm (*Sabal palmetto*), red mulberry (*Morus rubra*), Carolina cherry-laurel (*Prunus caroliniana*), blackcherry (*P. serotina*), and southern red cedar (*Juniperus silicicola*), with an understory of American holly (*Ilex opaca*), pawpaw (*Asimina parviflora*), saw palmetto (*Serenoa repens*), wax

Table 3. Other noteworthy plant species found during survey of Camden County flora.

Scientific Name	Common Name	Status
†*Asparagus setaceus*	Common Asparagus Fern	SR
†*Boerhavia diffusa*	Red Spiderling	SR
†*Bothriochloa ischaemum*	Yellow Bluestem	SR
Callitriche pedunculosa	Nuttall's Water-starwort	SR
Carex annectens	Yellow-fruit Sedge	SR
Carex chapmanii	Chapman's Sedge	seGA
Carex comosa	Longhair Sedge	seGA
Carex gholsonii	Gholson's Sedge	seGA
†*Ceratopteris pteridoides*	Water Horn Fern	SR
Cinna arundinacea	Sweet Woodreed	seGA
†*Cyperus digitatus*	Finger Flatsedge	SR
†*Dioscorea bulbifera*	Air Yam	SR, EPPC
†*Dichondra micrantha*	Asian Ponysfoot	SR
†*Eleocharis montana*	Nodose Spikerush	seGA
Fagus grandifolia	American beech	seGA
†*Hypochaeris microcephala var. albiflora*	Smallhead Cat's Ear	SR
†*Indigofera spicata*	Trailing Indigo	SR
†*Kyllinga squamulata*	Asian Spikesedge	SR
†*Panicum repens*	Torpedo Grass	SR
†*Pectis prostrata*	Spreading Chinchweed	SR
Pedicularis canadensis	Lousewort	seGA
Penthorum sedoides	Ditch Stonecrop	seGA
†*Pseudognaphalium luteoalbum*	Jersey Cudweed	SR
†*Rottboellia cochinchinensis*	Itchgrass	FNW
†*Solanum chenopodioides*	Black Nightshade	SR
Solidago rugosa var. celtidifolia	Wrinkle-leaf Goldenrod	seGA
†*Sporobolus indicus var. pyramidalis*	West Indian Dropseed	SR
Thalia geniculata	Alligator-flag	SR
†*Tradescantia fluminensis*	Small-leaf Spiderwort	SR, EPPC
†*Verbascum virgatum*	Wand Mullein	SR
†*Vicia ludoviciana subsp. leavenworthii*	Leavenworth's Vetch	SR
Vicia minutiflora	Pygmy-flower Vetch	SR

Key to symbols and abbreviations: †=introduced species; SR=putative state record; seGA=range extension into southeastern Georgia; EPPC=on Florida Exotic Pest Plant Council's 2007 List of Invasive Plant Species (FLEPPC 2007); FNW=Federal Noxious Weed (Anonymous 2006). Range extensions based on information in Kral (1983), Jones and Coile (1988), Sweeney and Giannasi (2000), and Chafin (2007).

Asclepias connivens (large flower milkweed)
Richard Carter

Asclepias humistrata (pinewoods milkweed)
Richard Carter

myrtle (*Morella cerifera*), red buckeye (*Aesculus pavia*), rusty lyonia (*Lyonia ferruginea*), sparkleberry (*Vaccinium arboreum*), redbay (*Persea borbonia*), yaupon (*Ilex vomitoria*), and tough bully (*Sideroxylon tenax*). The moderating influence of the ocean waters on temperature and humidity is especially evident here in the presence of species with tropical affinities, particularly the epiphytic green-fly orchid (*Epidendrum magnoliae*), ball-moss (*Tillandsia recurvata*), and Bartram's air-plant (*Tillandsia bartramii*).

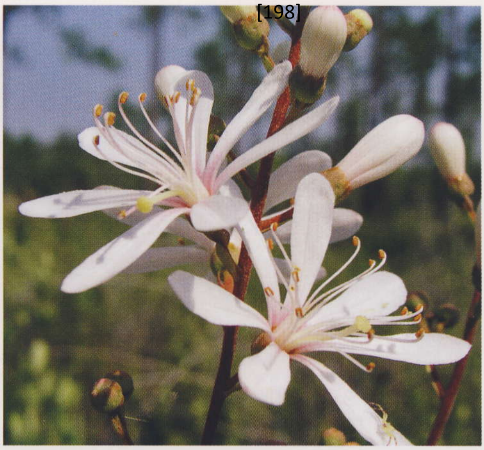
Midden sites—refuse piles of oyster shells left by Native American inhabitants during their seasonal occupation of the coast when oysters and other food items were abundant in the adjacent estuary—are found along the marsh edge within the Maritime Forest. The calcareous soils of the middens are habitat for specially adapted plants such as southern red cedar (*Juniperus silicicola*), rough-leaf dogwood (*Cornus asperifolia*), Carolina buckthorn (*Rhamnus caroliniana*), snow square-stem (*Melanthera nivea*), and rarities such as climbing buckthorn (*Sageretia minutiflora*) and Florida wild privet (*Forestiera segregata*).

The Southern Coastal Plain Hydric Hammock is one of the most diverse and impressive of plant communities in Camden County, and, fortunately, it is one of the least altered by human activity. Excellent examples are along tributary creeks and drains of the Satilla River in the vicinity of Woodbine and Whiteoak. This community is gently sloping to nearly flat, with an abundance of broadleaf evergreen trees forming a dense canopy. Overstory species include diamond-leaf oak (*Quercus laurifolia*), swamp chestnut-oak (*Q. michauxii*), water oak (*Q. nigra*), live oak (*Q. virginiana*), cabbage palm (*Sabal palmetto*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), persimmon (*Diospyros virginiana*), sweetgum (*Liquidambar styraciflua*), bullbay magnolia (*Magnolia grandiflora*), red mulberry (*Morus rubra*), black gum (*Nyssa sylvatica*), sugarberry (*Celtis laevigata*), and American elm (*Ulmus americana*). Understory shrubs such as American holly (*Ilex opaca*), pawpaw (*Asimina parviflora*), swamp dogwood (*Cornus stricta*), bluebeech (*Carpinus caroliniana*), fetterbush (*Lyonia lucida*), waxmyrtle (*Morella cerifera*), wild olive (*Osmanthus americanus*), swampbay (*Persea palustris*), bluestem palmetto (*Sabal minor*), saw palmetto (*Serenoa repens*), and highbush blueberry (*Vaccinium corymbosum*) are common. A variety of herbs is found here, including Jack-in-the-pulpit (*Arisaema triphyllum*), cardinal flower (*Lobelia cardinalis*), woodoats (*Chasmanthium* spp.), false nettle (*Boehmeria cylindrica*), and millet beaksedge (*Rhynchospora miliacea*). Large populations of the unusual needle palm (*Rhapidophyllum hystrix*) and epi-

Asclepias viridis (spider milkweed) Richard Carter

phytic green-fly orchid (*Epidendrum magnoliae*) may be found in the Hydric Hammock as well as specialties such as Florida Keys hempvine (*Mikania cordifolia*), Chapman's sedge (*Carex chapmanii*), Godfrey's sedge (*C. godfreyi*), and Gholson's sedge (*C. gholsonii*).

The Georgia Botanical Society Marie Mellinger Field Botany Research Grant funded thirteen trips to Camden County, enabling 29 days of field research from mid-March through late October 2006. Subsequently, the Faculty Research Fund and the Biology Department of Valdosta State University have supported additional field work during 2007-2008. In all, I have made 29 field trips to Camden County since March 2006, which have involved more than fifty days in the field there. Fortuitously, Wilson Baker—colleague and friend—accompanied me on most of these trips, and through his considerable network of associates we were able to gain access to some of the highest quality natural habitat remaining in the county. Access to rich slope forests along the Satilla River in western Camden County was kindly provided by Ms. Nell McClure of Magnolia Bluff, Mr. Jim Bailey of Woodbine, Mr. Alan Bailey of Savannah, and Mr. David Dockery and Ms. Rosemary Grigg of St. Simons. Others kindly allowing access to property in Camden County were Mr. Albert Flannigan to the Great Satilla Preserve, Mr. Walter Merck to



Befaria racemosa (tarflower) Richard Carter

his property at Clarks Bluff, and Mr. Robert Smith to Cabin Bluff. Additionally, Mr. William Dopson of McRae graciously hosted me for several days of superb botanizing on Little Cumberland Island, and Mr. Gordon Rogers, Satilla Riverkeeper, of Waynesville contributed the names of contacts in Camden County, and he and Mr. John Carswell generously provided for an excellent and memorable day botanizing along the Satilla by boat. ❀

References

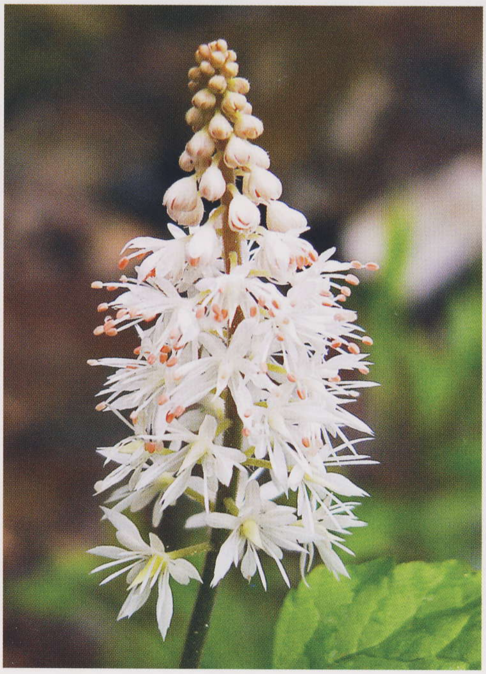
Anonymous. 2006. Federal Noxious Weed List (30 June 2006). United States Department of Agriculture, Animal and Plant Health Inspection Service. http://www.aphis.usda.gov/plant_health/plant_pest_info/weeds/downloads/weedlist2006.pdf (last accessed 09 March 2008).

Anonymous. 2008. Georgia Rare Species and Natural Community Information—Protected Plants, Special Concern Plants, Watched Plants (27 May 2008). Georgia Department of Natural Resources, Natural Heritage Program. Social Circle, Georgia. http://georgiawildlife.dnr.state.ga.us (last accessed 16 June 2008).

Clematis socialis (Alabama leather flower)
Henning von Schmeling

Ilex vomitoria (yaupon holly)
Hugh & Carol Nourse

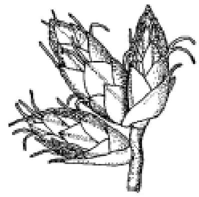
Mimosa strigillosa (powderpuff)
Richard Carter



Tiarella cordifolia (foamflower)
Richard & Teresa Ware

Verbascum virgatum (wand mullein)
Richard Carter

Chapter 2



The Significance of Cyperaceae as Weeds

Charles T. Bryson and Richard Carter

ABSTRACT Weedy Cyperaceae adversely affect natural plant communities and the health of humans and livestock and are major deterrents to agricultural and forest productivity. Most weeds are exogenous and have traits that give them biological and reproductive advantages over other plants. Weeds cost billions of dollars in agriculture, forestry, and urban areas and threaten diversity in natural communities worldwide. Of an estimated 8000 species of weeds worldwide, only about 200 species cause approximately 95% of the problems in production of food, feed, fiber, and livestock. About 25% of the world's weeds are monocots. Of these, sedges are among the most troublesome and difficult to control. The most important cyperaceous weeds in terms of their adverse effect on agriculture include *Cyperus rotundus* L., *C. esculentus* L., *C. difformis* L., *C. iria* L., and the *Fimbristylis miliacea* (L.) Vahl/*F. dichotoma* (L.) Vahl complex, ranking first, 16th, 32nd, 33rd, and 40th among the world's worst weeds, respectively. We provide an overview of cyperaceous weeds, including economic losses, population dynamics, control methods, identification, biology, ecology, dispersal mechanisms, spread, and discussions of major weeds of agriculture, forestry, urban areas, and natural communities.

KEY WORDS *Abildgaardia*, *Bolboschoenus*, *Bulbostylis*, *Carex*, *Cladium*, *Courtoisina*, *Cyperaceae*, *Cyperus*, *Eleocharis*, *Fimbristylis*, *Fuirena*, *Isolepis*, *Kyllinga*, *Lepidosperma*, *Lepironia*, *Lipocarpha*, *Mapania*, *Oxycaryum*, *Rhynchospora*, *Schoenoplectus*, *Scirpodendron*, *Scirpus*, *Scleria*, sedge, weed.

Cyperaceae is a cosmopolitan family with ca. 5000 species and 100 genera (Ball et al., 2002). Members of Cyperaceae, commonly called sedges, are monocot flowering plants with reduced, mostly wind-pollinated (anemophilous) flowers. The inconspicuous flowers are organized into spikelets, and the spikelets further arranged into higher order spicate, paniculate, or umbellate inflorescences. Flowers may be either perfect or imperfect, and when imperfect, plants are monoecious (or rarely dioecious). Fruits are small single-seeded achenes. Sedges are primarily grass-like herbs with linear leaves and parallel venation. Cyperaceae and Poaceae have traditionally been treated as related families (Cronquist, 1981). Recent cladistic analysis using molecular and morphological data confirms a closer relationship with Juncaceae, with the "sedge clade" consisting of Cyperaceae, Juncaceae, and Thurniaceae (Chase et al., 2000).

Many species of Cyperaceae are heliophytes, adapted to open, sunny areas with reduced competition from taller shading trees and shrubs. Such habitats are often dependent upon natural or artificial disturbance. A variety of plants, including many sedges, have intrinsic characteristics (e.g., high reproductive output, rapid growth, vegetative proliferation, extended seed dormancy) that promote population expansion after disturbance and probably originally evolved as colonizers of disturbed habitats (Baker, 1965, 1974; McNaughton & Wolf, 1973). In addition to catastrophic disturbances, more subtle and continual natural processes provide open areas for colonization by such species, e.g., exposed bars and banks along streams and coasts (Baker, 1974).

Plants are often called weeds when they opportunistically colonize and occupy habitats artificially disrupted and maintained by humans, e.g., agricultural fields, lawns, and gardens (Baker, 1974). The term "weed" is inherently anthropocentric and, therefore, is fundamentally problematic when used in science. Some definitions are entirely subjective and consequently are of little use in science, e.g., "a plant growing out of place" (James et al., 1991: 1) or "a plant growing where it is not desired" (Buchholtz, 1967: 389), and others emphasize only the negative effects of weeds on natural communities and ecosystems (Zimdahl, 1995; Randall, 1997). Although the latter are applicable to natural resource management and basic ecology, they are too restrictive for broader application to agriculture and other applied sciences. Bryson (2003: 1571) defined a weed as "an undesirable plant that adversely affects humans or other organisms which humans deem desirable." Reducing further the anthropocentric emphasis and incorporating elements applicable in both pure and applied sciences, we propose the following definition: *Weeds are plants that alter the structure of natural communities, interfere with the function of ecosystems, or have negative effects on humans, agriculture, or other societal interests.*

Cronk and Fuller (1995) clearly distinguish between invasive plants that invade natural areas and weeds or ruderals that infest agricultural or other highly disturbed, artificial habitats, and they provide a system of ranking weeds and invasive plants. The same characteristics that enable plants to colonize an area during ecological succession can make them invasive pests when they are introduced outside their natural ranges or habitats. Invasive weeds alter wildlife habitat by reducing quantity and quality of food sources, nesting sites, and cover, by increasing the frequency of fire and soil erosion, and by changing the natural dynamics of aquatic systems causing flooding or desiccation. Contrastingly, in agriculture the most important weeds are those that have the greatest economic impact through reduction in crop yield, interference, or reduced efficiency or quality of harvest.

About 8000 species, or approximately 3% of the total number of plant species worldwide, have been documented as weeds (Holm et al., 1977). Of these, about 200 species, less than 0.1% of the world's flora, account for approximately 95% of weed problems in agriculture (Holm et al., 1977, 1979, 1997). Invasive weeds possess a variety of characteristics enabling them to disperse rapidly into new areas and outcompete crops or native or desirable non-native vegetation for light, water, nutrients, and space (Westbrooks, 1998). To varying degrees, many characteristics contribute to the success and competitiveness of invasive weeds, and sedges share many of these traits with other plants (Table 1). The number of weeds reported in crops and nonagricultural areas is increasing. Two decades ago the important weeds in cotton (*Gossypium* spp.) worldwide slightly exceeded 100 species (Holm et al., 1977; Cronk & Fuller, 1995). Because of changes in production and cultural practices (especially reduced-tillage production

Table 1. Characteristics of weeds. Adapted from Muenscher (1955), Baker (1965, 1974), Klingman et al. (1982), Radosevich and Holt (1984), Stuckey and Barkley (1993), Rejmanek (1996), and Westbrooks (1998).

Copious production of small seeds
Early maturation
Extended seed dormancy and discontinuous germination
Germination and survival in a wide range of environments
Long life of propagules in soil or during dispersal
Profuse vegetative reproduction and fragmentation
Rapid growth
Short juvenile period
Self-compatible or if cross-pollinated then by wind or unspecialized floral visitors
Survival and the ability to produce seed under adverse environmental conditions
Seed size similar to associated crops or native plants
Structural modifications (e.g., thorns, prickles, spines, urticating hairs) that cause injury and repel animals or herbivores
Structural modifications facilitating dispersal
High photosynthetic rate (C_4 photosynthesis)
Increased water-use efficiency (C_4 photosynthesis)
Production of toxic secondary compounds that deter herbivores
Production of phytotoxins to prohibit or suppress growth of other plants (allelopathy)
Ability to parasitize other plants
Accumulation of large food reserves in roots, rhizomes, or other plant structures
Alternate host for insect pests and pathogens of crops
Resistance to pathogens
Small inconspicuous flowers
Short- and long-range dispersal mechanisms
Tolerance of environmental and chemical extremes, including fire, herbicides, and soil disturbances

systems), chemical control methods, weed shifts, adaptations of populations, evolution of herbicide-resistant weeds, and use of transgenic herbicide-resistant crops, the total number of important weeds in worldwide cotton production may currently exceed 200 species, as demonstrated by the total number recorded in cotton alone within the U.S.A. (Bryson et al., 1999). Natural barriers and restricted migration routes have historically prevented many plants from dispersing over great distances. However, the current speed and ease of world transportation by humans and cargo have increased the rate and distance of dispersal of plants. Upon introduction, if a species becomes naturalized, it may remain near the point of introduction without becoming a pest. In the case of invasive weeds, the local population amplifies and disperses, expanding the range. Unfortunately, newly introduced weeds often are undetected until after their numbers and ranges increase greatly. The period of time between introduction and invasion is the "lag phase" (Radosivich & Holt, 1984), the duration of which depends on a number of factors, e.g., size of population, dynamics of reproduction, and detection. The lag phase may vary from a few to many years, and facilitation of a naturalized population must occur before it expands, which may be brought about by new pathways for dispersal, introduction of new pollinators or dispersal vectors, environmental change (e.g., disturbance), and local adaptation through natural selection (Cronk & Fuller, 1995). Heterosis resulting from hybridization with related species may also be a factor in facilitation (Carter, 1990; Daehler & Strong, 1997).

Economics

There is little doubt that weeds cause severe economic losses, but placing an exact value on their impact worldwide is difficult, especially in natural or nonagricultural areas. In the U.S.A., economic loss due to invasive species (plants, animals, and pathogens) was estimated to be more than $138 billion per year (Westbrooks, 2001). Economic losses result from interference or competition with crops and forests and the costs of pest-control chemicals, fuel, equipment, labor, cultural-control practices, and additional irrigation and fertilizer (Chandler et al., 1984; Chandler & Cooke, 1992). Additional costs to human and animal health (i.e., allergies and toxins) are more difficult to estimate, but weeds, including sedges, cause substantial indirect economic losses worldwide.

In the U.S.A., it is estimated that cotton yields are reduced 8.5% by *Cyperus* L. weeds (Byrd, 1995a), a loss of about $40.5 million annually. The two primary *Cyperus* weeds in cotton and other row crops are *C. esculentus* L. (yellow nutsedge) and *C. rotundus* L. (purple nutsedge). In Mississippi alone, 31.4% and 23.5% of cotton fields are infested with *C. esculentus* and *C. rotundus*, respectively; however, population levels of *C. rotundus* were greater (75.6 aerial shoots/m^2) than those of *C. esculentus* (21.8 aerial shoots/m^2) (Byrd, 1995b). It is more difficult to estimate economic impact on nonagricultural areas, especially natural and public-use areas where losses are measured as reduction in tourism and recreation. Placing monetary values on native flora and fauna and wildlife habitat displaced or degraded by invasive species or the loss of the aesthetic value of a natural area is subjective and problematic. Control of weeds for the preservation of biological diversity is labor intensive and expensive, requiring manual labor where chemical methods may jeopardize natural plant communities (Randall, 1996). Upon control or eradication of invasive weeds, additional expense is incurred to prevent recolonization and to reintroduce native or innocuous nonindigenous niche replacements.

The importance of an agricultural weed is not necessarily correlated with its abundance within a crop but may depend on herbicide- and cultural-control regimes, soil type, climatic conditions, number of viable propagules in the seedbank, or other factors (McWhorter & Bryson, 1992). Some weeds may be abundant and conspicuous in crops without interfering, e.g., winter annuals that germinate, emerge, flower, and set seeds early enough so growth and yield of summer crops are unaffected. High population levels of *Isolepis carinata* Hook. & Arn. ex Torr. often occur in reduced-tillage cotton and soybean (*Glycine max* (L.) Merr.) in the southeastern U.S.A. (Bryson & Hanks, 2001). Because *I. carinata* completes its life cycle and dies early in the growing season, it does not adversely affect crop growth and yield. In agriculture, weeds that are difficult to control, compete with crops for light, nutrients, water, and space (Radosevich & Holt, 1984), interfere with crop harvest efficiency, or reduce quality of seed and lint (McWhorter & Bryson, 1992; Bryson et al., 1999) are the most important. Holm et al. (1977, 1997) list the world's most important agricultural weeds. Lists of weeds maintained by organizations include the Weed Science Society of America's *Composite List of Weeds* (WSSA, 1989) and Bayer AG's *Important Crops of the World and Their Weeds* (Bayer AG, 1992). Bayer AG (1992) is a more comprehensive worldwide list and includes more than 5000 scientific names of crops and weeds, while the WSSA lists about 2000 weeds found exclusively in the U.S.A. and Canada. Since the second edition of Bayer AG (1992), rights to the five-digit "Bayer codes" for weeds have been sold to the European Plant Protection Organization.

The economic, ethnobotanical, and horticultural importance of the family Cyperaceae is well documented (Simpson & Inglis, 2001). Many sedges are used as foods, food additives, drinks, fibers, animal poisons, and in the manufacturing of items including paper, perfumes, medicines, mats, boats, clothing, shoes, ropes, and roofing (Kükenthal, 1935–1936; Zeven & Zhukovsky, 1975; Darby et al., 1977; Allan, 1978; Burkill, 1985; Negbi, 1992; Stephens, 1994; Bryson et al., 1998; Simpson & Inglis, 2001). Tubers, rhizomes, seed, and foliage of sedges are important wildlife and domesticated animal feeds or forage (Hermann, 1970; Miller & Miller, 1999; Abad et al., 2000). Cyperaceae are also utilized for erosion control, revegetation after natural disturbances, and to amend and improve soil fertility (Tachholm & Drar, 1950; Hermann, 1970; Burkill, 1985; Fagotto, 1987; Simpson & Inglis, 2001). Traits that make sedge species useful for erosion control and soil stabilization also make them weeds.

Control Methods

Control methods for weedy sedges are diverse. Cultural methods of hand removal, hoeing, and draft plowing are still used in much of the world to control weeds including sedges (Shear, 1985). Mechanical tillage, flame cultivation, mowing, chemical treatments (herbicides and fumigants), cover crops (e.g., sweet potato [*Ipomoea batatas* (L.) Lam.]), and shading with a crop or black plastic have proven to be effective in controlling many sedge weeds of turf, pasture, and vegetable and row crops (Patterson, 1982; Glaze, 1987; Bryson & Keeley, 1992; Buchanan, 1992; Peterson & Harrison, 1995). As shown by Bryson et al. (2003a) with *Cyperus entrerianus* Boeckeler, mowing alone will not effectively control certain perennial sedge weeds, but it can prevent seed production if mowing intervals are shorter than the time required to set fertile achenes. Fumigants are usually applied on small areas to sterilize the soil for vegetable crop production. Herbicide treatments may vary depending on the susceptability of target species, crop tolerance, and required timing of application (McWhorter & Bryson, 1992). With each herbicide developed, research is conducted to determine the efficacy on weeds and the selectivity on crops (Holt et al., 1962; Hauser, 1963a, b; Duble et al., 1968, 1970; Hamilton, 1971; Hardcastle & Wilkinson, 1971; Keeley & Thullen, 1971; Keeley et al., 1972; Wills, 1972; Zandstra et al., 1974; Zandstra & Nishimoto, 1977; Wills & McWhorter, 1988; Grichar et al., 1992; Richburg et al., 1993, 1994; Wilcut et al., 1994; Vencill et al., 1995; Bryson et al., 2003b).

Effective methods of herbicide application include pre-emergence broadcast and incorporated (with tillage) applications to control unwanted sedges that germinate from seed, rhizomes, and tubers. Acceptable post-emergence treatments are dependent on the herbicide selectivity. Nonselective herbicides are applied in areas where nontarget species are of little concern, while selective herbicides are applied to control target sedges without harming crops or other desirable plants. Application technologies have been developed to spray or wipe nonselective herbicides on target weeds with special equipment (e.g., directed sprayers, hooded sprayers, recirculating sprayers, foam applicators, shielded sprayers, chemigation, control droplet applicators, air-assist systems, pneumonic applicators, sensing devices, electrically charged sprayers, and rope-wick applicators) to reduce or eliminate damage to crops (Burr & Warren, 1971, 1972; Wiese, 1986; Bryson & Wills, 1991; Wills et al., 1991; Barrentine et al., 1992; Bryson et al., 1992b, 1994a; Bryson & Hanks, 1993; Bryson, 1994, 1997). Directed sprayers and hooded sprayers are widely used in the U.S.A. for controlling *Cyperus rotundus*, *C. esculentus*, *C. iria* L. (rice flatsedge), and other weeds in cotton and soybean. Additives such as soaps and lightweight paraffinic oils effectively enhance activity of some herbicides (McWhorter, 1982; Bryson et al., 1990; Jordan, 1996). The development of herbicide-resistant, transgenic crops allows application of herbicides such as glyphosate over-the-top without damaging crops (Shaner & Lyon, 1980), while effectively controlling weeds. However, selection for herbicide-resistant sedges is a potential problem with the persistent use of a single herbicide or herbicide family (Dowler et al., 1974). Resistance to bensulfuron in *C. difformis* L. (smallflower umbrella sedge) populations is well documented in rice production (Pappas-Fader et al., 1993, 1994; Hill et al., 1994), and herbicide resistance is also known in other species (LeBaron, 1991).

Various pesticides also kill herbivores, predators, or pathogens of weeds, thereby potentially rendering weeds more competitive. For example, when nematocides control nematodes harmful to rice (*Oryza sativa* L.), they also kill nematodes attacking weeds of rice (e.g., *Echinochloa* spp. and *Cyperus haspan* L.) (Hollis, 1972).

Although several potential biological control agents (insects and pathogens) have been evaluated for controlling *Cyperus esculentus*, *C. rotundus*, and other sedges, none has been effective in reducing sedge populations outside controlled experiments (Phatak et al., 1987). It is unlikely that any single biological agent will provide total control of nutsedges (Morales-Payan et al., 2005). High parasitism and predation by other insects and use of pesticides that kill biocontrol agents are major constraints preventing effective biological control of sedges using insects in row crops (Frick, 1978). Excessive development, production, and registration costs, short shelf life, and ineffective delivery systems are major obstacles to utilizing pathogens for biological control of weeds (Boyette, 2000; Duke & Boyette, 2001).

Population Dynamics

Weed species and population levels differ depending on land use, cropland preparation, forestation, and disturbance in natural areas. In agricultural systems, weed shifts occur primarily when management practices or environmental conditions change (McWhorter & Bryson, 1992; Murray et al., 1992). A single natural occurrence (e.g., tornado, hurricane, earthquake, fire, flood) or cultural- and chemical-control practices in farming operations may eliminate or reduce populations of one weed, while enhancing the survival, growth, and reproductive potential of another. As an example, farmers in the southeastern U.S.A. claimed that *Sida spinosa* L. seed and some sedge weeds such as *Cyperus esculentus* and *C. rotundus* arrived in containers of dinitroanaline (DNA) herbicides. In actuality however, DNA herbicides controlled annual grasses and small seed broadleaf weeds and vacated a niche for other weeds to invade areas previously not infested (Frans, 1969; Dowler et al., 1974). Weed shifts may also occur when environmental factors are modified through row spacing, irrigation, and crop rotation in row crops or when irrigation and fertilization frequency is increased on lawns, turf, and flowerbeds. In row crops, many sedge weeds thrive on irrigated soils and occur in higher population levels prior to crop canopy closure. Canopy closure earlier in the growing season shades weeds and prevents seed or tuber germination; thus, it is an effective cultural practice in controlling many weeds, including sedges such as *C. esculentus* and *C. rotundus* (Bryson et al., 1990, 2003b).

Weed shifts may also occur as weeds disperse into new areas. Non-native weeds, such as *Cyperus rotundus*, *C. iria*, *C. difformis*, and *Kyllinga brevifolia* Rottb., are excellent examples of weeds that were introduced into the U.S.A. more than a century ago and spread (Appendix 1). Within the past 50 years, sedge weeds such as *C. entrerianus*, *C. sanguinolentus* Vahl, and *C. eragrostis* Lam. have become established and spread rapidly in areas previously not infested in the U.S.A. (Carter, 1990, 2005; Carter & Bryson, 1996, 2000b; Bryson et al., 1998). Once introduced into a new area, weeds may take several years to become established before causing problems (the lag phase). Duration of the lag phase may vary depending on factors such as the number of seeds produced, presence of dispersal vectors, and environmental conditions (Radosevich & Holt, 1984). Early detection and implementation of control strategies are important in effectively controlling non-native invasive weeds soon after introduction or while still in the lag phase.

Farmers, consultants, and landowners must be ever observant of new weeds and changes within populations of weeds. Weed shifts are inevitable when land use is altered or disturbance occurs. For instance, weed shifts occur in reduced-tillage production systems or where cover crops are utilized (Bryson & Hanks, 2001). Perennial sedges such as *Cyperus esculentus* and *C. rotundus* and many other perennial weeds regenerate from greater soil depths than most annual weeds (Elmore, 1984; Elmore et al., 1989). Likewise, seeds of many annual sedges germinate on the soil surface following a rainfall event without burial, e.g., *C. sanguinolentus* (Carter & Bryson, 2000b). No-tillage or conservation crop production systems tend to favor weeds that germinate from shallow soil depths and perennial weeds. Unless controlled, perennial weeds are an increased problem in reduced-tillage production systems. Difficult-to-control perennial sedges such as *C. esculentus*, *C. rotundus*, and perennial *Kyllinga* Rottb. species often require repetitive and integrated control methods (Bryson & Keeley, 1992; McWhorter & Bryson, 1992; Bryson et al., 1999, 2003b).

In order to assess the impact of a particular weed species effectively, researchers have devised a method to determine the competitive potential of weeds based on field interference studies in agricultural and forest areas (Coble & Byrd, 1992; Reichard & Hamilton, 1997). Interference is ranked among weed species to develop a competitive index or relative competitive abilities table such as the one for selected weeds in cotton created by Coble and Byrd (1992). Such an index aids farmers, consultants, and landowners in determining which species are the most pernicious and helps establish thresholds for the number of weeds that can be tolerated in a given situation. Computerized models (e.g., Soybean Weed Control [SWC] and Mississippi State University Herbicide Application Decision Support System [MSUHADSS]) have been developed to aid farmers and consultants in making recommendations, which take into account the weed-competitive index, herbicide options and prices, application costs, crop variety (cultivar), row spacing, crop stage, expected weed-free yield potential, expected selling price, soil moisture, and species of weed, population size, and density (Bryson, 2003). However, little research has been conducted to evaluate the thresholds of weeds in natural areas, where populations may far exceed threshold levels before a problem is perceived.

IDENTIFICATION

Accurate identification is essential in detecting the presence of weeds and developing the best management strategies for control (Palm et al., 1968; Murray et al., 1992). Traditionally, weed scientists have approached plant identification pragmatically and have adopted simplified systems to be used primarily by individuals with minimal training in systematic botany (e.g., Fischer et al., 1978; Stuckey et al., 1980; Elmore & Bryson, 1986–2001; DeFelice & Bryson, 2004). Such weed identification systems, usually very different from the dichotomous keys commonly used in taxonomic treatments, group weeds by similar susceptibility or resistance to herbicides, effectiveness of cultural-control practices, time of germination, and other factors (Bryson, 2003). In the simplest systems, plants are grouped into general categories (e.g., broadleaved species, grasses, sedges, annuals, or perennials), which is usually sufficient for making decisions about application of broad spectrum and nonselective herbicides. However, the increasing use of more selective herbicides and biological control agents demands greater precision in identification, i.e., determination to specific or infraspecific rank. Among sedges, susceptibility to herbicides is usually correlated with species; however, infraspecific biotypes (e.g., *Cyperus difformis*) do rarely exhibit differential resistance to herbicides (Pappas-Fader et al., 1993, 1994; Hill et al., 1994). In the case of herbicide-resistant biotypes, visual identification is impossible, necessitating the use of bioassays (LeBaron, 1991). Currently, when herbicide resistance is suspected, bioassays are used to determine if the lack of control is due to herbicide resistance, herbicide tolerance, environmental conditions, or misapplication.

Weed scientists and researchers in agriculture usually work with a relatively small subset of all possible plant species in their area, and the agricultural weeds are usually well known. Thus, simplified systems for identification generally work well for most common agricultural weeds. However, when new or unexpected weeds are encountered, more traditional taxonomic methods must be adopted (e.g., use of floristic manuals or systematic treatments in primary literature). Although it may be possible to identify immature sterile specimens of well-known sedges like *Cyperus esculentus* and *C. rotundus*, reliable identification of most sedges to species requires mature fertile specimens and oftentimes the assistance of taxonomic experts. To ensure that the specimen receives proper attention from a taxonomist, it should be prepared using standard methods and should include accurate geographical data (Carter, 2003). To avoid overlooking newly introduced weeds, every effort should be made to collect unfamiliar sedges and to identify them accurately. If one is not able to make a reliable identification, then the specimen with data should be sent to a competent taxonomist for determination. Vigilance, prompt action, and cooperation between plant systematists and weed scientists are absolutely essential in detecting newly introduced sedges and dealing effectively with emerging weed problems. Early detection and rapid response with effective control methods are essential for eradication of non-native invasive weeds (Westbrooks, 1998).

FACTORS DETERMINING COMPETITIVE ADVANTAGE

The general characteristics of weeds summarized in Table 1 are found to varying degrees in many groups of plants, including sedges. Although no single species exhibits all features, it is presumed that there is usually a direct relationship between the number of these characteristics and the degree of invasiveness of a weed (Radosevich & Holt, 1984; Bryson & Carter, 2004). Most sedges reproduce sexually through the production of large numbers of small achenes. Such small reproductive structures are well suited to both short- and long-distance dispersal. Because of their small size, the achenes of sedges are difficult to detect and are readily transported as contaminants of seeds of crop, lawn, and forage plants. *Cyperus difformis* and *C. iria* are major agricultural pests, particularly of rice (Holm et al., 1977). They probably originated as weeds by invading rice paddies in Asia, where they were subject to similar selective pressures as rice. Annual habit, rapid growth, short generation time, high fecundity, and tolerance of submergence of roots have enabled *C. difformis* and *C. iria* to persist and disperse as weeds of rice. *Cyperus difformis* completes its life cycle in just four to six weeks and can go through several generations within a single season (Holm et al., 1977), and an individual plant can produce as many as 50,000 achenes (Jacometti, 1912). These and other sedges are thought to have become naturalized throughout rice-producing areas around the world via dissemination of their achenes as contaminants of rice seed (Bellue, 1932; Muenscher, 1955; Kral, 1971).

Obviously, certain characteristics listed in Table 1 are more important as determinants of invasiveness than others. Given the importance of dispersal during the phases of introduction and spread of invasive species (Cronk & Fuller, 1995), characteristics relating to fecundity and dispersal of seeds would be of major importance, as would those providing the ability to spread vegetatively. According to Holm et al. (1977), *Cyperus rotundus* is the most pestiferous plant in the world. It reproduces and disperses primarily from vegetative tubers, with many biotypes rarely producing viable seeds (Wills, 1987). *Cyperus esculentus*, also a major agricultural weed, shares similar reproductive characteristics. Vegetative structures such as stolons, rhizomes, and tubers are important in localized spreading of many perennial sedges and may even be transported long distances both naturally and artificially when fragmentation occurs. Subterranean rhizomes, tubers, and corms also enable perennation and survival of sedges during adverse environmental conditions, e.g., cold temperatures, drought, or fire. Further discussion of dispersal in Cyperaceae, including dissemination of vegetative fragments and structural modifications facilitating transport of achenes and other structures, is included below in the Dispersal section.

The highly reduced and inconspicuous flowers of most sedges generally go undetected until after they produce seeds, which Muenscher (1955) cited as characteristic of many weeds. Cyperaceae are almost exclusively wind-pollinated (anemophilous). However, entomophily (insect pollination) has been documented to varying degrees in *Hypolytrum* Rich., *Mapania* Aubl., *Ascolepis* Nees ex Steud., *Rhynchospora* Vahl sect. *Dichromena* (Michx.) Griseb., *Cymophyllus* Mack., and even some species of *Bolboschoenus* (Asch.) Palla, *Carex* L., *Cyperus*, and *Eleocharis* R. Br. (Thomas, 1984a, b; Goetghebeur, 1998). Although there is a paucity of information, it is suspected that most sedges are cross-pollinated (allogamous). For example, *Cyperus esculentus* is self-incompatible, and therefore an obligate outcrosser (Brown & Marshall, 1981) with greater genetic variability within sexually reproducing populations than *C. rotundus*, which rarely produces viable seed (Horak & Holt, 1986; Horak et al., 1987). Cross-pollination in combination with anemophily is thought to contribute to the success of weeds (Baker, 1965, 1974). Some of the most pestiferous sedges are very broadly ranging, exhibiting great infraspecific diversity with many biotypes adapted to a wide variety of environmental conditions. *Cyperus rotundus* and *C. esculentus* are cosmopolitan weeds distributed widely throughout the tropics and throughout much of the temperate zone (Kükenthal, 1935–1936). In a worldwide treatment, Kükenthal (1935–1936) recognized numerous infraspecific taxa within these species, indicating considerable adaptation to local environmental conditions.

C_4 photosynthesis confers a competitive advantage under conditions of high temperature, high light intensity, and water stress (Hopkins & Hüner, 2004). C_4 plants have a lower transpiration ratio, thus, a higher water-use efficiency, than C_3 species, brought about by a lower CO_2 compensation point, reduced photorespiration, and enzymes (ribulose-1,5-bisphosphate carboxylase [RUBISCO], phosphoenolpyruvate carboxylase [PEPcase]) with higher optimal temperatures (Hopkins & Hüner, 2004). In Cyperaceae, C_4 photosynthesis is complex, consisting of four different anatomical types (chlorocyperoid, rhynchosporoid, fimbristyloid, eleocharoid) and two distinct carbon assimilation modes (Brown, 1975; Soros & Bruhl, 2000). In cladistic analyses using developmental, anatomical, and molecular data, Soros and Bruhl (2000) concluded that C_4 photosynthesis arose multiple times (at least four) in the Cyperaceae. Table 2 shows the occurrence of C_4 photosynthesis in the genera of cyperaceous weeds. In most cases genera are either C_3 or C_4; however, five genera, *Abildgaardia* Vahl, *Cyperus*, *Eleocharis*,

Table 2. The occurrence of C_3 and C_4 photosynthesis by genus of cyperaceous weeds.[1, 2, 3]

Mapanioideae (13/140)
- Hypolytreae (9/130)
  - *Mapania* (70) **C_3**
  - *Scirpodendron* (2) **C_3**
- Chrysitricheae (4/13)
  - *Lepironia* (1) **C_3**

Cyperoideae (71/2380)
- Scirpeae (6/60)
  - *Scirpus* (20) **C_3**
- Fuireneae (5/90)
  - *Fuirena* (30) **C_3**
  - *Bolboschoenus* (11) **C_3**
  - *Schoenoplectus* (50) **C_3**
  - *Actinoscirpus* (1) **C_3**
- Eleocharideae (3/200)
  - *Eleocharis* (200) **$C_3[C_4]$**
- Abildgaardieae (6/420)
  - *Abildgaardia* (10) **$C_4[C_3]$**
  - *Fimbristylis* (300) **$C_4[C_3]$**
  - *Bulbostylis* (100) **C_4**
- Cypereae (19/900)
  - *Cyperus* (incl. *Anosporum*, *Juncellus*, *Mariscus*, *Torulinium*) (550) **$C_4[C_3]$**
  - *Kyllinga* (60) **C_4**
  - *Queenslandiella* (1) **C_4**
  - *Pycreus* (100) **C_4**
  - *Lipocarpha* (35) **C_4**
  - *Oxycaryum* (1) **C_3**
  - *Isolepis* (60) **C_3**
  - *Courtoisina* (2) **C_3**
- Schoeneae (29/700)
  - *Rhynchospora* (250) **$C_3[C_4]$**
  - *Cladium* (4) **C_3**
  - *Lepidosperma* (55) **C_3**

Sclerioideae (15/340)
- Sclerieae (1/250)
  - *Scleria* (250) **C_3**

Caricoideae (5/2150)
- Cariceae (5/2150)
  - *Carex* (2000) **C_3**

[1] Data on photosynthetic pathway from Bruhl (1993,1995) and Soros and Bruhl (2000); $C_3[C_4]$ = mostly C_3, $C_4[C_3]$ = mostly C_4.

[2] Subfamily and tribal classification and numbers of genera and species in parentheses are from Goetghebeur (1998).

[3] Authority names for genera in Table 2 not discussed elsewhere in this paper are as follows: *Actinoscirpus* (Ohwi) R. W. Haines & Lye; *Cyperus* sect. *Anosporum* (Nees) Pax.

Fimbristylis Vahl, and *Rhynchospora* have both C_3 and C_4 species. Of these, the mostly aquatic to subaquatic *Eleocharis* is almost entirely C_3, and all of the subgenera of *Cyperus* are C_4 except *Pycnostachys* C. B. Clarke [= *Protocyperus*]. Although many weeds are not, some of the most competitive are characterized by C_4 photosynthesis (Black et al., 1969; Elmore & Paul, 1983). Holm et al. (1977) rank *C. rotundus*, *C. esculentus*, *C. difformis*, and *C. iria* among the world's worst weeds. *Cyperus rotundus*, *C. esculentus*, and *C. iria* are C_4 plants; *C. difformis* is C_3 (Hesla et al., 1982). Because C_4 photosynthesis is only one of many factors contributing to the competitiveness of weeds (Baskin & Baskin, 1978), it is not surprising that other characteristics enable certain C_3 Cyperaceae to be highly competitive weeds. C_4 photosynthesis is normally most advantageous in the terrestrial environment under conditions of drought, high light, and high temperatures (Hopkins & Hüner, 2004). *Cyperus difformis* is almost exclusively a pest of rice and is well adapted to aquatic environments, where excessive water in the environment ameliorates high temperatures, and water stress is normally not a factor. Thus, it is not surprising that *C. difformis* has C_3 photosynthesis. Similarly, the C_3 species *C. haspan* is a major weed of rice agriculture.

Although data on photosynthetic pathways for most species of cyperaceous weeds are lacking, generic-level data for species listed in Appendix 2 indicate a predominance of weeds in genera that are exclusively or primarily C_4 (Fig. 1). Thus, it appears that C_4 photosynthesis has been a major factor in the success of genera such as *Cyperus*, *Fimbristylis*, *Kyllinga*, and *Bulbostylis* DC. as weeds.

Certain plants, including weeds, achieve a competitive advantage through allelopathy, the production of chemical compounds that suppresses seed germination and growth in competing plants. Allelopathy is well known in *Cyperus rotundus* and *C. esculentus* and has been cited as a factor in its competition with cotton and other crops (Friedman & Horowitz, 1971; Mallik & Tesfai, 1988; Martinez-Diaz, 1997). Although it has not been investigated, the nearly monotypic nature of invasive populations of *C. entrerianus*, observed in southern Louisiana and eastern Texas, U.S.A. (Carter, 1990; Carter & Bryson, 1996), suggests an allelopathic effect.

Weeds may also harbor insects and pathogens that adversely affect agricultural crops and native plants (USDA, 1960; Tietz, 1972). *Cyperus dives* Delile, the natural host for a moth (*Eldana saccharina* Walker) whose larvae cause losses to the sugar industry, is of some concern as a weed in southern Africa, where it is native and where an increase in its frequency is associated with clearing of natural vegetation for the cultivation of sugarcane (Gordon-Gray, 1995). *Cyperus papyrus* L. is also thought to harbor this same moth (Gordon-Gray, 1995). Noctuiid moth larvae of *Spodoptera frugiperda* (J. E. Smith) [= *Laphygma frugierda* (Abbott & Smith)] reportedly feed on *C. rotundus*, *Carex* spp., barley (*Hordeum vulgare* L.), cotton, milo (*Sorghum bicolor* (L.) Moench.), potato (*Solanum tuberosum* L.), rice, soybean, sweet potato, and other crops and native plant species (Tietz, 1972). *Colletotrichum graminicola* (Ces.) G. W. Wils., a fungal pathogen, infects *Carex* spp., other Cyperaceae, and grass crops (USDA, 1960). *Cyperus esculentus*, *C. rotundus*, chili peppers (*Capsicum annuum* L.), and other crops are hosts to the southern root-knot nematode (*Meloidogyne incognita* (Kofoid & White) Chitwood) (Schroeder et al., 1993).

DISPERSAL

Dispersal is fundamentally important in determining distributional patterns of plant species. Dispersal may be complex and dynamic involving both sexual and asexual systems, multiple vectors, and shifts in vectors. When released from competition, predation, and disease, many species, upon introduction outside their natural ranges, have potential to become weeds. Dispersal is crucial at two points during invasion by plants: first, during the initial introduction of the species and later, after naturalization, as the invasive species spreads, expanding its range (Cronk & Fuller, 1995). Consequently, basic knowledge about attributes of reproduction and natural dispersal can provide insight into which species are likely to become invasive weeds and how they might be dispersed.

Vegetative growth from rhizomes, stolons, runners, tubers, and corms is common in many perennial sedges and is undoubtedly very important in local expansion. Some species, e.g., *Eleocharis melanocarpa* Torr., *E. microcarpa* Torr., and *E. rostellata* Torr., have arching aerial stems that take root apically upon contact with the ground, and others, like *E. vivipara* Link, proliferate vegetatively from spikelets. *Cyperus pectinatus* Vahl forms plantlets vegetatively from its inflorescence (Haines & Lye, 1983). Vegetative growth when coupled with fragmentation and transport of asexual propagules can also result in more distant dispersal. This is perhaps most effective in the dispersal of fragments broken from rafts (sudds) of floating or submerged natant aquatic sedges by water currents or wind. Such dispersal has been noted in *C. cephalotes* Vahl, *C. colymbetes* Kotschy & Peyr., *C. mundtii* Kunth, *C. papyrus*, *C. pectinatus*, and *Oxycaryum cubense* (Poepp. & Kunth) Palla (Kern, 1974; Haines & Lye, 1983; Gordon-Gray, 1995). We have noted this phenomenon in *C. alopecuroides* Rottb., *C. prolifer* Lam., *Eleocharis baldwinii* (Torr.) Chapm., *E. vivipara*, and *O. cubense* and suspect that it occurs in other species similar in habit and habitat, e.g., *C. elatus* L. and *Websteria confervoides* (Poir.) S. S. Hooper (Kern, 1974).

Sedges exhibit a variety of modifications exploiting various agents of dispersal, most of which directly involve fruits or inflorescences. A number of mechanisms involving dispersal of achenes by wind (anemochory) are known in Cyperaceae. In *Afrotrilepis* (Gilly) J. Raynal, *Carpha* Banks & Sol. ex R. Br., *Costularia* C. B. Clarke, *Eriophorum* L., and *Scirpus* L., a persistent perianth adnate to the achene is modified into long, silky bristles or hairs that facilitate transport by wind (Kern, 1974; Pijl, 1982; Haines & Lye, 1983; Goetghebeur, 1998), and in *Androtrichum* Brongn. and *Machaerina* Vahl, persistent elongated filaments have the same function (Goetghebeur, 1998). Also, the flattened wing-like floral scales of *Anosporum* spp. and the flattened winged spikelets of certain *Kyllinga* spp. (Haines & Lye, 1983) promote wind dispersal of the achenes retained within. Such dispersal of spikelets has been

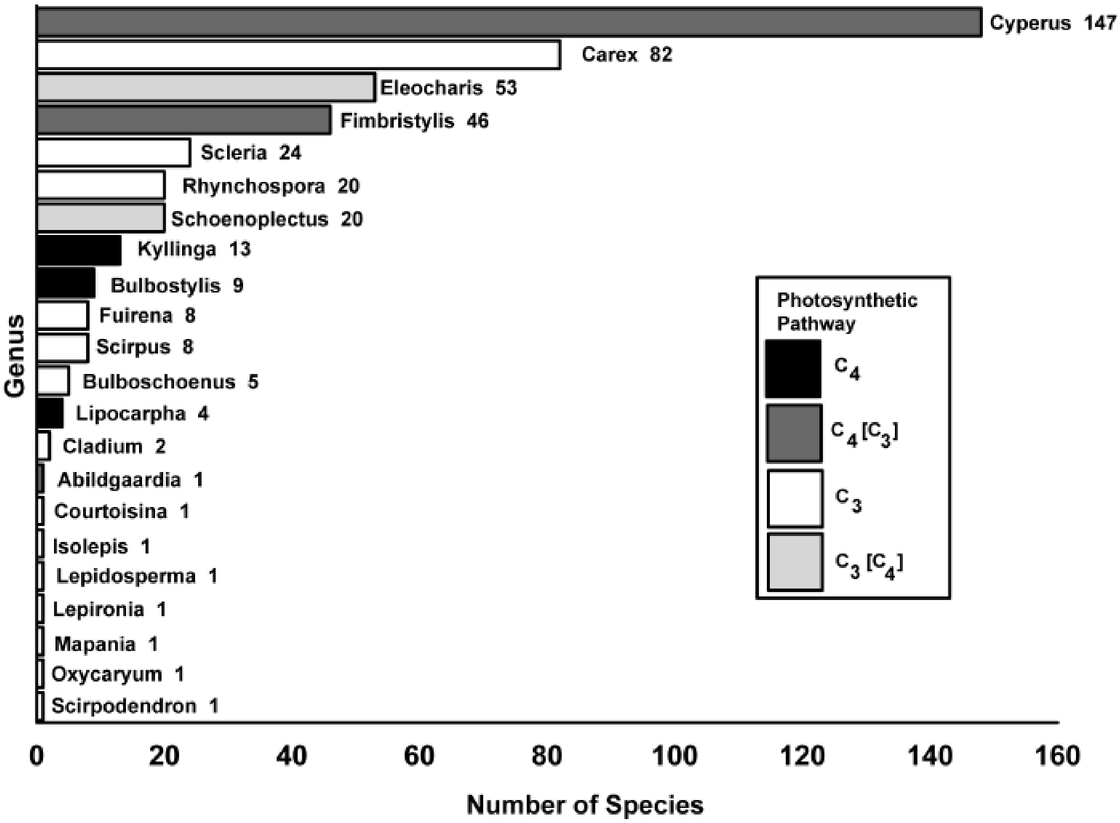


Figure 1. Photosynthetic pathways among genera of Cyperaceae with weeds; data on photosynthetic pathways from Bruhl (1993, 1995) and Soros and Bruhl (2000).

observed over short distances during collection of specimens of the introduced weed *K. squamulata* Thonn. ex Vahl (Carter, pers. obs.).

Dispersal by water (hydrochory) is well documented in Cyperaceae. The fruits or spikelets of most terrestrial sedges are disseminated to some extent by rain; however, such dispersal is usually quite local (Ridley, 1930). The achenes of the aquatic and wetland sedges *Cyperus (Anosporum) colymbetes*, *C. pectinatus*, *C. platystylis* R. Br., *Oxycaryum cubense*, several *Scirpus* spp., and certain wetland *Carex* spp. have a spongy suberized pericarp that facilitates flotation and dispersal by moving water (Chermezon, 1924; Ridley, 1930; Kern, 1974; Lye, 1981; Haines & Lye, 1983). Achenes of *Cladium* P. Browne were observed to float in the laboratory for up to 15 months (Ridley, 1930). Similarly in *Cyperus odoratus* L. and *Remirea maritima* Aubl., the achene remains enclasped in a buoyant corky rachilla and is thereby dispersed by moving water (Kern, 1974; Haines & Lye, 1983). Floods undoubtedly transport even unmodified, nonbuoyant achenes, vegetative fragments of plants (e.g., rhizomes, tubers), and whole plants (Kern, 1974) and deposit them far from the main channel along basins of major rivers. *Cyperus fuscus* L., a potential rice weed in the U.S.A., has apparently been dispersed by floodwaters along the Missouri River in the central U.S.A. (McKenzie et al., 1998).

Dispersal of achenes by animals (zoochory), especially birds, is important in Cyperaceae. Zoochory may involve the internal (endozoic) transport of achenes within the digestive system or external (epizoic) transport. The achenes of *Carex*, *Cladium*, *Cyperus*, *Fimbristylis*, *Rhynchospora*, and *Scirpus* have been identified in the alimentary systems of waterfowl (Ridley, 1930). Waterfowl and other birds consume large quantities of achenes, especially of *Cyperus* spp. and *Eleocharis* spp., and their endozoic transport plays an important role in dispersal of sedges over long and short distances (Ridley, 1930; Kern, 1974; Haines & Lye, 1983). Vlaming and Proctor (1968) experimentally determined that sedge achenes remained viable after retention in avian digestive systems for periods up to 120 hours: *Cyperus ochraceus* Vahl, max. 37 hr.; *Eleocharis albida* Torr., max. 38 hr.; *E. macrostachya* Britton, max. 77 hr.; *E. parvula* (Roem. & Schult.) Link ex Bluff, Nees & Schauer max. 30 hr.; and *E. quadrangulata* (Michx.) Roem. & Schult., max. 120 hr. Brightly colored fruits in the tropical genus *Gahnia* J. R. Forst. & G. Forst. are consumed and dispersed by birds (Benl, 1937; Pijl, 1982; Lye, 2000), and, according to Sauer (1988), seeds of *Carex nigra* (L.) Reichard were brought to Iceland by snow buntings from Great Britain. Short-distance endozoic dispersal by cattle (*Carex*, *Scirpus*) and water buffalo (*Fimbristylis globulosa* (Retz.) Kunth, *F. littoralis* Gaudich.) has been reported by Kern (1974).

Similarly, the epizoic transport of achenes in mud adhering to the feet of migratory waterfowl is implicated in long-distance dispersal in *Cyperus*, *Eleocharis*, *Rhynchospora*, and *Scirpus* (Ridley, 1930; Kern, 1974). Such mechanisms could account in part for the wide distributions of *C. drummondii* Torr. & Hook., *C. odoratus*, *C. virens* Michx., and *Oxycaryum cubense*. A number of epizoic mechanisms involving various structural modifications are known in Cyperaceae. The achenes of many species of *Eleocharis*, *Fuirena* Rottb., *Rhynchospora*, *Schoenoplectus* (Rchb.) Palla, and *Websteria* S. H. Wright are subtended by persistent, hypogynous bristles beset with retrorse barbs that readily attach to feathers or hair of animals (Kern, 1974; Haines & Lye, 1983), and the North American sedge, *C. plukenetii* Fernald, exhibits a number of modifications that facilitate dispersal of intact spikelets by attachment to animal hair (Carter, 1993). *Uncinia* Pers., widely distributed in the Southern Hemisphere, including many islands of the Pacific, is characterized by a hooked inflorescence axis that extends beyond the utricle, attaching readily to feathers and enabling transport by birds (Pijl, 1982; Mabberley, 1997). *Carex pauciflora* Lightf. has a springing mechanism that disperses its perigynia over relatively short distances when touched by animals (Hutton, 1976), and the perigynia of certain other *Carex* spp. produce oil-rich appendages and are dispersed by ants (Handel, 1976, 1978; Gaddy, 1986). Similarly, a fleshy perianth in *Lepidosperma* Labill. reportedly facilitates dispersal by ants (Goetghebeur, 1998).

High fecundity and small fruits (achenes) make sedges especially susceptible to unintentional dissemination directly by humans or through their activities. A variety of human activities are known or suspected to disperse sedges, and most of these involve movement of their small, inconspicuous achenes. Sedge achenes are readily dispersed as contaminants of commercial seed supplies (Koyama, 1985; Bryson & Carter, 1992; Sell & Murrell, 1996), and achenes or even live plants may contaminate ornamental nursery stock, potted plants, or mulch. A number of sedges associated with rice agriculture around the world (cf. *Bolboschoenus*, *Cyperus*, *Eleocharis*, *Fimbristylis*, *Schoenoplectus* in Appendix 1) are thought to have dispersed via achenes as contaminants of rice seed (Bellue, 1932; Muenscher, 1955; Kral, 1971). Shipments of shorn wool may contain achenes of sedges, which when dispersed result in the introduction of so-called "wool aliens" (Sell & Murrell, 1996). Other kinds of cargo, including live animals, transported by land, sea, or air may harbor achenes resulting in the unintentional introduction of sedges (Carter & Mears, 2000). Dumping of ballast contaminated with achenes or vegetative propagules (e.g., rhizomes, stolons, tubers) has long been associated with dispersal of sedges and other plants (e.g., Smith, 1867; Brown, 1880; Britton, 1886; Mohr, 1901). The inadvertent transport of achenes or vegetative propagules embedded in mud or lubricants adhering to wheels or other parts of freight cars, trucks, automobiles, and airplanes undoubtedly disperses sedges, and migration of plants, including sedges, along railroads (ferroviatic migration) is well documented (e.g., Mühlenbach, 1979, 1983). It also seems likely that tiny achenes of sedges, drawn by jet airplane engines, could lodge in the housing of the engine or other parts and be carried great distances. The transport of turfgrass sod, mulch, soil, hay, and fodder has been associated with dispersal of sedges, e.g., *Cyperus esculentus*, *C. rotundus*, *Kyllinga brevifolia*, and *K. gracillima* Miq. (Bryson et al., 1992b, 1996, 1997; Sell & Murrell, 1996), and movement of achenes and vegetative propagules occurs during construction and maintenance of roads, e.g., *Cyperus entrerianus*, *C. sanguinolentus*, *Carex oklahomensis* Mack., and

C. praegracilis W. Boott (Kern, 1974; Reznicek & Catling, 1987; Carter, 1990; Carter & Bryson, 1996, 2000b).

Because sedges are generally inconspicuous, and other than as weeds are of minimal economic importance, they escape all but casual notice and interest of most humans; consequently, it is presumed that the intentional dispersal of sedges by humans is infrequent. However, as shown in Appendix 1 and in Figures 2 and 3, there is an increased interest in using sedges as ornamentals, and a surprising number of species are subject to deliberate transfer by humans. Some of these have become naturalized weeds from cultivation, and any could potentially become pests. *Carex comans* Berggr., *C. morrowii* Boott, *C. pendula* Huds., *C. riparia* Curtis, *Cymophyllus fraserianus* (Ker Gawl.) Kartesz & Gandhi, *Cyperus compressus* L., *C. eragrostis*, *C. longus* L., *C. owanii* Boeckeler, and *C. strigosus* L. are used in gardens, and *Carex baccans* Nees, *Cyperus albostriatus* Schrad., *C. fertilis* Boeckeler, and *Isolepis cernua* (Vahl) Roem. & Schult. are sometimes used as potted plants or in hanging baskets (Bailey, 1935, 1949; Bailey & Bailey, 1976; Everett, 1980–1982; Brickell & Zuk, 1997). Of these, *Carex riparia*, *Cyperus compressus*, *C. eragrostis*, and *C. longus* are listed as weeds (cf. Appendix 2), and the South African *C. owanii* is naturalized, but apparently not invasive, in California, U.S.A. (Tucker et al., 2002).

Cyperus alternifolius L. subsp. *flabelliformis* Kük. (umbrella plant, umbrella sedge) has been used as an ornamental in water gardens and as a potted plant for more than 200 years (Bailey & Bailey, 1976). It is widely naturalized from cultivation throughout the tropics and subtropics (Kern, 1974; Koyama, 1985) and is frequently cited as a weed (cf. Appendix 2). Other sedges cultivated in water gardens include *C. papyrus* (papyrus), *C. prolifer* (dwarf papyrus, miniature papyrus), *C. sexangularis* Nees, *C. textilis* Thunb., and various bulrushes, *Bolboschoenus robustus* (Pursh) Soják, *Schoenoplectus acutus* (Muhl. ex J. M. Bigelow) Á. Löve & D. Löve, *S. heterochaetus* (Chase) Soják, *S. tabernaemontani* (C. C. Gmel.) Palla, *S. lacustris* (L.) Palla, and *Scirpus cyperinus* (L.) Kunth (Bailey, 1935, 1949; Everett, 1980–1982; Gordon-Gray, 1995). *Cyperus papyrus* is naturalized in Australia (Wilson, 1993) and in Florida, U.S.A. (Wunderlin, 1998), and *C. prolifer* is naturalized in Florida (Carter et al., 1996).

Appendix 1 is a list of sedges known or suspected to be transported by human activities. The frequencies of various modes of anthropogenic dispersal in Cyperaceae are shown in Figure 2: ornamentals (53%); wool aliens (13%); ballast (7%); rice agriculture (7%); revegetation, reclamation, erosion control, and soil improvement (7%); and highways and railroads (3%). The burgeoning human population and the current ease and frequency of rapid long-distance transportation of humans and cargo make it inevitable that such dispersal of sedges, both unintentional and deliberate, will continue into the foreseeable future.

Invasion by *Cyperus entrerianus*: A Case Study

The following case study of *Cyperus entrerianus* (deeprooted sedge), based upon Carter (1990) and subsequent investigation (Carter, unpubl. data), shows how basic research in the field and the herbarium allows for the detection of invasive weeds and illustrates the need for accurate and timely identification in order to take appropriate action against them. In 1987, Carter found a species of *Cyperus* in Ware County, Georgia, that did not fit any descriptions of species known from the southeastern U.S.A. During 1988 and 1989, intensive searching in the field resulted in discovery of numerous additional populations of this perplexing sedge in Florida, Georgia, Alabama, Louisiana, and eastern Texas. During this same period, an examination of herbarium specimens at FSU, IBE, and VDB revealed additional ones, variously misidentified, that were collected from northern Florida in the 1970s and 1980s, southern Louisiana in 1975, and eastern Texas in 1981. In early 1989, Carter correctly determined that the enigmatic sedge was *C. entrerianus*.

Based upon data gleaned from herbarium specimens and intensive field research and Rosen et al. (2006), the following hypothetical scenario for the introduction, naturalization, and dispersal of *Cyperus entrerianus* in the U.S.A. is proposed (Fig. 4). *Cyperus entrerianus* was introduced into the U.S.A. before 1941, and the suspected points of introduction are Cameron County, Texas, and Pensacola, Florida (*Brinker 413*, US). The species was not found again in

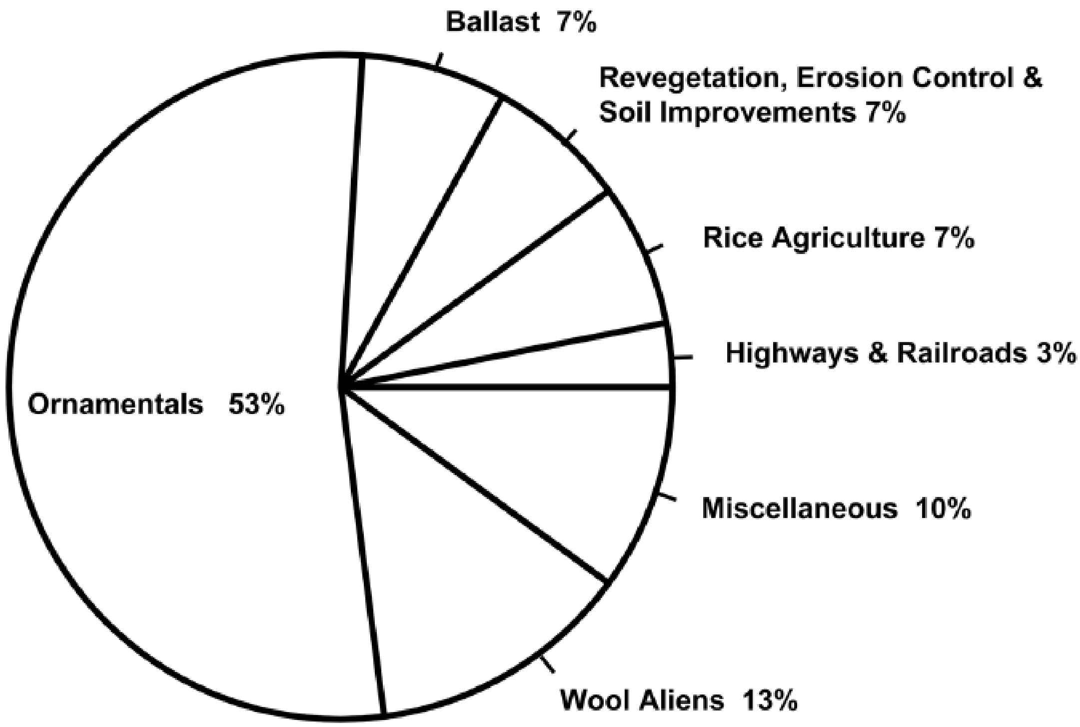


Figure 2. Percentages of various kinds of anthropogenic dispersal of cyperaceous weeds listed in Appendix 1.

the U.S.A. until 1974, when it was collected again in Pensacola (*Godfrey 73755*, FSU). It was collected in southern Louisiana in 1975 (*Allen 6674*, VDB), additional collections were made in Escambia and Gulf counties, Florida, during the late 1970s and 1980s, and it was found in eastern Texas in 1981 (Carter, 1990). All of the collections of *C. entrerianus* made by others before it was reported new to the U.S.A. by Carter (1990) were variously misidentified as *C. pseudovegetus* Steud., *C. robustus* Kunth, *C. virens*, and *C. virens* var. *drummondii* (Torr. & Hook.) Kük. The paucity of herbarium records before the mid-1980s suggests that *C. entrerianus* was in its lag phase until then. Although the apparent rapid expansion of range in the late 1980s and 1990s is undoubtedly in part an artifact of intensive searching for *C. entrerianus* by Carter and others (Carter, 1990; Carter & Jones, 1991; Bryson & Carter, 1994; Carter & Bryson, 1996), its collection at a number of sites in Louisiana and Florida during the later 1970s by researchers who had no knowledge of its correct identity indicates that its lag phase had ended some years earlier.

It is suspected that *Cyperus entrerianus* was introduced independently in southern Texas and at Pensacola from temperate South America or Mexico (Carter, 1990; Rosen et al., 2006). There are other cases of introduced *Cyperus* weeds that were probably imported into Pensacola via ballast: *C. aggregatus* (Willd.) Endl., *C. difformis*, *C. pilosus* Vahl, and *C. reflexus* Vahl (Burkhalter, 1985; Wunderlin, 1998); thus, introduction of *C. entrerianus* via ballast is plausible. Distribution and habitat indicate that *C. entrerianus* has spread from its point of introduction at Pensacola via dispersal from road construction and maintenance activities, primarily along highway Interstate 10 and secondarily along intersecting highways (Carter, 1990; Carter & Bryson, 1996). It is probably also now dispersed endozoically by birds or other animals that consume its achenes. Certain populations of *C. entrerianus* in the southeastern U.S.A. show evidence of introgression with *C. surinamensis* Rottb., which could account in part for the robust habit (heterosis) observed in plants there (Carter, 1990). Vigorous growth and robust form have probably facilitated the rapid expansion of *C. entrerianus* in the southeastern

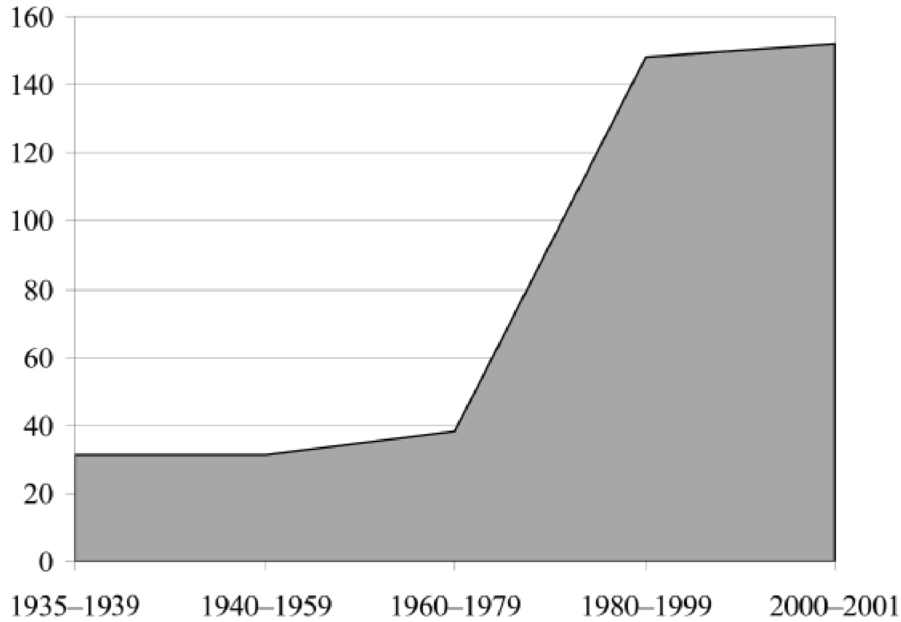


Figure 3. Cumulative numbers of ornamental and cultivated species of Cyperaceae listed in selected horticultural references from 1935 to 2001.

U.S.A. from Florida and southern Georgia west into eastern Texas, and it has begun to invade natural areas in eastern Texas (Rosen et al., 2006).

Survey of Genera and Selected Species

There is no comprehensive, contemporary, cosmopolitan enumeration and description of species of Cyperaceae, and such comprehensive accounts of most cyperaceous genera do not exist. Furthermore, there is still considerable disagreement about taxonomic limits and circumscriptions of many genera. Consequently, estimates of numbers of taxa (genera/species) vary considerably: ca. 70/ca. 4000 (Cronquist, 1981); 98/4350 (Mabberley, 1997); 104 genera/5000+ (Goetghebeur, 1998); ca. 100/ca. 5000 (Ball et al., 2002). For example, there is little consensus about the circumscription of *Cyperus*, i.e., whether it should be defined broadly to include *Diclidium* Schrad. ex Nees, *Juncellus* C. B. Clarke, *Kyllinga*, *Mariscus* Vahl, *Pycreus* P. Beauv., and *Queenslandiella* Domin with infrageneric rank, or whether it should be defined narrowly with the segregates treated as genera. This problem has major implications with respect to nomenclature in *Cyperus*, the most important genus of weeds in the family (Carter & Bryson, 2000a). Use of molecular techniques (e.g., Muasya et al., 2000a, b) should help to stabilize nomenclature by resolving the taxonomic status and rank. However, until such basic problems are resolved through additional research and alignment of nomenclature, we think a conservative approach is warranted. Herein where possible, nomenclature at the generic level follows the recently published *Flora of North America*, volume 23. However, in the absence of a synonym under *Cyperus*, one species, *Pycreus decumbens* T. Koyama, reported as a weed in Brazil by Kissmann (1997), was not listed in Appendix 2. *Cyperus decumbens* Govind., the name for a different species from India published in 1973, prevents legitimate transfer of the name under *Cyperus*.

Based upon a survey of more than 60 publications, Appendix 2 is a worldwide list that includes 449 species of Cyperaceae that have been cited as weeds. Additionally, we have included other sedges indigenous to the southeastern U.S.A. that we have observed to be weeds. Table 3 summarizes numbers of weedy species by genus. *Cyperus* is by far the

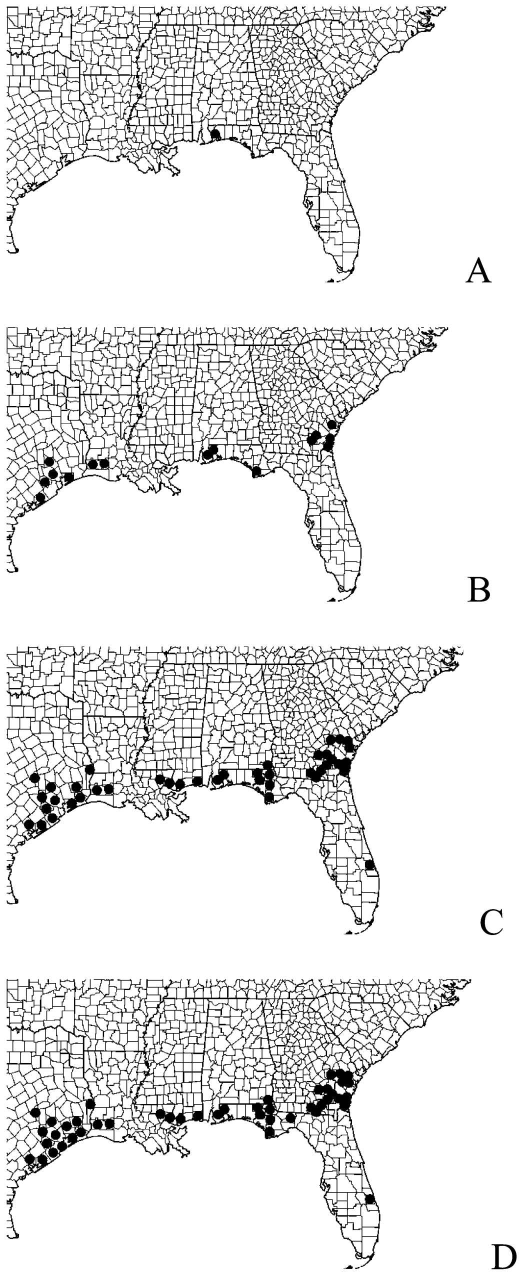


Figure 4. The dispersal of *Cyperus entrerianus* Boeckeler in the U.S.A. —A. 1941–1979. —B. 1941–1989. —C. 1941–1999. —D. 1941–2003.

largest genus with more than 147 species or 33% of the total, followed by *Carex* with 82 species and 18%, *Eleocharis* with 53 species and 12%, *Fimbristylis* with 46 species and 10%, and *Scleria* P. J. Bergius with 24 species and 5%. *Schoenoplectus*, *Rhynchospora*, *Kyllinga*, *Bulbostylis*, *Fuirena*, *Scirpus*, and *Bolboschoenus* had fewer than 5% each, and the remaining 10 genera had fewer than 1% each. Cypereae, which includes *Cyperus*, is the largest tribe of weeds (Fig. 5), and subfamily Cyperoideae, which includes Cypereae, has the overwhelming majority of weedy sedges (Fig. 6).

The previous lists of Holm et al. (1977, 1979, 1997) and WSSA (1989) show a substantially larger proportion of weeds in *Cyperus* (ca. 42%); ca. 43% in *Eleocharis*, *Fimbristylis*, *Scirpus* (incl. *Bolboschoenus*, *Isolepis* R. Br., *Schoenoplectus*); and the remaining 15% in *Carex*, *Cladium*, *Fuirena*, *Kyllinga*, *Rhynchospora* (incl. *Dichromena*, *Psilocarya* Torr.), and *Scleria*. Our survey (Appendix 2) shows a much smaller proportion in *Cyperus* and substantial increases in *Carex* and other genera. Bayer AG (1992) was not used in compiling Appendix 2 because it does not separate weeds from crops and because it is based upon key sources cited in Appendix 2.

ABILDGAARDIA

Abildgaardia is a genus of ca. 15 species distributed mostly in the pantropics and subtropics in both the Eastern and Western hemispheres (Kral, 2002d). Although *Abildgaardia* spp. have been placed in *Bulbostylis* and *Fimbristylis*, embryological and anatomical data support segregation as a separate genus (Lye, 1973). The results of our survey (Appendix 2) show only one species, *A. ovata* (Burm. f.) Kral, cited as a weed, which is reported to be a weed in Asia, North America, and the Pacific Islands (Holm et al., 1979). In southern Florida, U.S.A., it is occasionally a weed of gravelly soils in waste areas, along highways, and in lawns (Carter, pers. obs.).

BOLBOSCHOENUS

Bolboschoenus is a genus of 6 to 15 species (Smith, 2002a), five of which are listed as weeds in Appendix 2. *Bolboschoenus maritimus* (L.) Palla, considered among the world's worst weeds, is a pest in agricultural lands and waterways in Africa, Asia, Australia, Europe, and North and South America (Holm et al., 1997; Kissmann, 1997). It is a troublesome rice weed in paddy fields (Holm et al., 1977, 1997), and in the southern Korean peninsula *B. maritimus* infests more than 80% of rice fields reducing yields by as much as 50% when adequate control

Table 3. Numbers and percentages of cyperaceous weeds by genus (data extracted from Appendix 2).

Genus	Species (infrasp.)	Percent of Total
Cyperus[1]	147 (2)	33
Carex	82	18
Eleocharis	53	12
Fimbristylis	46	10
Scleria	24	5
Rhynchospora	20	4
Schoenoplectus	20	4
Kyllinga	13	3
Bulbostylis	9	2
Fuirena	8	2
Scirpus	8	2
Bolboschoenus	5	1
Lipocarpha	4	< 1
Cladium	2	< 1
Abildgaardia	1	< 1
Courtoisina	1	< 1
Isolepis	1	< 1
Lepidosperma	1	< 1
Lepironia	1	< 1
Mapania	1	< 1
Oxycaryum	1	< 1
Scirpodendron	1	< 1
Total	449 (2)	100

[1] Includes *Diclidium*, *Juncellus*, *Mariscus*, *Pycreus*, and *Queenslandiella*.

measures are not taken (Ryang et al., 1978). Integrated weed management schemes, including rotation of crops, water regimes, and chemical and cultural methods, effectively control *B. maritimus* in rice-producing areas of Asia (De Datta & Jereza, 1976; Verga et al., 1977). *Bolboschoenus maritimus* is less a problem in the equatorial zone than in semitropical and temperate regions of the world (Holm et al., 1997). The achenes of *B. maritimus* are readily dispersed by birds (Holm et al., 1997) and by water (Guppy, 1893). *Bolboschoenus fluviatilis* (Torr.) Soják is reported as an aquatic weed in Asia, Australia, and North America (Holm et al., 1979; WSSA, 1989).

BULBOSTYLIS

Bulbostylis is a genus of ca. 100 species, occurring mostly in dry or periodically dry, sunny, sandy uplands and savannas in warm temperate and tropical regions worldwide (Kral, 2002c). Nine species are listed as weeds in Appendix 2; however, none is a major weed. *Bulbostylis barbata* (Rottb.) C. B. Clarke and *B. capillaris* (L.) C. B. Clarke are occasionally weeds of sandy soil in flowerbeds and poorly managed turf in the southeastern U.S.A. In late summer and fall in the Coastal Plain of the southeastern U.S.A., *B. barbata* can be a conspicuous feature of the landscape when en masse its reddish brown inflorescences appear in sandy cultivated fields (Kral, 1971). *Bulbostylis capillaris* and *B. ciliatifolia* (Elliott) Fernald are common weeds of sandy fallow fields, roadsides, and on gravel and cinders of railroad right-of-ways (Kral, 1971; Godfrey & Wooten, 1979). All three species often grow in sandy soil in flowerbeds and lawns or through cracks in sidewalks and parking lots. *Bulbostylis barbata* is reported as a weed of cultivated lands in Taiwan (Lin, 1968), and *B. capillaris* is reported as a weed in Brazil (Kissmann, 1997).

CAREX

Of the more than 2000 species worldwide (Ball & Reznicek, 2002), only a small proportion of *Carex* spp. are major weeds when compared to other sedge groups (e.g., *Cyperus*, *Kyllinga*). Although not among the most troublesome weeds of rice, *Carex diandra* Schrank and *C. pycnostachya* Kar. & Kir. are reported from rice field habitats in Pakistan (Kukkonen, 2001). Very few *Carex* spp. are invasive, and none is a principal agricultural weed (Holm et al., 1977), which may be due to several factors including more restrictive habitat requirements, fewer or larger seeds, shorter period of sexual reproduction, fewer vectors for dispersal, lack of tolerance to mowing or tillage, and greater susceptibility to herbicides. In Appendix 2, 82 species of *Carex* are listed as weeds.

Carex blanda Dewey and *C. leavenworthii* Dewey are occasional weeds of poorly kept lawns, especially under shade of deciduous trees in the southeastern U.S.A. (Bryson, 1985a). *Carex blanda* is often locally abundant and capable of being weedy in diverse environmental and edaphic conditions (Bryson & Naczi, 2002). It is highly likely that *C. blanda* and other weedy *Carex* species are dispersed as contaminates of grass seed, sod, or clippings for turf establishment (Jones et al., 1993). In lawns and on golf courses, *C. blanda* and *C. leavenworthii* are controlled by frequent mowing and herbicide treatments (Bryson, 1985a). Listing of *C. cephalophora* Muhl. ex Willd. as a weed (Callahan et al., 1995) may be due to taxonomic confusion with *C. leavenworthii* and literature that considered the two taxa conspecific. Another occasional lawn weed, *C. cherokeensis* Schwein., is a weed of pastures (Burns & Buchanan, 1967; Burns et al., 1969; Bryson, 1985a). In the Black Prairie and Lower Coastal Plains regions of Alabama, *C. cherokeensis* is reported to displace desirable forage species in poor quality pastures (Burns & Buchanan, 1967; Burns et al., 1969). *Carex cherokeensis* persists and spreads in the early spring or late fall by extensive rhizomes when many pasture grasses are dormant. It is more prevalent in poorly managed pastures lacking herbicide applications, and mowing alone is not effective in *C. cherokeensis* control.

Carex longii Mack. is weedy along roadsides and in lawns and flowerbeds (Bryson, 1985a). Unlike most *Carex*, *C. longii* flowers and fruits throughout the frost-free months. Frequently in the southeastern U.S.A., establishment of this species occurs following dispersal of pine bark mulch around shrubs and in flowerbeds suggesting contamination by *C. longii* seeds. From flowerbeds, *C. longii* can invade surrounding areas; however, it is not as aggressive as several invasive *Cyperus* and *Kyllinga* spp. in lawns, turf, gardens, and row crops (Bryson, pers. obs.). Listing of *C. albolutescens* Schwein. as a weed (WSSA, 1989) may be due to taxonomic confusion recently clarified by Rothrock (1991). Although *C. albolutescens* may be locally common, it is not weedy along roadways and in lawns, pastures, and flowerbeds like *C. longii*.

Non-native *Carex* species have become invasive weeds in natural areas through accidental introduction or escape from cultivation as ornamentals. On sandy beaches and dunes, *C. kobomugi* Ohwi, native to Japan, has become an invasive weed along Atlantic coasts (Standley, 1983). It was first collected in the U.S.A. in 1929 (Fernald, 1930), but at that time, it was misidentified as the closely related species *C. macrocephala* Willd. ex Spreng. Since 1929, *C. kobomugi* has spread on sandy beaches from Rhode Island southward to North Carolina and displaced native vegetation and altered the structure of beaches (Small, 1954; Svenson, 1979; Stalter, 1980; Standley, 1983). Its range is likely to expand (Mastrogiuseppe, 2002) despite current eradication efforts in several states. Following introduction as an ornamental, *C. pendula* has recently escaped into natural areas and is beginning to appear on roadsides and stream banks; however, its potential as an invasive weed is unknown (Reznicek, 2002).

Some *Carex* species native to one region of a continent have become weedy in other regions of the same continent. Northern and eastern records of *C. oklahomensis* are most recent, and this sedge may be increasing its range (Standley, 2002). Because *C. oklahomensis* has been frequently collected from recently completed construction sites, it is probably dispersed in hay mulch used for erosion control along roadsides, lakesides, and ditch banks (Bryson et al., 1992a, 1996). *Carex opaca* (F. J. Herm.) P. Rothr. & Reznicek appears to be similarly dispersed (Bryson et al., 1994b).

Seeds and rhizomes of *Carex praegracilis* are dispersed along highways by traffic and by construction and maintenance equipment, and it is sometimes called “tollway sedge” or “freeway sedge” (Swink & Wilhelm, 1979; Bruton & Catling, 1982). *Carex praegracilis* is adapted to extreme environmental conditions (e.g., salty or dry roadsides) and is spreading rapidly eastward and southward from its native range, especially along roadsides where salt is applied for deicing (Reznicek et al., 1976; Bruton & Catling, 1982; Cusick, 1984; Reznicek & Catling, 1987, 2002).

Carex nebrascensis Dewey is listed as a weed (WSSA, 1989; Callahan et al., 1995); it was apparently introduced into Missouri and Illinois, U.S.A., and has become weedy along roadsides (Standley et al., 2002). Heavy infestations of *C. lanuginosa* Michx. were effectively controlled by herbicides, and tillage provided better control of this sedge in light (sandy) soils than in heavier (silt or clay) soils in New Mexico, U.S.A. (Hollingsworth, 1969).

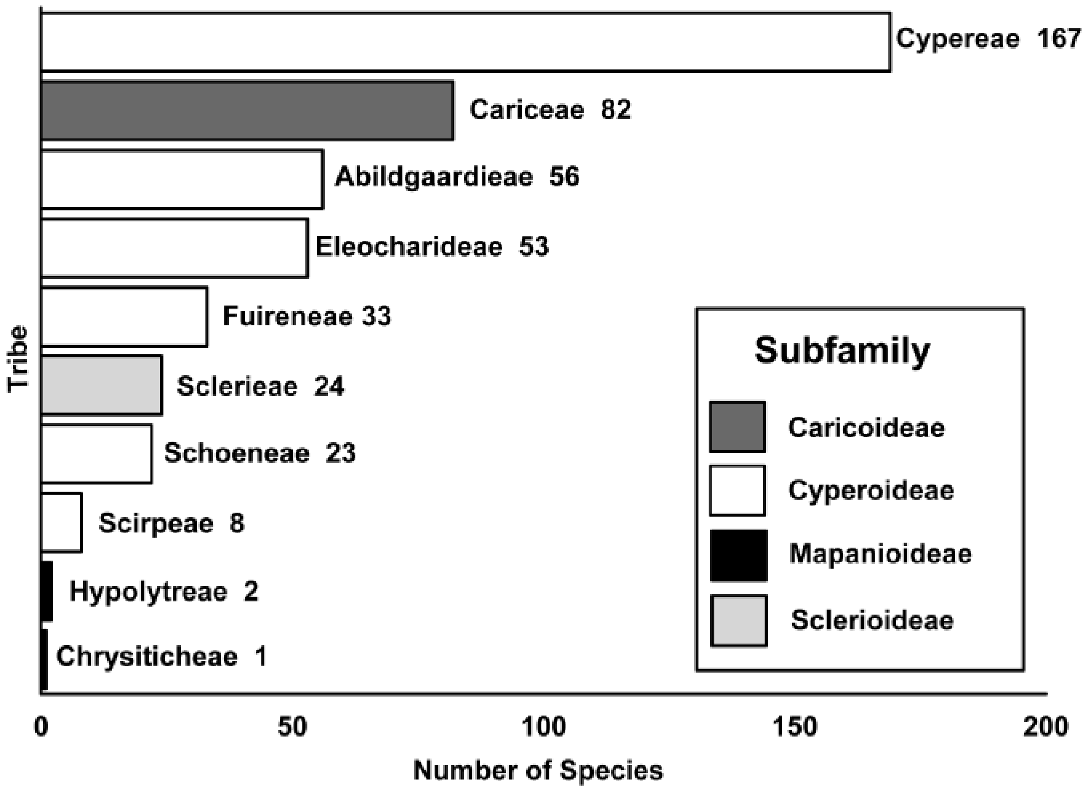


Figure 5. Number of cyperaceous weeds by tribe; classification follows Goetghebeur (1998).

Carex aquatilis Wahlenb., *C. atherodes* Spreng., *C. glaucescens* Elliott, *C. frankii* Kunth, *C. lacustris* Willd., *C. lasiocarpa* Ehrh., *C. louisianica* L. H. Bailey, *C. pallescens* L., *C. rostrata* Stokes in With., *C. senta* Boott, and *C. verrucosa* Muhl. are listed as weeds by the WSSA (WSSA, 1989), while *C. lupulina* Muhl. ex Willd. is listed as a weed by WSSA (1989) and Callahan et al. (1995). *Carex comosa* Boott is considered weedy by Callahan et al. (1995). The U.S. Fish and Wildlife Service (USFWS) (1988) lists *C. comosa* as an obligate wetland species. According to Bernard and Seischab (1994), *C. comosa* invades gaps in wetlands and persists for up to a decade while producing seeds that are dispersed into new gaps. Treated in *Flora of North America* as distinct from *C. frankii*, *C. aureolensis* Steud. (Ford & Reznicek, 2002) is weedy in the southeastern U.S.A. in pastures and along wet roadsides and agricultural field borders. *Carex heterostachya* Bunge and *C. rigescens* (Franch.) V. Krecz. are reported as weeds in China along roadsides and field borders or in orchards and nursery gardens (Zhirong et al., 1990).

CLADIUM

There are four species of *Cladium* worldwide with three in North America (Tucker, 2002a), of which two, *C. jamaicense* Crantz and *C. mariscoides* (Muhl.) Torr., are cited as weeds (Holm et al., 1979; WSSA, 1989). Both of these wetland species occur in the U.S.A. *Cladium jamaicense* (saw grass) inhabits marshes near the coast and is the predominant species of the Everglades marshes of southern Florida, U.S.A. (Steward & Ornes, 1975; Godfrey & Wooten, 1979). Much of this formerly vast marshland has been drained for flood control and converted into agricultural fields for the cultivation of sugarcane and other crops (Godfrey & Wooten, 1979). In such an altered and unnatural landscape, *C. jamaicense* is viewed as an impediment to drainage and navigation and a hindrance to agriculture.

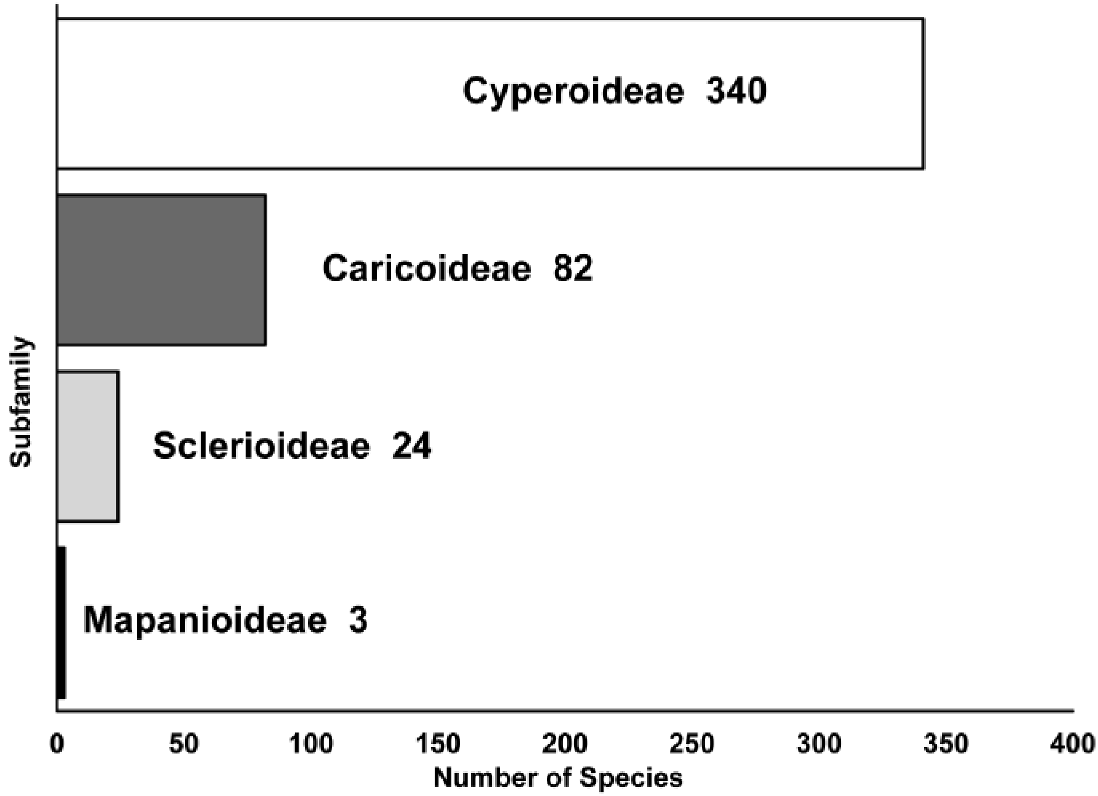


Figure 6. Number of cyperaceous weeds by subfamily; classification follows Goetghebeur (1998).

However, a massive venture is currently underway (U.S. Army Corps of Engineers, 1999) to reverse the damage done by drainage projects of the past and to reclaim portions of the Everglades ecosystem, which if successful will also restore the natural habitat of *C. jamaicense*, taking it from weed to its former status as the predominant plant of its natural community. Weediness is oftentimes an artifact of human perception and folly.

COURTOISINA

Courtoisina Soják is a small genus of two species found in Africa, Madagascar, India, and southeastern Asia (Haines & Lye, 1983; Gordon-Gray, 1995; Vorster, 1996; Mabberley, 1997). *Courtoisina cyperoides* (Roxb.) Soják was cited as a weed in rice fields (Simpson & Koyama, 1998; Simpson & Inglis, 2001) and has also been reported from wet mud of freshwater pans, seasonally wet grasslands, and temporary pools (Haines & Lye, 1983; Gordon-Gray, 1995).

CYPERUS

There are about 600 species of *Cyperus* worldwide (Tucker et al., 2002). In terms of their significance as weeds, *Cyperus* species are by far the most important in Cyperaceae. Appendix 2 lists 147 species of *Cyperus* that have been cited as weeds. The adverse economic impact of *Cyperus* is great. According to Holm et al. (1977), it contains the world's worst weed and three additional species listed among the 33 worst agricultural weeds in the world. The most recent comprehensive, universal treatment of *Cyperus* was by Kükenthal (1935–1936), who defined the genus broadly as consisting of six subgenera: *Cyperus*, *Mariscus* (Vahl) C. B. Clarke, *Torulinium* (Desv.) Kük., *Juncellus* (C. B. Clarke) C. B. Clarke, *Pycreus* (P. Beauv.) A. Gray, and *Kyllinga*. *Cyperus* is taxonomically complex, and the status of its subgenera is widely disputed even among contemporary workers (cf. Kern, 1974; Haines & Lye, 1983; Koyama, 1985; Lye, 1992; Wilson, 1993; Adams, 1994; Gordon-Gray, 1995;

Muasya et al., 2000a, b, 2002; Tucker et al., 2002). Although we question the apparent inconsistency in segregating *Kyllinga* and not *Pycreus* and *Juncellus*, herein we pragmatically adopt the generic taxonomy in *Flora of North America*, Vol. 23 (Tucker et al., 2002). Recent molecular evidence seems to support a broad circumscription of *Cyperus* to include *Kyllinga*, *Pycreus*, and other segregate genera (Muasya, 2002).

To varying degrees, the following characteristics undoubtedly contribute to the aggressive, invasive tendencies of *Cyperus* spp. and other sedges: large numbers of small, readily dispersed achenes; vegetative reproduction; longevity of tubers, rhizomes, or other subterranean structures; production of allelopathic compounds; paucity of pathogens; short life reproductive cycle, especially in annual species; tolerance of broad ranges of environmental conditions; C_4 photosynthesis; and resistance to control with herbicides and cultural methods, including tillage.

Cyperus rotundus is considered the world's worst weed because of its ability to survive, spread, and compete, especially in agricultural areas (Holm et al., 1977; Terry, 2001). It was reported in 52 crops and 92 countries (Holm et al., 1977, 1979, 1997). In the U.S.A., Elliott (1821) described *C. rotundus* (*C. hydra* Michx.) as a "scourge" of plantations in Georgia and South Carolina and recommended daily tilling of the soil for control. The infraspecific taxonomy of this cosmopolitan weed is extremely complex and in need of revision (cf. Kükenthal, 1935–1936). In addition to threatening agriculture, *C. rotundus* is a troublesome weed in urban areas and natural communities after disturbance. Although it rarely sets viable seeds (Holm et al., 1977; Thullen & Keeley, 1979), *C. rotundus* produces numerous rhizomes that reportedly can penetrate and grow through fleshy subterranean organs of root crops and even asphalt pavement (Hauser, 1962a, b; Thullen & Keeley, 1979). These rhizomes form tubers that give rise to new aerial plants or produce other rhizomes or they may remain dormant during periods of adverse environmental conditions including heat, cold, drought, flooding, or inadequate aeration (Ranade & Burns, 1925; Williams, 1978; Bendixen & Nandihalli, 1987; Wills, 1987; Miles et al., 1996). The tubers of *C. rotundus* are bitter, rough, and are often connected serially by rhizomes with or without giving rise to new plants (Plowman, 1906; Ranade & Burns, 1925; Hauser, 1962a; Wills & Briscoe, 1970; Holm et al., 1977; Wills, 1987). Dormant tubers make *C. rotundus* difficult to control in turf, and only a few selective herbicides that effectively control sedges are approved for use in turf or in row crops (Aleixo & Valio, 1976; Keeley, 1987; Pereira et al., 1987; Holt & Orcutt, 1996). Tubers and rhizomes of *C. rotundus* produce allelopathic compounds that reduce growth in crops such as cotton (Martinez-Diaz, 1997).

Diagnostic features of *Cyperus rotundus* include abruptly tapering leaves, inflorescence bracts equaling or longer than the inflorescence, and purplish floral scales (Wills & Briscoe, 1970; Horowitz, 1972; Wills, 1987). In a comparative study of *C. rotundus* morphology based on collections from 13 states in the U.S.A. and 21 locations from around the world, Wills (1998) detected differences in numbers of shoots produced by single tubers, numbers of leaves per shoot, lengths and widths of leaves, lengths of culms, flowering times during the year, numbers and lengths of rachises, lengths of rachillae and spikelets, and numbers, lengths, and widths of involucral bracts. Infraspecific variation in *C. rotundus* is also documented in Ceylon (Koyama, 1985), East Africa (Haines & Lye, 1983), and Natal Province (now KwaZulu-Natal Province), South Africa (Gordon-Gray, 1995). Although these differences occurred within some traits on a worldwide basis, the basic characteristics distinguishing *C. rotundus* from other taxa were consistent (Wills, 1998) and differed from closely related taxa such as *C. bifax* C. B. Clarke. Worldwide, *C. rotundus* is a troublesome weed in corn (*Zea mays* L.), cotton, peanut (*Arachis hypogaea* L.), rice, sorghum (*Sorghum vulgare* Pers.), soybean, sugarcane (*Saccharum officinarum* L.), turf grass species, and many other vegetable, nursery, row, rotation, and plantation crops (Long et al., 1962; Bryson, 1985b; Bendixen & Nandihalli, 1987; Holt & Orcutt, 1991; Derr & Wilcut, 1993; Grichar et al., 1992; Wills, 1998; Bryson et al., 2002, 2003b).

Cyperus esculentus is ranked as the world's 16th worst weed (Holm et al., 1977). Highly variable and widely distributed in tropical, subtropical, and temperate regions around the world, its infraspecific taxonomy was revised by Schippers et al. (1995). Schippers et al. (1993) attribute invasiveness in *C. esculentus* to an increase in the rate of population growth brought about by tillage. *Cyperus esculentus* has rhizomes and tubers (Thumbleson & Kommedahl, 1961; Jansen, 1971; Stoller et al., 1972); however, its rhizomes are fleshy and terminate in a sweet-tasting tuber (Garg et al., 1967). Additional diagnostic characters include gradually tapering, acute leaves, yellow to yellowish orange floral scales, and bracts longer than the inflorescence. *Cyperus esculentus* is pernicious and difficult to control in agricultural and urban areas. Although it produces seeds more frequently than *C. rotundus* (Wills, 1987), *C. esculentus* reproduces primarily from tubers (Thumbleson & Kommedahl, 1961). *Cyperus esculentus* tubers remain dormant for prolonged periods during adverse environmental conditions and only produce tubers from rhizomes of the parent plant (Wills, 1987). *Cyperus esculentus* is able to survive colder winter conditions than *C. rotundus* and thus is more widespread worldwide (Stoller & Sweet, 1987; Wills, 1987). The tubers of *C. esculentus* are called chufas, tiger nuts, or rush nuts (Abad et al., 2000; DeFelice, 2002). *Cyperus esculentus* is often planted for its tubers that provide food for deer, turkey, wild hogs, and other animals (Miller & Miller, 1999; Abad et al., 2000; DeFelice, 2002). Humans also use the tubers as food for domesticated animals (e.g., chickens, swine) and directly consume them as food, use them as a spice, and use them to prepare a drink called "horchata de chufas" (Zeven & Zhukovsky, 1975; Darby et al., 1977; Allan, 1978; DeFilipps, 1980c; Negbi, 1992; Stephens, 1994; Bryson et al., 1998). Unfortunately, the tubers used by humans contribute to the invasive character of *C. esculentus* and to its dispersal. In addition to the crops mentioned above for *C. rotundus*, *C. esculentus* is also a principal weed of potato (*Solanum tuberosum*), sugarbeet (*Beta vulgaris* L.), and many cool-season crops (Bendixen & Nandihalli, 1987).

Cyperus difformis and *C. iria* are ranked 32nd and 33rd among the world's worst weeds, respectively (Holm et al., 1977). Both are caespitose annuals and often produce clumps of many culms and have become established in tropical and temperate areas of the world. In the southeastern U.S.A., *C. difformis* and *C. iria* are primarily weeds of drainage ditches, rice fields, and poorly drained sites in other agricultural fields or disturbed areas. *Cyperus difformis* and *C. iria* produce multiple generations per year under optimal growing conditions and in the tropics flower and produce seeds year-round (Holm et al., 1977). *Cyperus difformis* can complete its life cycle every four to six weeks throughout the growing season (Holm et al., 1977). A single plant of *C. iria* may produce more than 5000 viable seeds, while an individual of *C. difformis* can produce 50,000 seeds with a germination rate of 60% or more (Jacometti, 1912). Short generation times and high seed production favor rapid dispersal (Vaillant, 1967), large seed reservoirs in the soil, high population levels (Holm et al., 1977; Bryson, 1984), and an increased potential for the development of herbicide resistance. In rice-production areas of California, multiple *C. difformis* generations per year and large seed production may be primary factors in the rapid development of herbicide resistance to bensulfuron (Pappas-Fader et al., 1993, 1994; Hill et al., 1994). Despite similarities in habitat and growth and reproductive patterns, *C. difformis* is C_3 and *C. iria* is C_4 (Hesla et al., 1982).

Cyperus rotundus, *C. esculentus*, *C. difformis*, and *C. iria* are all suspected to have originated in Asia. Other *Cyperus* spp. of probable Asian origin include *C. compressus*, *C. haspan*, *C. pilosus*, and *C. sanguinolentus* (Holm et al., 1979). All are naturalized weeds in other regions of the world (Bryson & Carter, 1995; Carter & Bryson, 2000b).

Cyperus haspan is among the world's worst weeds (Holm et al., 1997). It has been reported as a weed in 12 crops and 39 countries throughout tropical and semitropical areas of Africa, Asia, Australia, South America, and North America (Lin, 1968; Holm et al., 1977, 1979; Kissmann, 1997). *Cyperus haspan* is a recent introduction into Hawaii with the first collection made in 1957 (Wagner et al., 1990). An individual plant can produce more than 50,000 achenes per year (Datta & Banerjee, 1976), and although plants produce achenes during the first season of growth, they do not form rhizomes until the second year (Tadulingam & Venkatanaryana, 1955). *Cyperus haspan*, a C_3 plant, commonly occurs in shallow standing water and germinates and grows well in wet, sandy, acidic soils (Bertels, 1957; Eyles & Robertson, 1963; Dirven, 1970). *Cyperus haspan* is sometimes broken into two subspecies; *C. haspan* subsp. *juncoides* (Lam.) Kük. is a taller plant with conspicuous rhizomes (Kükenthal, 1935–1936; Kern, 1974; Koyama, 1985). *Cyperus haspan* is sometimes confused with closely related *C. tenuispi-*

ca Steud., a species with more widely spaced floral scales, and both species are cited as frequent weeds in rice fields in Asia (Kern, 1974; Koyama, 1985).

Cyperus entrerianus is native to temperate regions of South America; it is also known from the Caribbean, Mexico, and the Coastal Plain of the southern U.S.A. (Kükenthal, 1935–1936; Barros, 1960; Carter, 1990; Tucker, 1994). In his comprehensive revision of *Cyperus*, Kükenthal (1935–1936) accorded specific rank to *C. entrerianus*; however, Barros (1960) reduced it to varietal status under *C. luzulae* (L.) Rottb. ex Retz., and Denton (1978) gave it no rank, treating it as a synonym of *C. luzulae*. Carter (1990) and subsequent authors (Tucker, 1994; Tucker et al., 2002) treated this taxon at the rank of species. In the southeastern U.S.A., flooding, construction equipment, mowing, and soil-moving activities, especially along highways, disperse the small achenes of *C. entrerianus*, resulting in infestations in a variety of disturbed habitats (Carter, 1990; Carter & Bryson, 1996). *Cyperus entrerianus* displaces native vegetation even in undisturbed habitats, and, without widespread control, it will likely continue to spread rapidly, infesting agricultural, forested, riparian, and urban areas. Figure 4 shows the dispersal of *C. entrerianus* in the U.S.A., where by 2003 it was documented in 43 counties from Florida and southern Georgia into southeastern Texas. In the southern U.S.A., *C. entrerianus* reproduces copiously from achenes and spreads vegetatively and perennates from short rhizomes. *Cyperus entrerianus* is a prolific seed producer, with the number of seeds per inflorescence ranging from 1000–20,000+ depending on the size and maturity of plants and mature plants (> 1 year old) producing 10–100+ inflorescences per year (Carter & Bryson, 1996; Bryson et al., 2003a). Preliminary seed germination studies indicate moderate to high viability (55%–95%) (Carter & Bryson, 1996). In the southeastern U.S.A., *C. entrerianus* flowers and fruits from June until frost in November or December (Carter, 1990; Carter & Jones, 1991; Bryson & Carter, 1994). *Cyperus entrerianus* continues to spread at an alarming rate and threatens agricultural and natural areas. Also, preliminary studies suggest that populations will potentially spread northward into Arkansas, North Carolina, South Carolina, Tennessee, and Virginia. Additional research is needed to determine more effective methods of prevention and control.

Cyperus acuminatus Torr. & Hook., *C. eragrostis*, *C. luzulae*, *C. ochraceus*, *C. pseudovegetus*, *C. reflexus*, *C. surinamensis*, and *C. virens* are cited as weeds (Appendix 2) and are classified with *C. entrerianus* in *Cyperus* sect. *Luzuloidei* Kunth (Kükenthal, 1935–1936; Denton, 1978). *Cyperus acuminatus*, *C. pseudovegetus*, and *C. virens* are all native to North America, where they are currently relatively minor weeds; however, they could become problems if introduced beyond their native ranges. *Cyperus pseudovegetus* is widely distributed in eastern North America (Denton, 1978; Tucker et al., 2002). In the U.S.A., *C. pseudovegetus* and *C. virens* are common in disturbed, intermittently wet soils, e.g., roadside ditches, margins of ponds, and swales in fields, pastures, and grasslands. *Cyperus virens* is widely distributed in the New World, ranging from South America, Central America, the Caribbean Islands, Mexico, and the southern U.S.A. (Denton, 1978), and is recently introduced into Hawaii with the first collection made in 1976 (Wagner et al., 1990). Several infraspecific taxa have been recognized (Denton, 1978), including *C. virens* var. *drummondii*. Carter et al. (1999) showed that *C. drummondii* is specifically distinct from *C. virens* and in the southeastern U.S.A. has a more restricted distribution and habitat and is less weedy than *C. virens*. *Cyperus reflexus* occurs in temperate South America, Central America, Mexico, and in the U.S.A. (Denton, 1978; Tucker, 1994). It is introduced in Australia, where it is naturalized near Sydney (Wilson, 1993). In the U.S.A., *C. reflexus* is most common in southeastern Texas and Louisiana, where it is found in intermittently wet, disturbed soils of ditches, fields, and grasslands (Denton, 1978; Carter, pers. obs.); it has also been reported in western Florida (Wunderlin, 1998). Additional research is needed to elucidate the relationship between *C. fraternus* Kunth and *C. reflexus*, which has been treated as *C. reflexus* var. *fraternus* (Kunth) Kuntze (Kükenthal, 1935–1936; Denton, 1978). *Cyperus ochraceus* is widespread in the New World and is known from South America, Central America, Mexico, the U.S.A., and the Caribbean Islands (Denton, 1978). It is currently only a minor weed in the southern U.S.A., where it is found in disturbed, intermittently wet soils and is most common in Texas and Louisiana but has dispersed to scattered sites elsewhere (Denton, 1978; Tucker et al., 2002; Carter, pers. obs.).

Cyperus surinamensis is widely distributed in the New World, ranging from South America, Central America, Mexico, and the Caribbean Islands into southeastern and south-central U.S.A. (Denton, 1978). Readily identified by its retrorsely scabrid culms, *C. surinamensis* has been cited as a weed in both North and South America (WSSA, 1989; Kissman, 1997). In warmer parts of the southeastern U.S.A., it is a common weed in a variety of open disturbed sites with hydric soils.

Cyperus eragrostis occurs naturally in South America and in California, Oregon, Washington, and British Columbia in North America (Denton, 1978). It has been used ornamentally, which in part accounts for its introduction into other parts of the world (Tucker, 1987; Sell & Murrell, 1996; Darke, 1999; Petřík, 2003). It occurs sporadically in the eastern U.S.A., where it is introduced and appears to be spreading (Bryson & Carter, 1994; Bryson et al., 1996; Tucker et al., 2002). *Cyperus eragrostis* is naturalized in Australia and has expanded its range and frequency there, where it is a weed of rice and ephemerally wet, disturbed sites (Wilson, 1993). In reporting *C. eragrostis* new to the Czech Republic, Petřík (2003) provides a thorough account of its invasion of Europe, where it is widely distributed and has been known since the mid-1800s. Given its association with rice as a weed in Australia, *C. eragrostis* could become a problem in rice agriculture in the southeastern U.S.A. and elsewhere. Additional research is needed to determine more about the distribution and dispersal of *C. eragrostis*, its potential to become an agricultural pest, and its control.

Cyperus oxylepis Nees ex Steud. and *C. elegans* L. are widely distributed in tropical, subtropical, and warm temperate regions of the New World. Both species have viscid foliage and are markedly aromatic, with the fragrance of cedar wood (*Juniperus virginiana* L.) sometimes sensed in the field before the plants are seen. The floral scales of *C. oxylepis* are golden brown and those of *C. elegans* are greenish tan. *Cyperus oxylepis*, listed as a weed (WSSA, 1989), is apparently expanding its range in coastal areas of the southeastern U.S.A. (O'Neill, 1938b; Thieret, 1964; Tucker, 1987; Bryson & Carter, 1992; Bryson et al., 1996), where it is found in disturbed clay soils of salt marshes.

A number of aquatic *Cyperus* species cultivated in ponds and water gardens have become naturalized. All have the potential to become invasive weeds in aquatic and wetland habitats in tropical and subtropical areas, and at least one, *C. prolifer*, is invasive in the U.S.A. (Carter et al., 1996). Trade and importation of these species should be carefully regulated to prevent further impact. *Cyperus alternifolius* subsp. *flabelliformis* has been used as an ornamental in water gardens and as a potted plant for more than 200 years (Bailey & Bailey, 1976) and is widely naturalized from cultivation in the tropics and subtropics and other warm areas (Bailey, 1935, 1949; O'Neill, 1946; Kern, 1974; DeFilipps, 1980c; Koyama, 1985; Wagner et al., 1990; Sell & Murrell, 1996). It has been variously known as *C. alternifolius* subsp. *flabelliformis* Kük.; *C. flabelliformis* Rottb., nom. illeg.; and *C. involucratus* Rottb. In the U.S.A. it is naturalized in Florida, Louisiana, Texas, and California, where it is occasionally found in moist to hydric soils of roadside ditches, stream banks, vacant lots, and other disturbed sites (Carter, pers. obs.; Tucker et al., 2002). In his worldwide monograph of *Cyperus*, Kükenthal (1935–1936) recognized two subspecies: *C. alternifolius* subsp. *alternifolius* and *C. alternifolius* subsp. *flabelliformis*. Baijnath (1975) treated these as species and stated that *C. alternifolius* is rare and mostly restricted to Madagascar where it is native and that *C. involucratus* [= *C. alternifolius* subsp. *flabelliformis*] is the correct name for the widely naturalized cultivated plant indigenous to Africa. More recently, Gordon-Gray (1995) adopted Kükenthal's taxonomy, indicating the need for additional critical investigation of this complex in southern Africa, which also includes the related cultivated aquatics *C. sexangularis* and *C. textilis*. Until further research elucidates the relationships among these taxa, we have adopted the more conservative taxonomy of Kükenthal (1935–1936) and Gordon-Gray (1995), recognizing two subspecies within *C. alternifolius*. Although popular in water gardens in southern Africa, *C. sexangularis* survives under drier conditions in the absence of extended water stress (Gordon-Gray, 1995), and *C. textilis* is naturalized in the Azores (DeFilipps, 1980c). Thus, it would appear that *C. alternifolius*, *C. sexangularis*, and *C. textilis* have the potential to become invasive pests in a variety of aquatic, wetland, and terrestrial habitats in tropical and subtropical regions.

Cyperus prolifer is sold as an ornamental for water gardens (Bailey & Bailey, 1976; Simpson, 1994) and has been variously listed as *Cyperus has-*

pan cv. 'viviparus' (Watkins & Sheehan, 1975; Graf, 1985), *C. papyrus* cv. 'nanus' (Bailey & Bailey, 1976), and *C. isocladus* Kunth (Bailey & Bailey, 1976; Everett, 1980–1982). It has been confused with *C. haspan*, from which it is readily distinguished by its thick rhizome and inflorescence of 50 to 100 rays of more or less uniform length. *Cyperus prolifer* is indigenous to eastern Africa where it inhabits marshes, marshy shores, and swampy stream banks (Kükenthal, 1935–1936; Haines & Lye, 1983). Although Simpson (1994) stated that it was not a weed, *C. prolifer* has become naturalized from cultivation in the U.S.A. in central Florida where it has invaded the margins of lakes (Carter et al., 1996) and in Hawaii (Strong & Wagner, 1997). In Florida, *C. prolifer* grows in floating mats and along margins of natural limesink lakes, where it is associated with *Oxycaryum cubense* (Carter et al., 1996). One extensive population of *C. prolifer* in Lake Huntley, Florida, was established after dispersing from an adjacent water garden during eight years of cultivation (Carter et al., 1996).

Cyperus papyrus is a remarkable plant. Because of its use in the manufacture of the first paper by the ancient Egyptians, it is perhaps the best known of the sedges (Schery, 1972). It is found in central and southern Africa and the Nile River valley and is naturalized in Sicily (Kükenthal, 1935–1936; DeFilipps, 1980c; Gordon-Gray, 1995). *Cyperus papyrus* forms dense stands in aquatic and wetland habitats and dominates swamps with low biodiversity in northern Uganda (Mabberley, 1997). Plants may grow to 5 m high, making it one of the largest sedges (Koyama, 1985), and it is cultivated as an ornamental and curiosity in greenhouses and outdoors in ponds and water gardens in tropical and subtropical regions of the world (Bailey, 1935, 1949; Bailey & Bailey, 1976). *Cyperus papyrus* is naturalized in Florida, U.S.A. (Wunderlin, 1998), where it is evidently not yet invasive, but would appear to have the potential to invade aquatic and wetland habitats in tropical and subtropical areas given its dominance in swamps of northern Uganda.

Cyperus alopecuroides is a widely distributed aquatic sedge in tropical and subtropical regions of the Old World, e.g., northern and tropical Africa, Madagascar, India, Ceylon, Indo-China, Malaysia, and northern Australia; in the New World it is known only from Guadeloupe in the West Indies and Florida, U.S.A. (Kükenthal, 1935–1936; Koyama, 1985; Carter et al., 1996). It is a robust plant to 1.5 m high and in its habit and general inflorescence pattern resembles the tropical species *C. imbricatus* Retz. Both taxa were placed in section *Exaltati* Benth. by Kükenthal (1935–1936). Its size in combination with other characters make *C. imbricatus* a striking plant in the field: broad bracts and leaf blades (to 15 mm wide) with contrasting surfaces (adaxial light green, abaxial glaucous), and a branched inflorescence with spikes of densely clustered golden-brown spikelets (Carter et al., 1996). Although it seems to be more clearly allied with subgenus *Cyperus* (Kükenthal, 1935–1936; Koyama, 1985), it has characteristics that seem to defy placement there: namely, a bicarpellate gynoecium with two stigmas and a lenticular achene with face adjacent to rachilla. When taken alone, the gynoecium and fruit characteristics seem to indicate a relationship with subgenus *Juncellus* (Clarke, 1908); however, both bi- and trigynous pistils have been found in the same inflorescence (Koyama, 1985), which supports inclusion in subgenus *Cyperus*. In central Florida, where this emergent aquatic sedge was probably introduced with nursery stock used to revegetate a reclamation wetland in an abandoned phosphate pit, *C. alopecuroides* exhibits invasive characteristics, forming extensive stands in shallow water and floating mats (Carter et al., 1996). According to Kantor (1999), *C. alopecuroides* was cultivated by the ancient Egyptians and its inflorescence was widely depicted in one of the characteristic motifs of their decorative art. Additional research on *C. alopecuroides* is needed to understand better its potential for becoming an invasive weed and its phylogenetic relationships.

Cyperus odoratus is widely distributed in tropical and subtropical regions around the world (Kükenthal, 1935–1936; Kern, 1974) and is generally found in disturbed hydric soils and wetlands. It is frequently cited as a weed and has been listed as a pest of rice (Appendix 2). In the southeastern U.S.A., *C. odoratus* is commonly found in wet disturbed sites, e.g., ditches, stream banks, swamps, wetlands, and edges of ponds, but it is not of major economic importance. *Cyperus odoratus* is classified in subgenus *Diclidium* (Schrad. ex Nees) C. B. Clarke [= *Torulinium*] characterized by spikelets that disarticulate into one-fruited segments (Kükenthal, 1935–1936), and its achenes, enclasped within corky rachilla segments, are dispersed by water (Kern, 1974; Haines & Lye, 1983). Jones et al. (1996) recognized several infraspecific taxa of this variable species in North America. In the U.S.A., *C. odoratus* is frequently associated with *C. erythrorhizos* Muhl., which is also listed as a weed (Holm et al., 1979; WSSA, 1989). *Cyperus erythrorhizos*, a widespread annual sedge restricted to North America (Kükenthal, 1935–1936; Tucker et al., 2002), inhabits disturbed hydric soils of wetlands, ditches, stream banks, floodplains, edges of ponds and swamps, swales in fields and pastures, and occasionally rice fields. It is of minor economic importance. *Cyperus digitatus* Roxb. is closely related to *C. erythrorhizos*, but it is perennial and generally a much larger plant. *Cyperus digitatus* is widely distributed in tropical and subtropical regions of both the Eastern and Western hemispheres (Kükenthal, 1935–1936; Kern, 1974; Koyama, 1985) and, as can be seen in Appendix 2, is frequently cited as a weed. Because it is much more wide-ranging and cited as a pest of rice in the Eastern Hemisphere (Kern, 1974), *C. digitatus* is probably of greater economic significance than *C. erythrorhizos*.

Cyperus articulatus L. ranges widely in tropical, subtropical, and warm temperate regions around the world (Kükenthal, 1935–1936). It is a rhizomatous perennial with a reed-like habit, septate culms, and bladeless (usually) leaves. In the southeastern U.S.A., *C. articulatus* occurs near the coast in marshes, ditches, or other open disturbed sites, and populations usually appear as scattered, solitary aerial stems. As shown in Appendix 2, *C. articulatus* is widely reported as a weed (Holm et al., 1979; Kühn, 1982; WSSA, 1989; Kissman, 1997).

Cyperus compressus is widely distributed in tropical, subtropical, and warm temperate regions around the world (Kükenthal, 1935–1936). It is frequently cited as a weed and is found in a variety of habitats disturbed and altered by humans, e.g., waste places, grasslands, lawns, crops, roadsides, fallow rice fields (Ohwi, 1965; Lin, 1968; Kern, 1974; Kühn, 1982; Koyama, 1985; WSSA, 1989; Ravi & Mohanan, 2002). In warmer parts of the southeastern U.S.A., it is a common weed in sandy loam soils of agricultural fields, roadsides, gardens, and other disturbed sites. According to Bailey (1935) and Huxley (1992), *C. compressus* has been cultivated as an ornamental, which probably partly accounts for its wide distribution.

Cyperus pilosus is a weed of tropical, subtropical, and warm temperate areas in Asia, western Africa, and Australia (Kükenthal, 1935–1936; Koyama, 1985; Wilson, 1993) and is commonly cited as a weed of rice (McGivney, 1938; Kern, 1974; Wagner et al., 1990). It has been collected in Hawaii, where it was possibly introduced with rice agriculture, but has not been found there since 1916 (Wagner et al., 1990). *Cyperus pilosus* has been known in the southeastern U.S.A. since 1938, where it was probably introduced through the cultivation of rice (McGivney, 1938; O'Neill, 1938a). In the southeastern U.S.A., it is found in rice fields, wet ditches, and other wet disturbed sites and is apparently spreading, having been reported new to several states in recent years (Burkhalter, 1985; Bryson & Carter, 1992; Tucker et al., 2002). *Cyperus procerus* Rottb. is related to *C. pilosus*. It is known from tropical and subtropical regions of western Africa, India, Asia, Malaysia, and Australia (Koyama, 1985; Wilson, 1993) and has been cited as a weed of rice fields in Asia and western Africa (Hooper & Napper, 1972; Kern, 1974). *Cyperus pilosus* and *C. procerus* share several characteristics that distinguish them from most other *Cyperus* spp.: stoloniferous habit, triquetrous culm, and hispidulous rachis.

Cyperus sphacelatus Rottb. is widely distributed in the tropics and subtropics from eastern Africa, Ceylon, Malaysia, northern Australia (Queensland), Tahiti, South America, Central America, and the Caribbean (Clarke, 1900; Uittien, 1932; Kükenthal, 1935–1936; Haines & Lye, 1983; Tucker, 1983; Koyama, 1985). It is a heliophyte of moist disturbed sites, beaches, riverbanks, fields, and roadsides (Reed, 1977; Tucker, 1983; Carter et al., 1996), and, in Malaysia, *C. sphacelatus* is reportedly a common weed on airstrips (Kern, 1974), which suggests dispersal via air traffic. Mohr (1901) reported *C. sphacelatus* from ballast heaps in Mobile, Alabama, U.S.A., and more recently naturalized populations have been found in southern Florida, U.S.A. (Carter et al., 1996). An analysis of floral scale length on herbarium specimens indicates that the populations in Florida probably originated from the West Indies (Carter et al., 1996). The recent discovery of naturalized populations in peninsular Florida suggests that *C. sphacelatus* is currently undergoing range expansion in the southeastern U.S.A. Field botanists and weed scientists should be vigilant to detect additional populations of this introduced pest, and appropriate governmental agencies should initiate measures to survey for and eradicate populations of *C. sphacelatus* in the U.S.A. before it spreads further. The following combination of characteristics distinguishes *C. sphacelatus* from other *Cyperus* spp.: annual caespitose habit, triquetrous achene, diffuse inflorescence with flattened spikelets, and variegated floral scales pale, nearly white, each with two conspicuous reddish patches.

Cyperus distans L. f. is a pantropical weed of marshes, canal banks, ditches, agricultural crops, and grasslands in Africa, India, Sri Lanka, southeastern Asia, Malaysia, southern China, the Philippines, the Caribbean islands, Central America, Mexico, and tropical South America (Clarke, 1900; Uittien, 1932; Kükenthal, 1935–1936; Koyama, 1985; Adams, 1994; Tucker, 1994). *Cyperus distans* is frequently cited as a weed in the Eastern Hemisphere, where aquatic biotypes are known, and it is a pest of rice fields and grasslands (Appendix 2). It occurs sporadically in the southeastern U.S.A. and has been reported from coastal North Carolina, Georgia, and Florida (Small, 1933; Kükenthal, 1935–1936; McGivney, 1938; Radford et al., 1968; Beal, 1977; Carter et al., 1996). The recent report (Carter et al., 1996) from Florida, U.S.A., suggests that *C. distans* is expanding its range there. The following combination of characteristics distinguishes *C. distans* from other *Cyperus* spp.: rhizomes; scales ascending, remote, with 3- to 5-nerved greenish keels, sanguineous to reddish brown nerveless sides, and with scarious emarginate tips. Field botanists and weed scientists should seek and report additional populations, and appropriate state and federal agencies should undertake eradication measures to ensure early control of this potentially invasive pest in the southeastern U.S.A.

A number of species classified by Kükenthal (1935–1936) in *Cyperus* sect. *Umbellati* C. B. Clarke are listed as weeds in Appendix 2. *Cyperus cyperinus* (Retz.) Suringar and *C. cyperoides* (L.) Kuntze are broadly distributed in warm parts of the Eastern Hemisphere (Kükenthal, 1935–1936; Kern, 1974). *Cyperus cyperoides* is introduced in the West Indies (Kükenthal, 1935–1936; Kern, 1974), and *C. cyperinus* has been reported as a wool alien in Great Britain (Sell & Murrell, 1996). Both species have frequently been cited as weeds (Appendix 2). The variation within these species is complex and poorly understood, with numerous infraspecific taxa recognized, and the synonymy is formidable (cf. Kükenthal, 1935–1936; Kern, 1974; Haines & Lye, 1983; Koyama, 1985). No thorough systematic review of this group has been done since Kükenthal (1935–1936). Additional research to elucidate the relationships of infraspecific taxa and their relationships with one another and with related species, e.g., *C. paniceus* Boeckeler, is needed. Such research with North American species of section *Umbellati* has been productive, resulting in substantial taxonomic and nomenclatural clarification (Carter, 1984; Carter & Jarvis, 1986; Carter & Kral, 1990; Carter & Jones, 1997).

Cyperus croceus Vahl, *C. echinatus* (L.) A. W. Wood, and *C. retrorsus* Chapm. are listed as weeds by WSSA (1989). All are caespitose perennials with umbelliform inflorescences of simple spikes of densely clustered spikelets, classified by Kükenthal (1935–1936) in section *Umbellati*. These taxa are native and widely distributed in the southeastern U.S.A., where they are found in lawns, pastures, roadsides, waste places, disturbed woodlands, and other ruderal sites (Carter, 1984). *Cyperus croceus* and *C. echinatus* were long known as *C. globulosus* auct. non Aubl. and *C. ovularis* (Michx.) Torr., respectively (Carter & Kral, 1990). *Cyperus croceus* also occurs in the Caribbean Islands (Carter, 1984). *Cyperus croceus* and *C. echinatus* have been reported as wool aliens in Great Britain (Sell & Murrell, 1996), and *C. croceus* has been associated with ballast (Britton, 1886). *Cyperus echinatus* is reportedly naturalized in the Azores (DeFilipps, 1980c). Carter (1984, in prep.) shows that plants with ascending yellowish scales are distinct from *C. retrorsus* and should be called *C. ovatus* Baldwin. *Cyperus ovatus* is a coastal species in the southeastern U.S.A., which is found in slightly wetter sites than related *C. retrorsus*, e.g., moist ditches, disturbed sites in moist sandy, loamy, or peaty soils in coastal flatwoods (Carter, 1984, in prep.). Although not listed by WSSA (1989), we include the related taxa *C. retroflexus* Buckley and *C. floribundus* (Kük.) R. Carter & S. D. Jones in Appendix 2, because they are commonly weeds of roadsides, poorly kept lawns, pastures, disturbed grasslands, and agricultural fields; see Carter and Jones (1997) for clarification of the taxonomy of *C. retroflexus* and its allies. *Cyperus floribundus* is native to northeastern Mexico and southern Texas (Carter, in prep.). *Cyperus retroflexus* ranges from northern Mexico north through Texas into Oklahoma and east into western Mississippi, Arkansas, and Missouri and is apparently expanding its range eastward into Alabama, Mississippi, and Missouri (Carter et al., 1987; Carter & Bryson, 1991a, b). *Cyperus plukenetii* also belongs to section *Umbellati*. It has spikelet modifications facilitating animal dispersal (Carter, 1993) and is endemic to the eastern U.S.A., where it is well adapted to open xeric sands of the Coastal Plain (Carter, 1984, in prep.). *Cyperus plukenetii* currently does not appear to be invasive in its natural range; however, because of its specialized dispersal mechanism and adaptation to dry soils, it could potentially become an invasive weed if introduced into suitable habitat elsewhere.

Cyperus aggregatus is frequently cited as a weed (Appendix 2) and has been classified in section *Umbellati* (Kükenthal, 1935–1936). The species was previously called *C. flavus* (Vahl) Nees, nom. illeg., non J. Presl & C. Presl and *C. cayennensis* (Lam.) Britton, non. illeg., non Willd. ex Link (Tucker, 1985). *Cyperus aggregatus* is native to Central and South America, was introduced with ballast in the U.S.A. (Britton, 1886; Mohr, 1901; Horvat, 1941; Tucker et al., 2002), and is also introduced and weedy in Australia (Wilson, 1993). *Cyperus aggregatus* occurs sporadically in the Coastal Plain of the southeastern U.S.A., where it can be locally abundant and somewhat invasive on open, disturbed sandy soils (Bryson & Carter, 1992; Tucker et al., 2002; Carter, pers. obs.). It is likely to continue to expand its range in warmer parts of the southeastern U.S.A. and elsewhere.

Cyperus ligularis L. is occasionally cited as a weed (Appendix 2). It is widely distributed in the West Indies, Mexico, Central America, and South America and is introduced in Africa and the southeastern U.S.A. (O'Neill, 1946; Tucker et al., 2002). It is a frequent weed of disturbed sites in southern peninsular Florida, U.S.A. (Wunderlin, 1998), and Mohr (1901) reported that it was collected in 1891 on ballast at Mobile, Alabama, U.S.A., where it has apparently not survived. Thus, *C. ligularis* is apparently not tolerant of prolonged cold temperatures. *Cyperus ligularis* is readily identified by its robust caespitose habit; coarse lacerating leaves; grayish green foliage; umbelliform inflorescence of dense, oblong-cylindric, often branched spikes; and reddish brown floral scales.

A number of *Cyperus* species colonize coastal or inland sand dunes by forming extensive rhizomes. *Cyperus dentatus* Torr., *C. lecontei* Torr. ex Steud., and *C. onerosus* M. C. Johnst. are related North American species sharing similar growth forms and habitats, spreading vegetatively through growth of rhizomes. *Cyperus lecontei* is listed as a weed by the WSSA (1989), and we have observed it colonizing disturbed sandy roadsides and other open sandy areas along the Gulf Coast. *Cyperus lecontei* and *C. dentatus* are coastal fringe species. *Cyperus lecontei* is found on exposed sands of coastal dunes and swales in the southeastern U.S.A., and *C. dentatus* occupies similar habitats but with a more northerly distribution from the mid-Atlantic states north into the maritime provinces of Canada (Tucker et al., 2002). *Cyperus onerosus* is a related species endemic to swales and pools far inland in nonmaritime dune formations in western Texas (Carter, pers. obs.; Tucker et al., 2002). Rhizomes of *C. dentatus* form tubers, but do not in *C. lecontei* and *C. onerosus* (Tucker et al., 2002). *Cyperus arenarius* Retz. ranges from southern Iran through Pakistan, India, and Ceylon into Indochina (Kükenthal, 1935–1936; Koyama, 1985) and has been introduced into southern Australia and southern Africa (Kukkonen, 2001). Simpson and Inglis (2001) listed it as a weed, and Koyama (1985: 209) described it as a coastal species in Ceylon commenting that its "extensive rhizome system … forms a large pure community." The endemic *C. crassipes* Vahl from coastal southeastern Africa has a similar habit and habitat: sandy seashores and riverbanks (Gordon-Gray, 1995). *Cyperus stoloniferus* Retz., another vegetative colonizer of coastal sands, ranges from Pakistan and India to China and northern Australia and is also known from Mauritius and Madagascar (Kukkonen, 2001). Although only *C. arenarius* and *C. lecontei* are listed in Appendix 2, we think these ecologically similar species have great potential to invade coastal dunes or other open sandy areas, if introduced outside their natural ranges, as the alien *Carex kobomugi* has done along the mid-Atlantic coast of North America (Standley, 1983).

Cyperus fuscus is native to Eurasia and the Mediterranean region of northern Africa and has spread in Asia and Africa and into Greenland, Iceland (Kükenthal, 1935–1936; DeFilipps, 1980c), and North America (Smith, 1867; Britton, 1886; Knowllton et al., 1911; McGivney, 1938; McKenzie et al., 1998). This small caespitose annual produces large numbers of tiny achenes. It is reported as a weed in rice-producing areas of Asia and Portugal and is a common weed in Afghanistan and Israel (Weedon & Stephens, 1969; Holm et al., 1977; Zhirong et al., 1990). Early records of *C. fuscus* in North America were mostly associated with ballast waste and wharf areas (Britton, 1886; Rhoads & Klein, 1993). *Cyperus fuscus* seems to be expanding its range in the U.S.A. (McKenzie et al., 1998), where it is possibly still in the lag phase and could pose problems in the future for rice agriculture.

Cyperus amabilis Vahl, *C. cuspidatus* Kunth, and *C. squarrosus* L. are widely distributed in tropical, subtropical, and warm temperate regions of both the Eastern and Western hemispheres (Kükenthal, 1935–1936; Kern, 1974). All three are diminutive sedges listed in Appendix 2, and both *C. amabilis* and *C. cuspidatus* have prominently cuspidate floral scales. *Cyperus amabilis* has been reported as a weed (Healy & Edgar, 1980; Kühn, 1982) and is known from Africa, Asia, South America, Central America, and North America (Kükenthal, 1935–1936; Tucker et al., 2002). As shown in Appendix 2, *C. cuspidatus* and *C. squarrosus* are listed as weeds of rice and are also found in waste places, disturbed sites, sandy fields, and grasslands. In warmer parts of the southeastern U.S.A., *C. cuspidatus* is sometimes locally abundant in disturbed sandy soils in and around agricultural fields and has also been observed as a weed in container-grown plants and plant nurseries (Carter, pers. obs.). *Cyperus squarrosus* is characterized by the distinctive aroma of fenugreek (*Trigonella foenum-graecum* L.), which is shared by *C. fuscus*, *C. hyalinus* Vahl, and *C. setigerus* Torr. & Hook. (McKenzie et al., 1998; Carter & Mears, 2000). Kern (1974) showed that *C. aristatus* Rottb. is a synonym of *C. squarrosus*, and, subsequently, contemporary workers have followed Kern without reviewing the status of a number of varieties and forms of *C. aristatus* recognized by Kükenthal (1935–1936). North American plants have been segregated as *C. inflexus* Muhl. or *C. aristatus* var. *inflexus* (Muhl.) Boeckeler. Preliminary research (Carter, unpubl. data) indicates that *C. inflexus* is a smaller plant with smaller spikelets and scales and supports its recognition as a distinct endemic North American taxon. The names *C. inflexus* and *C. squarrosus* var. *runyonii* (O'Neill) S. D. Jones & Wipff were placed into synonymy, without justification, under *C. squarrosus* by Tucker et al. (2002). *Cyperus granitophilus* McVaugh is an autotetraploid derivative of *C. squarrosus*, endemic to granite and sandstone outcrops in the Piedmont region from Virginia to Georgia, U.S.A. (Garoni & Murdy, 1964; Tucker et al., 2002). Preliminary observations (Carter, unpubl. data) indicate that *C. granitophilus* is a coarser plant than the more common widespread *C. inflexus* and is morphologically more similar to *C. squarrosus*. Although new taxa have been described and other major nomenclatural changes have occurred, the entire complex has not been studied since Kükenthal (1935–1936). A systematic review worldwide of *C. squarrosus* and related taxa is needed to achieve a consistent treatment of these and other infraspecific taxa not accounted for by contemporary authors.

Cyperus gracilis R. Br., yet another diminutive sedge cited as a weed (Holm et al., 1979), is native to Australia, where it grows in open woodlands and grasslands in drier sites than related species (Wilson, 1993). It was once promoted for use as a ground cover in Hawaii, where it is naturalized and common in disturbed sites, lawns, and roadsides (Hughes, 1995). It is also introduced in California, U.S.A. (Tucker et al., 2002).

Cyperus subg. *Pycreus* is characterized by persistent rachillae, bifid styles, and lenticular achenes with the achene angle adjacent to the rachilla (Kükenthal, 1935–1936; Tucker et al., 2002), which some treat as genus *Pycreus* (e.g., Koyama, 1985; Adams, 1994; Gordon-Gray, 1995). Weeds belonging to subgenus *Pycreus* include *C. flavescens* L., *C. flavicomus* Michx., *C. flavidus* Retz., *C. lanceolatus* Poir., *C. polystachyos* Rottb., *C. puncticulatus* Vahl, *C. pumilus* L., *C. sanguinolentus*, and *C. substramineus* Kük.

Cyperus sanguinolentus has been frequently cited as a weed (Holm et al., 1977; Reed, 1977; Kühn, 1982; Zhirong et al., 1990). It is widely distributed in the Eastern Hemisphere, where it is known from northeastern Africa, the Middle East, India, Sri Lanka, central Asia, southeastern Asia, China, Taiwan, Japan, Korea, the Philippines, Indonesia, Malaysia, and Australia (Clarke, 1894; Kükenthal, 1935–1936; Ohwi, 1965; Kern, 1974; Holm et al., 1977; Reed, 1977; Kühn, 1982; Haines & Lye, 1983; Zhirong et al., 1990; Wilson, 1993). In the Western Hemisphere, it has been reported from Hawaii (Wagner et al., 1990) and from the Coastal Plain of the southeastern U.S.A. in North America (Carter & Bryson, 2000b, 2001). *Cyperus sanguinolentus* is a weed in paddy and damp, low-dryland crop fields in Asia (Holm et al., 1977; Zhirong et al., 1990). In the southeastern U.S.A. it is a locally common annual weed in periodically disturbed sites with hydric soils, e.g., road ditches and margins of artificial ponds (Carter & Bryson, 2000b). Its introduction into the southeastern U.S.A. is associated with the cultivation of rice, and its dispersal and range expansion there are associated with road construction and maintenance activities (Carter & Bryson, 2000b). *Cyperus louisianensis* Thieret, once thought to be a rare endemic species in southern Louisiana, U.S.A. (Thieret, 1977), has been shown to be the nonindigenous weed *C. sanguinolentus* (Carter & Bryson, 2000b).

Cyperus flavescens is widely distributed in both Old and New Worlds (Kükenthal, 1935–1936; O'Neill, 1946; Barros, 1960; Haines & Lye, 1983; Tucker et al., 2002). It is a common weed of seeps, roadside ditches, and disturbed wet sites in Natal Province (now KwaZulu-Natal Province), South Africa (Gordon-Gray, 1995). In the U.S.A. it is a common tuft-forming weed in drainage ditches, disturbed hydric sites, and moist lawns and fields (Carter, pers. obs.), ranging widely from Florida north into southern Canada and west to Texas and Missouri (Tucker et al., 2002). *Cyperus lanceolatus* is similar to *C. flavescens* and frequently occurs in the same habitats in the southeastern U.S.A. Both taxa have similar habits (dense tufts) and differ primarily in the color of their achenes: black in *C. flavescens*, brown in *C. lanceolatus*. Apparently less tolerant of cold winter temperatures, *C. lanceolatus* is restricted to the warmest parts of the southeastern U.S.A., ranging from Florida north into southern Georgia then west along the coast to Texas (Bryson et al., 1996; Tucker et al., 2002). *Cyperus lanceolatus* also occurs in the West Indies, Mexico, Central and South America, and Africa (O'Neill, 1946; Barros, 1960; Haines & Lye, 1983; Tucker, 1994). Although the type locality is Georgia, U.S.A. (Elliott, 1821), *C. fasciculatus* Elliott is not cited by contemporary American authors (e.g., Tucker, 1994; Tucker et al., 2002) but is cited as a weed in Asia (Appendix 2). This problem should be researched to determine how the name *C. fasciculatus* impinges on nomenclature of the North American plants currently known as *C. flavescens* and *C. lanceolatus*.

Cyperus polystachyos is a cosmopolitan weed, widely distributed in tropical, subtropical, and warm temperate areas (Uittien, 1932; Kükenthal, 1935–1936; Barros, 1960; Kern, 1974; DeFilipps, 1980c; Haines & Lye, 1983; Tucker, 1983, 1994; Koyama, 1985; Wilson, 1993; Adams, 1994; Gordon-Gray, 1995). *Cyperus polystachyos* is cited as a weed of hydric soils in ditches, waste places, grasslands, and disturbed agricultural areas and fields, including rice fields (Kern, 1974; Haines & Lye, 1983). *Cyperus polystachyos* is taxonomically and nomenclaturally complex. Kükenthal (1935–1936) segregated 16 infraspecific taxa from *C. polystachyos* (11 varieties, 5 forms). Also, the relationships between *C. polystachyos* and related taxa like the North American species *C. filicinus* Vahl and *C. fugax* Liebm. are poorly understood and are in need of clarification. We have observed at least three entities passing as *C. polystachyos* in the southeastern U.S.A., with the greatest diversity centered along the Gulf Coast. This group is in need of critical taxonomic review on a worldwide basis. *Cyperus polystachyos* is cited as a weed of hydric soils in ditches, waste places, grasslands, and disturbed agricultural areas and fields, including rice fields (Kern, 1974; Haines & Lye, 1983).

Cyperus flavicomus is found in North America, South America, and Africa (Kükenthal, 1935–1936; Barros, 1960; Tucker, 1994) and in Appendix 2 is cited as a weed of waste places, rice fields and various other crops, pastures, and turf. *Cyperus flavicomus* occurs sporadically on moist soil in and around agricultural fields in the southeastern U.S.A., where it is of minor importance as a weed. *Cyperus pumilus* is a diminutive, densely tufted annual and a minor weed of disturbed sandy soils of rice fields and fallow fields (Kern, 1974; Haines & Lye, 1983; Carter, pers. obs.). As shown in Appendix 2 it is widespread in the Old World. In the New World, *C. pumilus* is known from the West Indies and the U.S.A.

(Kükenthal, 1935–1936; Kern, 1974; Haines & Lye, 1983; Koyama, 1985; Gordon-Gray, 1995). In the U.S.A., *C. pumilus* has long been known from Florida (Chapman, 1889 [as *C. divergens* Kunth]; Small, 1933; Long & Lakela, 1971; Godfrey & Wooten, 1979; Clewell, 1985; Wunderlin, 1998) and was reported in 1996 in southern Georgia (Bryson et al., 1996). *Cyperus pumilus* appears to be spreading in the southeastern U.S.A., as plants were found in northern Georgia in 2003 (*M. Czarnota s.n.*, 29 January 2003, VSC).

Cyperus hyalinus is transitional between *Cyperus* and *Kyllinga* and is pragmatically treated here in subgenus *Queenslandiella* (Domin) Govind. Its taxonomic affinities are unclear, and it has been variously placed in *Pycreus*, *Kyllinga*, *Cyperus*, and the monotypic genus *Queenslandiella* based on morphological traits (Clarke, 1884; Kükenthal, 1935–1936; Kern, 1974; Govindarajalu, 1975; Haines & Lye, 1983). However, recent molecular evidence suggests that *Kyllinga*, *Pycreus*, and, by extension, *Queenslandiella* should be included in *Cyperus* (Muasya et al., 2002). *Cyperus hyalinus* is known from eastern Africa, Madagascar, Mauritius, India, Sri Lanka, tropical Australia (Queensland), and Malaysia (Kükenthal, 1935–1936; Kern, 1974; Haines & Lye, 1983; Koyama, 1985) and has recently been found in southern Florida, where it was apparently introduced by air traffic (Carter & Mears, 2000). Because Haines and Lye (1983: 293) described it as "a weed of sandy soils, near sea level" in eastern Africa and it is similar in habit and habitat to certain weeds in *Kyllinga*, we suspect that *C. hyalinus* could become a pest in turf, flowerbeds, and containerized nursery plants in the southeastern U.S.A. Additional research is needed to determine its potential as a weed and to clarify its taxonomic relationships.

Cyperus laevigatus L. and *C. serotinus* Rottb. are frequently cited as weeds (Appendix 2). Both species have lenticular achenes with the achene face adjacent to the rachilla and, thus, are classified into subgenus *Juncellus*. *Cyperus laevigatus* is cosmopolitan in tropical and warm temperate regions (Kükenthal, 1935–1936; DeFilipps, 1980c). Aquatic biotypes have been reported by Kühn (1982), and this highly variable perennial sedge generally grows in saline, alkaline, or mineral soils associated with salt marshes in coastal areas or salt lakes, hot springs, or artesian wells or along rivers inland (Kükenthal, 1935–1936; Haines & Lye, 1983; Wilson, 1993; Gordon-Gray, 1995; Tucker et al., 2002). *Cyperus laevigatus* was collected along the coast of North Carolina, U.S.A., where it was reportedly introduced with ballast, but it apparently no longer exists there (Radford et al., 1968). A number of varieties were recognized by Kükenthal (1935–1936), which contemporary authors ignore. Wilson (1993) noted the presence of three forms of *C. laevigatus* in Australia and stated the need for its taxonomic study on a worldwide basis. *Cyperus serotinus* occurs from the Mediterranean region of southern Europe through much of Eurasia (Kükenthal, 1935–1936; DeFilipps, 1980c), and it is introduced sparingly in salt marshes along the mid-Atlantic coast of North America (Tucker et al., 2002). Kühn (1982) reported aquatic biotypes in *C. serotinus*, indicating it as a weed of rice fields in Asia. If introduced more widely, *C. serotinus* could pose problems for rice agriculture in North America and elsewhere.

ELEOCHARIS

Eleocharis is a genus of ca. 200 species worldwide (Smith et al., 2002), about half of which are aquatic or semi-aquatic (Holm et al., 1997). Appendix 2 lists 53 species of *Eleocharis* as weeds. Of 118 species of *Eleocharis* studied by Ueno et al. (1989), all but six were shown to have C_3 photosynthesis. Holm et al. (1997) considered *E. acicularis* (L.) Roem. & Schult., *E. dulcis* Trin. ex Hensch., and *E. palustris* (L.) Roem. & Schult. to be among the world's worst weeds and cite *E. acicularis* among the five most troublesome weeds in Asian rice paddies. Elliott (1821: 79) described *E. quadrangulata* (*Scirpus quadrangulatus* Michx.) as "very injurious" in rice fields of Georgia and South Carolina, U.S.A. The tubers of *E. dulcis* are consumed as Chinese water chestnuts, and the species is widely cultivated in Asia (Kern, 1974; Mabberley, 1997). Sculthorpe (1967) cited *E. acicularis* and *E. palustris* among the most broadly distributed aquatic plants in the world, and Svenson (1957) cited the cosmopolitan weed *E. geniculata* (L.) Roem. & Schult. (as *E. caribaea* (Rottb.) S. F. Blake) as the most widespread *Eleocharis* species. As shown in Appendix 2, *E. geniculata* is frequently cited as a weed and has been reported as a pest in rice (Kern, 1974) and taro paddies (Wagner et al., 1990). *Eleocharis radicans*

(Poir.) Kunth is reportedly naturalized in taro paddies in Hawaii (Wagner et al., 1990). Walters (1980) reported the South American species *E. bonariensis* Nees as naturalized on banks of estuarine rivers in France, with no indication of it being a weed.

Eleocharis macrostachya, *E. mamillata* H. Lindb., and *E. palustris* belong to a taxonomically perplexing complex and are widely distributed around the world, found in hydric soils in a variety of habitats, e.g., pond margins, marshes, ditches, and wet meadows (Svenson, 1957; Smith et al., 2002). All three taxa are listed as weeds in Appendix 2. Additionally, the related taxon, *E. erythropoda* Steud., is sometimes associated with disturbance (Smith et al., 2002) and, therefore, might be considered a weed. *Eleocharis palustris* and *E. mamillata* are found in both the Eastern and Western hemispheres, whereas *E. macrostachya* and *E. erythropoda* are restricted to the New World (Smith et al., 2002). *Eleocharis macrostachya* has an essentially western distribution in the U.S.A., ranging from Alaska, south through British Columbia and California, east to Mississippi, Illinois, and Wisconsin; it is also in Mexico and South America (Svenson, 1957; Smith et al., 2002). *Eleocharis macrostachya* seems to be dispersing eastward in the U.S.A. and was only recently reported from western Mississippi where it was locally abundant in hydric soils in a roadside ditch along a major highway (Bryson et al., 1996).

Although none of the primary sources used to compile Appendix 2 lists either *Eleocharis montevidensis* Kunth or *E. montana* (Kunth) Roem. & Schult. as weeds, we have included them based upon observations made in the southeastern U.S.A. *Eleocharis montevidensis* is widely distributed in North and South America and restricted to the Western Hemisphere (Svenson, 1957; Smith et al., 2002). In the southeastern U.S.A., this rhizomatous perennial is sometimes locally abundant and weedy in hydric soils of ditches, roadsides, or other disturbed sites (Carter, pers. obs.). *Eleocharis montana* is a perennial restricted to the Western Hemisphere. It is probably indigenous to South America and is known from the Gulf coastal states of the southern U.S.A., the Caribbean, and throughout much of South America (Svenson, 1957; Smith et al., 2002). In the southeastern U.S.A., *E. montana* is a weed of hydric soils in disturbed areas and roadside ditches and seems to be most common on fine-textured soils in the rice-growing areas of southern Louisiana and eastern Texas (Carter, pers. obs.).

Eleocharis albida is common along the Gulf and Atlantic coasts in the southeastern U.S.A.; it also occurs in Mexico and the Caribbean (Smith et al., 2002). It is often locally abundant in hydric brackish soils of disturbed open sites and ditches adjacent to salt marshes (Carter, 2005). Extensive coastal real estate development has undoubtedly facilitated the expansion of *E. albida* in the southeastern U.S.A. Although we include it in Appendix 2 because of its propensity to form extensive stands following disturbance, we do this with some reservation, because it is indigenous and is apparently invasive only in areas where humans have severely altered the habitat. *Eleocharis parvula* is frequently associated with *E. albida* along the coast in the southeastern U.S.A. (Carter, 2005); however, it is much more widely distributed, ranging throughout much of eastern North America from eastern Canada southward into Central America; it also occurs along the West Coast of North America and in Eurasia (Smith et al., 2002). Like *E. albida*, *E. parvula* can be locally abundant in disturbed, hydric, brackish soils in coastal areas; however, *E. parvula* also occurs sporadically inland. A number of salt marsh species, including the sedges *E. parvula* and *Bolboschoenus robustus* [= *Scirpus robustus* Pursh], occur 400 km from the coast in western Virginia, U.S.A., on saline soils formed by the pumping of brine wells and are thought to have been dispersed there by birds (Sauer, 1988).

Eleocharis baldwinii and *E. vivipara* are listed as weeds (WSSA, 1989). Both species are profuse in their vegetative proliferation and also reproduce from achenes. *Eleocharis baldwinii* is common in parts of the southeastern U.S.A., where it may be locally abundant in dense mats on disturbed moist sandy or peaty soils or floating in ponds or ditches (Carter, pers. obs.). *Eleocharis vivipara* spreads vegetatively, forming dense clumps on moist soil or tangled mats in ponds and ditches (Carter, pers. obs.). In the U.S.A., both *E. baldwinii* and *E. vivipara* are currently of minor economic importance as weeds and are probably only opportunistically weeds following disturbance by humans. However, because of their ability to proliferate vegetatively and to reproduce sexually from achenes, we suspect they could become invasive if introduced into suitable habitats outside their natural ranges.

Eleocharis ovata (Roth) Roem. & Schult. and *E. obtusa* (Willd.) Schult. are cited as weeds (Appendix 2; WSSA, 1989; Callahan et al., 1995) in North America. *Eleocharis ovata* ranges broadly in Eurasia and throughout much of Canada and the northern U.S.A. (Svenson, 1957). *Eleocharis obtusa* is common throughout much of North America and is naturalized in Hawaii (Svenson, 1957; Smith, 2002c) and in rice fields in southern Europe (Walters, 1980). Both *E. ovata* and *E. obtusa* are closely related caespitose annuals (rarely perennials), found in seasonally wet disturbed sites, margins of ponds, and ditches (Svenson, 1957). Tufts of these plants continue to increase in diameter, producing new fertile culms throughout the growing season so long as there is sufficient moisture (Bryson, pers. obs.). *Eleocharis engelmannii* Steud. and *E. lanceolata* Fernald are related taxa, similar to and easily confused with *E. ovata* and *E. obtusa* in habitat and growth characteristics. *Eleocharis engelmannii* occurs sporadically throughout much of the range of *E. obtusa* and differs from that species primarily in its shorter tubercle. *Eleocharis lanceolata* is found in the south-central U.S.A. and was collected in 1949 in California as a weed in a rice field (Smith, 2002c). Hybrids between *E. lanceolata* and closely related *E. obtusa* are known (e.g., *Carr 13969*, VSC). Its narrower, more cylindrical spikelet, acute scale, and narrower tubercle distinguish *E. lanceolata* from *E. obtusa* (Svenson, 1957; Smith, 2002c). *Eleocharis flavescens* (Poir.) Urb. var. *flavescens* and *E. flavescens* var. *olivacea* (Torr.) Gleason, like their New World relative *E. obtusa*, have become naturalized in rice fields of southern Europe (Walters, 1980).

Eleocharis sect. *Limnochloa* (P. Beauv. ex T. Lestib.) Torr. is a group of robust (for *Eleocharis*) emergent aquatics. These perennial species show considerable variation in the shape of their stems in transverse section, from terete, to triquetrous, to quadrangular (Svenson, 1957). As shown in Appendix 2, a number of species in this group are cited as weeds, including *E. acutangula* (Roxb.) Schult., *E. cellulosa* Torr., *E. dulcis*, *E. interstincta* (Vahl) Roem. & Schult., *E. mutata* (L.) Roem. & Schult., *E. philippinensis* Svenson, and *E. quadrangulata*. *Eleocharis acutangula* and *E. mutata* are widely distributed in both hemispheres (Svenson, 1957; Koyama, 1985), whereas *E. cellulosa*, *E. interstincta*, and *E. quadrangulata* are exclusively New World species (Svenson, 1957). *Eleocharis philippinensis* and *E. dulcis* are wide-ranging in the Eastern Hemisphere, where *E. dulcis* is widely introduced and naturalized from cultivation for its tubers (Chinese water chestnuts) (Kern, 1974; Koyama, 1985). Several species are cited as pests in rice fields, and given their aquatic habitat and emergent habit, it would appear that all have the potential to be weeds of rice agriculture or invasive pests of wetlands in natural areas (Kern, 1974; Holm et al., 1979; Koyama, 1985). As discussed in the Dispersal section, there is considerable potential for achenes of these species to be disseminated long distances by waterfowl.

FIMBRISTYLIS

There are more than 100 species of *Fimbristylis* worldwide (Kral, 2002b), and 46 are listed as weeds in Appendix 2. *Fimbristylis dichotoma* (L.) Vahl and *F. miliacea* (L.) Vahl are co-ranked as the world's 40th worst complex of weeds (Holm et al., 1977). *Fimbristylis dichotoma* is a rapidly growing annual or perennial that thrives in poorly aerated soils with high moisture content (Holm et al., 1977). It has been reported as a weed of paddy crops, old rice fields, ditches, lawns, open wetland pastures and meadows, roadsides, cultivated lands, and along forest margins in 21 countries throughout the tropical and semitropical regions of the world including Africa, Asia, the Pacific Islands, and North and South America (Holm et al., 1977). *Fimbristylis dichotoma* is cited as a weed in pineapple, rice, roselle, teak, taro, and other upland row crops (Holm et al., 1977). In the southeastern U.S.A., *F. dichotoma*, *F. caroliniana* (Lam.) Fernald, and *F. castanea* (Michx.) Vahl are frequently weeds following mechanical disturbance of the soil (Kral, 1971).

Fimbristylis miliacea, a native to tropical America, is now a troublesome weed in Africa, Asia, Australia, and North and South America in 21 countries (Holm et al., 1977). It is considered a major weed in rice in Asia, but it is also a weed of taro, bananas, corn, sorghum, and sugarcane (Holm et al., 1977). *Fimbristylis miliacea*, an annual or sometimes perennial in the tropics, is reported to produce more than 1000 seeds per plant per year and without dormancy (Holm et al., 1977). Seeds of *F. miliacea* are easily dispersed and seedlings emerge rapidly on moist soil (Holm et al., 1977). Infestations can constitute 70% of all seedling weeds in agricultural areas (Verga & Sierra, 1970), and in Malaysia, *F. miliacea* is reported to be the first sedge emerging after rice planting and the first sedge to recover following tillage (Burkill, 1935). Emergence of *F. miliacea* seedlings seems to be environmentally dependent. In Japan, rice planted mid-season reduced the number of emerging *F. miliacea* seedlings by 80% when compared to rice planted early season, and seedling emergence was even less in late-season rice plantings (Noda & Eguchi, 1965).

Fimbristylis annua (All.) Roem. & Schult. and *F. autumnalis* (L.) Roem. & Schult. are also listed as weeds in North America (WSSA, 1989) but are not as troublesome as *F. miliacea* in rice production in the southeastern U.S.A. At least some of the forms of *F. annua* were introduced into the U.S.A. with rice agriculture (Kral, 1971). *Fimbristylis decipiens* Kral was described from specimens collected in the U.S.A. (Kral, 1971). Because it is morphologically similar to and often occurs with *F. annua* and *F. dichotoma*, herbarium specimens of these three species are difficult to distinguish (Kral, 1971). A number of *Fimbristylis* spp. are thought to have been introduced in the U.S.A. and elsewhere around the world with rice agriculture (Appendix 1). *Fimbristylis aestivalis* (Retz.) Vahl has been reported as a weed of rice and in taro paddies in the Eastern Hemisphere and in Hawaii (Kern, 1974; Wagner et al., 1990; Ravi & Mohanan, 2002).

FUIRENA

The 30 species of *Fuirena* worldwide are nearly all heliophytic wetland plants of acidic soils in the tropics and subtropics (Kral, 1980, 2002a). Eight species are listed in Appendix 2, including two, *F. ciliaris* (L.) Roxb. and *F. umbellata* Rottb., cited as weeds of rice fields in the Eastern Hemisphere. *Fuirena breviseta* (Coville) Coville, *F. pumila* (Torr.) Spreng., *F. scirpoidea* Michx., *F. simplex* Vahl, and *F. squarrosa* Michx. are weeds in the U.S.A. (WSSA, 1989), where they occur in wet soils of pastures or along waterways and roadsides. None of the *Fuirena* spp. is a major weed.

ISOLEPIS

Isolepis contains about 69 species worldwide, predominately found in cool-tropical and temperate regions of Africa and Australia (Smith, 2002d); a single species is listed as a weed in Appendix 2. *Isolepis carinata* [= *Scirpus koilolepis* (Steud.) Gleason] is occasionally a weed on moist bare soils in gardens, row crops, and natural areas, following fire or tillage (Carter et al., 1990; Bryson & Hanks, 2001). It is usually not a particularly troublesome weed in row crops because of its diminutive stature, susceptibility to foliar herbicides, and early-season phenology. *Isolepis cernua* is widely distributed around the world primarily in temperate and subtropical regions, occurring in southern Africa (absent from tropical Africa), Eurasia (absent from southeastern Asia), Australia and New Zealand, temperate South America, and North America (Wilson, 1981; Gordon-Gray, 1995; Smith, 2002d). It is apparently a recent arrival (since 1888) in the U.S.A. and Canada, where it is found primarily on the Pacific coast in fresh to brackish water on beaches, dunes, and marine bluffs (Smith, 2002d). It is also known from Texas, where the earliest collection seen by Smith (2002d) was from 1974. The taxonomy of *I. cernua* and related species is in need of revision on a worldwide basis to clarify relationships of taxa and complex nomenclature (Wilson, 1981; Gordon-Gray, 1995). According to Smith (2002d), only *I. cernua* var. *cernua* is known from North America. Although no citations were found of *I. cernua* as a weed, it is included here because of its apparent introduction into the U.S.A. and its potential to be introduced and naturalized elsewhere in temperate and subtropical areas through the ornamental trade (Bailey, 1935; Everett, 1980–1982; Grounds, 1989; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999).

KYLLINGA

Kyllinga, a genus of short rhizomatous perennials or caespitose annuals, consists of 40 to 45 species distributed in tropical, subtropical, and warm temperate regions around the world (Tucker, 1984, 1987, 2002b). Appendix 2 lists 13 species as weeds, and *K. brevifolia* is among the world's worst weeds, having been reported in 17 crops and 43 countries (Holm et al., 1997). The maximum diversity of *Kyllinga* occurs in tropical East Africa and Madagascar, where there are 30 to 35 species (Kükenthal, 1935–1936; Haines & Lye, 1983). An additional 11 to 12 *Kyllinga* species occur in Asia and two occur in Australia; none is native to Europe and only one is thought to be native to North America. *Kyllinga brevifolia*, *K. gracillima*, *K. odorata* Vahl, *K. pumila* Michx., and *K. squamula-*

ta are known from the continental U.S.A. (Kartesz, 1994). *Kyllinga brevifolia* and *K. nemoralis* (J. R. Forst. & G. Forst.) Dandy ex Hutch. & Dalziel are introduced weeds in Hawaii (Delahoussaye & Thieret, 1967; Holm et al., 1979; Tucker, 1987). *Kyllinga polyphylla* Willd. ex Kunth, a native of Africa, is introduced into Samoa, Tahiti, and Fiji, where it is a weed of disturbed places, pastures, and roadsides at elevations up to 700 m (Whistler, 1994). Spreading by rhizomes, it is a particularly serious pest in pastures because it displaces acceptable forage and is not eaten by livestock (Whistler, 1994).

Kyllinga pumila, a weed of lawns and turf, was initially described in the first North American flora by Michaux (1803) and is evidently the only *Kyllinga* species native to the continental U.S.A. *Kyllinga brevifolia*, *K. gracillima*, *K. odorata*, and *K. squamulata* are all pantropical species (Reed, 1977; Holm et al., 1979; Tucker, 1984, 1987; Koyama, 1985) and were apparently all introduced into the continental U.S.A. from Asia. Although the precise time of their introductions is unknown, *K. brevifolia* was established in the U.S.A. prior to 1821 (Elliott, 1821), and *K. odorata* before 1836 (Torrey, 1836). Both are widespread in the eastern U.S.A., especially in the southern Atlantic and Gulf coastal plains, and are introduced weeds of South America (Bryson et al., 1996; Kissmann, 1997). In the U.S.A., distributions and recent range expansions indicate later introductions for *K. gracillima* and *K. squamulata* (Delahoussaye & Thieret, 1967; Sipple, 1978; Ferren & Schuyler, 1980; Kral, 1981; Webb & Dennis, 1981; Webb et al., 1981; Wunderlin, 1982; Snyder, 1983, 1984; Naczi, 1984; Naczi et al., 1986; Sundell & Thomas, 1988; Bryson & Carter, 1992, 1994; Mears & Libby, 1995; Bryson et al., 1996). *Kyllinga brevifolia* and *K. odorata* have continued to spread northward and westward in the U.S.A., especially as weeds of turf, pastures, and roadways (Bryson & Carter, 1992, 1994; Jones et al., 1993; Bryson et al., 1996), while *K. gracillima* continues to spread south and westward (Sipple, 1978; Ferren & Schuyler, 1980; Kral, 1981; Webb & Dennis, 1981; Webb et al., 1981; Snyder, 1983, 1984; Naczi, 1984; Naczi et al., 1986; Sundell & Thomas, 1988; Bryson & Carter, 1994; Mears & Libby, 1995; Bryson et al., 1996, 1997).

The small achenes of the introduced *Kyllinga* spp. could have arrived in the U.S.A. by a variety of dispersal methods. Following introduction, *Kyllinga* probably first naturalized along sandbars and disturbed areas along streams or in open ruderal sites with adequate moisture. *Kyllinga* spp. are common weeds of highly maintained, frequently irrigated turf in urban areas and on golf courses, and such sites now provide excellent habitat for local proliferation, dispersal, and range expansion of populations (Yelverton, 1996). *Kyllinga* spp. are also frequent weeds of mulched irrigated flowerbeds and containerized nursery plants (Whitwell & Smith, 1997).

Kyllinga brevifolia and *K. gracillima* are rhizomatous perennials, and *K. odorata*, *K. pumila*, and *K. squamulata* are annuals or short-lived perennials in warmer climates. *Kyllinga brevifolia* flowers 10 to 12 weeks after germination and produces mature seeds three weeks after flowering (Holm et al., 1997). *Kyllinga brevifolia* seeds are disseminated by wind and water and germinate without aging (Sumaryono & Basuki, 1986), and human activities result in the movement of whole plants, fragments, or seeds in sod, soil, or grass clippings. A combination of frequent (often daily) irrigation and mowing (3–6 times/week) without removal of clippings, especially around golf course greens, enhances vegetative growth of perennial *Kyllinga* species (Yelverton, 1996). *Kyllinga brevifolia* and *K. gracillima* produce culms that produce fruit below most turfgrass mowing heights (< 1.25 cm), resulting in a reproductive advantage over many other weeds, and they spread rapidly in turf via rhizome growth (Yelverton, 1996). Factors contributing to the increasing importance of *Kyllinga* species as weeds include irrigation of turf, type and timing of herbicide applications, use of fertilizer, and the expansion in the container nursery plants and turfgrass industry to meet the increasing demand for "instant," well-manicured flowerbeds, lawns, and golf courses (Yelverton, 1996; Bryson et al., 1997).

Kyllinga brevifolia and *K. gracillima* are similar in appearance and difficult, if not impossible, to distinguish vegetatively (Yelverton, 1996). Collections of fruiting specimens of *K. gracillima* are primarily from late August until frost, suggesting that the initiation of flowering is dependent upon photoperiod. The more northern distribution of *K. gracillima* in the U.S.A. suggests that it can withstand cooler winter temperatures. *Kyllinga brevifolia*, *K. odorata*, *K. pumila*, and *K. squamulata* flower and produce fruit during the frost-free months throughout their ranges in the continental U.S.A. (Bryson et al., 1997).

LEPIDOSPERMA

Lepidosperma is a genus of ca. 60 species distributed in tropical and subtropical areas of China, Malaysia, Australia, New Caledonia, and New Zealand (Kern, 1974; Mabberley, 1997). One species, *L. chinense* Nees & Meyen, grows in rice fields in southern China (Kern, 1974) and is cited as a weed in Appendix 2.

LEPIRONIA

Lepironia Rich. is a genus of five species distributed in Polynesia and Madagascar (Mabberley, 1997). *Lepironia articulata* (Retz.) Domin, cultivated for fibers used in sails and as packing material (Mabberley, 1997), is a weed of rice fields in Malaysia (Moody, 1989) and is cited in Appendix 2.

LIPOCARPHA

Lipocarpha R. Br. (including *Hemicarpha* Nees) consists of ca. 35 species of wet pantropical and warm temperate regions (Tucker, 2002c). In Appendix 2, three species are cited as weeds of rice or other wet agricultural fields: *Lipocarpha chinensis* (Osbeck) J. Kern, *L. microcephala* (R. Br.) Kunth, and *L. squarrosa* (L.) Goetgh. (Lin, 1968; Kern, 1974; Holm et al., 1979; Kühn, 1982; Koyama, 1985). Additionally, we have observed *L. maculata* (Michx.) Torr. in the southeastern U.S.A. as a weed of disturbed hydric soils, poorly kept moist lawns, roadsides, and ditches. Based upon our observations of its habitat and the citation of congeners as weeds in the Eastern Hemisphere (Kern, 1974; Koyama, 1985), we suspect that *L. maculata* could become a weed in rice fields in the U.S.A. and elsewhere.

MAPANIA

Mapania (including *Thoracostachyum* Kurz) is a genus of 73 species distributed in tropical and subtropical areas of Asia (Mabberley, 1997). *Mapania cuspidata* (Miq.) Uittien grows in rice fields in Indonesia (Moody, 1989) and is cited as a weed in Appendix 2.

OXYCARYUM

Oxycaryum Nees is a monotypic genus widely distributed in the tropics and subtropics of Africa and the Americas (Bruhl, 2002). The only species, *O. cubense*, is in the West Indies (Kunth, 1837), South and Central America (Nees von Esenbeck, 1842; Adams, 1994), the southeastern U.S.A. (Chapman, 1889; Small, 1933; Godfrey & Wooten, 1979; Tucker, 1987), and tropical Africa (Lye, 1971; Hooper & Napper, 1972; Haines & Lye, 1983). In the southeastern U.S.A., it occurs sporadically in Florida (Chapman, 1889; Clewell, 1985; Wunderlin, 1998), southern Georgia (Bryson et al., 1996), southern Alabama (Mohr, 1901; Lelong, 1988), Louisiana (Thomas & Allen, 1993), and coastal Texas (Correll & Johnston, 1970; Hatch et al., 1990; Jones et al., 1997). *Oxycaryum cubense* has spirally arranged scales and has been treated as *Scirpus cubensis* Poepp. & Kunth (e.g., Correll & Johnston, 1970; Godfrey & Wooten, 1979); however, its habit and embryo resemble *Cyperus* (van der Veken, 1965; Lye, 1971), and its taxonomic placement has been disputed: Cypereae (Lye, 1971) and Scirpeae (Bruhl, 1995). The molecular analysis of Muasya et al. (2002) supports classification of *Oxycaryum* in Cypereae. Two forms differing only in gross inflorescence features occur throughout the range of the species. Plants with umbellate inflorescences are called *O. cubense* f. *cubense*, while those with monocephalous inflorescences are called *O. cubense* f. *paraguayense* (Maury) Pedersen (Barros, 1960; Pedersen, 1995). This aquatic species forms extensive floating rafts in ponds, lakes, ditches, or impounded swamps in the southeastern U.S.A. and elsewhere (Haines & Lye, 1983; Bryson et al., 1996). *Oxycaryum cubense* is one of the most vigorous plants (along with *Salvinia molesta* D. S. Mitch. and *Pistia stratiotes* L.) in forming sudds in African lakes (Holm et al., 1977), thereby impeding navigation. In the southeastern U.S.A., *O. cubense* appears to be invasive, with floating mats covering large areas to the exclusion of other aquatic vegetation (Bryson et al., 1996); however, its sporadic distribution in the U.S.A. suggests low fertility of achenes. Its corky buoyant achenes are adapted to dispersal by moving water, and its mat-forming, floating habit facilitates asexual reproduction and transport of vegetative fragments by moving water (Haines & Lye, 1983). *Oxycaryum cubense* has been in the southeastern U.S.A. for more than a century (Chapman, 1889; Mohr, 1901), and we suspect that it was dispersed into North America from the West Indies or South America by migratory birds or with ballast. In order to understand better its dispersal and potential to invade wetland habitats, additional research into its reproductive biology is needed to determine the extent to which *O. cubense* reproduces sexually and spreads from achenes.

RHYNCHOSPORA

Rhynchospora is a cosmopolitan genus of more than 250 species, most of which inhabit wet, acidic soils (Kral, 2002e). *Rhynchospora* spp. are of little economic importance as weeds, and 20 species are listed in Appendix 2. Although most *Rhynchospora* spp. considered to be weeds are only secondarily or occasionally so, *R. corymbosa* (L.) Britton, *R. holoschoenoides* (Rich.) Herter, *R. submarginata* Kük., and *R. wightiana* (Nees) Steud. are cited as weeds of rice agriculture in the Eastern Hemisphere (Kern, 1974; Simpson & Inglis, 2001). In the U.S.A., *R. corniculata* (Lam.) A. Gray and *R. globularis* (Chapm.) Small are occasionally weeds (WSSA, 1989) along ground transportation routes but usually do not cause economic losses, and dense stands of the caespitose perennial, *R. corniculata*, along waterways impede flow in canals associated with rice production and can cause unwanted flooding of agricultural fields. Several species related to *R. corniculata* are sometimes locally abundant in roadside ditches in the Coastal Plain of the eastern U.S.A. *Rhynchospora macrostachya* Torr. ex A. Gray and *R. corniculata* are found in hydric soils in a variety of wetland habitats, including roadside ditches and margins of artificial ponds, and both are caespitose perennials of wide distribution in eastern North America (Kral, 2002e). The related species, *R. inundata* Fernald and *R. careyana* Fernald, are emergent rhizomatous perennials that form extensive stands in shallow depressions in the flatwoods, including roadside ditches (Kral, 2002e). Although only *R. corniculata* is listed as a weed, we suspect that *R. careyana*, *R. inundata*, and *R. macrostachya* might be invasive, if introduced into similar habitats outside of their natural ranges. *Rhynchospora caduca* Elliott, of little value as forage for livestock, is sometimes a weed in poorly maintained pastures in the southeastern U.S.A. where it is native (Bryson, pers. obs.) and is recently introduced and spreading rapidly in Hawaii (Wagner et al., 1990; Wagner & Herbst, 1995). *Rhynchospora globularis*, another native of the continental U.S.A., was collected in 1982 as an introduction in Hawaii (Wagner et al., 1990) and also occurs in northern California (Cranfil, 1993) where it is perhaps introduced from the eastern U.S.A. Other *Rhynchospora* spp. that opportunistically spread into artificially disturbed sites within their native ranges in the southeastern U.S.A. include *R. cephalantha* A. Gray, *R. debilis* Gale, *R. fascicularis* (Michx.) Vahl, *R. glomerata* (L.) Vahl, *R. fernaldii* Gale, *R. inexpansa* (Michx.) Vahl, *R. microcephala* (Britton) Britton ex Small, *R. odorata* C. Wright ex Griseb., and *R. torreyana* A. Gray (Godfrey & Wooten, 1979; Bryson & Carter, pers. obs.). We suspect that such plants would likely become invasive if introduced into suitable habitats elsewhere, as *R. caduca* has in Hawaii.

SCHOENOPLECTUS

Schoenoplectus is a genus of 77 species worldwide (Smith, 2002b), of which 20 are cited as weeds in Appendix 2. *Schoenoplectus mucronatus* (L.) Palla [= *Scirpus mucronatus* L.], considered to be among the world's worst weeds (Holm et al., 1997), is a pest in rice and other row and tree crops in Bangladesh, France, India, Malaysia, the Philippines, Portugal, Spain, and the U.S.A. (Holm et al., 1997). *Schoenoplectus mucronatus* is a greater problem in paddy fields where hand labor is the primary method of weed control than in rice production involving mechanical tillage and the use of herbicides. *Schoenoplectus grossus* (L. f.) Palla [= *Scirpus grossus* L. f.] is a weed of rice, riverbeds, reservoirs, and irrigation systems in southeastern Asia including regions of Vietnam, India, and the Philippines, and *S. tabernaemontani* is also listed as a weed of rice in China (Zhirong et al., 1990). *Schoenoplectus juncoides* (Roxb.) Palla is reportedly naturalized in rice fields in Europe (DeFilipps, 1980a). *Schoenoplectus acutus* and *S. americanus* (Pers.) Volkart ex Schinz & R. Keller are weeds in wetland areas of North America (WSSA, 1989; Callahan et al., 1995), while *S. californicus* (C. A. Mey.) Soják is reported as a weed in North America and Brazil (WSSA, 1989; Kissmann, 1997).

SCIRPODENDRON

Scirpodendron Zipp. ex Kurz is a genus of two species ranging from Sri Lanka and southeastern Asia through Malesia to Australia and Polynesia (Goetghebeur, 1998). *Scirpodendron* inhabits freshwater tidal swamps, tidal swamp forests, and forests adjacent to mangroves, and its large fruits are dispersed by water (Kern, 1974). It is cultivated in Sumatra for its leaves, which are used for thatching and weaving mats and hats (Kern, 1974). *Scirpodendron ghaeri* (Gaertn.) Merr. has been cited as a weed of rice fields in Asia (Moody, 1989).

SCIRPUS

Scirpus is a genus of 35 species widely distributed in North America, Mexico, Eurasia, Australia, and the Pacific Islands (Whittemore & Schuyler, 2002). Eight species are listed as weeds in Appendix 2, none of which is invasive in agricultural croplands. *Scirpus atrovirens* Willd., *S. pendulus* Muhl., and *S. cyperinus* (L.) Kunth are native to North America and cited as weeds there (WSSA, 1989; Callahan et al., 1995). These *Scirpus* species are occasional weeds along roadsides and waterways and in wet pastureland but rarely cause economic losses. *Scirpus atrovirens* and *S. pendulus* are naturalized in Europe (DeFilipps, 1980a). In the U.S.A., where it is native, *S. cyperinus* sometimes forms extensive stands dominating disturbed wetlands (Carter, pers. obs.), and we strongly suspect it would be an invasive pest if introduced into suitable habitats outside its natural range.

SCLERIA

Scleria is widely distributed in tropical and subtropical regions around the world and consists of ca. 200 species (Reznicek et al., 2002). As shown in Appendix 2, 24 species are weeds, a number of which are aquatics and known or potential weeds of rice agriculture (e.g., *Scleria biflora* Roxb., *S. laevis* Retz., *S. lithosperma* (L.) Sw., *S. novae-hollandiae* Boeckeler). The non-native invasive weed *S. lacustris* C. Wright has been found in freshwater marshes of peninsular Florida, U.S.A., where it can be locally abundant and dominant in water up to 1 m deep, forming dense stands and displacing native vegetation (Tobe et al., 1998; Wunderlin, 1998; Jacono, 2001). *Scleria lacustris* seems to require recession of standing water in order to become established (Jacono, 2001). It is thought to be native in scattered areas of the Neotropics, Africa, and Madagascar (Core, 1933; Hennessy, 1985) and is known from Brazil, Cuba, Costa Rica, French Guiana, Guyana, Jamaica, Paraguay, Suriname, U.S.A., and six countries across tropical Africa (Jacono, 2001). Additional research is needed to determine the ecological range of *S. lacustris* and control strategies. *Scleria vaginata* Steud. is an aggressive vine native to Central and South America that was collected once in southern Florida, U.S.A. (Reznicek et al., 2002), and we suspect it could be invasive if introduced into tropical and subtropical areas outside its native range.

DISCUSSION

Cyperaceae is a large, diverse, cosmopolitan family, and many of its species are biologically predisposed to spread opportunistically into areas altered by humans. Data compiled in Appendix 1 show that humans have played a tremendous role in the dispersal of sedges, including many weeds. Given the fundamental importance of dispersal and habitat disturbance in the evolution and survival of weeds and their intrinsic attributes favoring competition, colonization, and migration, it is not surprising that many sedges have evolved and continue to evolve as weeds. The magnitude of the human "footprint" on Earth is immense. Given the role that humans play in destruction and conversion of natural areas into disturbed and highly artificial ruderal habitats and urban and agricultural systems, it is axiomatic that the numbers of noxious weeds and invasive plant species will increase in step with the human population.

It is difficult to anticipate which species will become weeds, and where and under what circumstances they will be invasive. *Rhynchospora caduca*, a seemingly innocuous sedge native to the southeastern U.S.A., has recently been reported as an invasive weed in Hawaii (Wagner & Herbst, 1995). *Rhynchospora caduca* is not extraordinary among the beak-rushes in the southeastern U.S.A., which suggests that any number of apparently harmless species could pose similar problems in an alien environment. Insular systems, such as the Hawaiian Islands, have great potential as natural laboratories for the study of invasion.

Appendix 2 is a list of 447 species of Cyperaceae cited as weeds, which was compiled from more than 60 publications. Most cyperaceous weeds are from tropical and subtropical regions, and the most troublesome sedges (*Cyperus rotundus*, *C. esculentus*, *C. difformis*, and *C. iria*) are native to Asia and Africa but are now widely dispersed on other continents.

In order to examine the impact of humans on dispersal and introduction of cyperaceous weeds, we noted commonalities in listings of species in Appendices 1 and 2 and used these data to construct Table 4. Thus, Table 4 shows the number of weed species in each genus that are known or suspected to have been anthropogenically dispersed. When Appendices 1 and 2 are compared, 111 species are common to both lists (Table 4) with the greatest number of cyperaceous weeds known or suspected to be dispersed by humans in *Cyperus* (43 spp., ca. 39%), followed by *Carex* (24 spp., ca. 22%); *Eleocharis* (9 spp., ca. 8%); *Fimbristylis* (8 spp., 7%); *Kyllinga* and *Schoenoplectus* (6 spp. each, 5%); *Scirpus* (5 spp. each, ca. 5%); *Rhynchospora* (3 spp., ca. 3%); *Fuirena* (2 spp., ca. 2%); and *Bolboschoenus, Bulbostylis*, *Lepironia*, *Lipocarpha*, and *Mapania* (1 spp. each, ca. 1%).

Cyperus, by far, has been subject to greater anthropogenic dispersal than the other cyperaceous genera, which undoubtedly has been an important factor. It is readily concluded from Appendix 1 that *Cyperus* spp. have been mostly introduced unintentionally through a variety of human activities, especially as contaminants of seeds (particularly rice), wool, and dumping of ship's ballast. It seems reasonable to conclude from these data that systematic surveys of flora in vicinity of ports of entry are needed for early detection of new introductions and reintroductions and to understand better the dynamics of inadvertent importation of noxious weeds.

The role of rice agriculture in the introduction of cyperaceous weeds has long been recognized and is reinforced by data presented in Appendix 1. The number of cyperaceous weeds associated with rice agriculture in Appendix 2 is great, and, despite advancements in the regulation of importation of grain, there still exists the possibility of unintentional movement and introduction of other potentially noxious sedges as contaminants in shipments of seeds. These data indicate the need for continued vigilance and regulation of movement and importation of sedges throughout the world.

Historically, *Carex* spp. have received little attention as agricultural weeds. However, Kukkonen (2001) includes rice fields in Pakistan as habitats of *Carex diandra*, *C. pycnostachya*, and *C. divisa* Huds., and he describes *C. songorica* Kar. & Kir., *C. diluta* M. Bieb., and *C. orbicularis* Boott as growing in irrigation channels. The latter set of species is not listed in Appendix 2, which includes only entries explicitly characterized as weeds or invasives or directly associated with agricultural fields, gardens, or turf. However, populations of native sedges that have spread into irrigation canals associated with agriculture have certainly adapted to human disturbance, and biotypes adapted to conditions in the adjacent fields could easily evolve.

The large number of ornamental and cultivated sedges (>150 spp.) listed in Appendix 1 was not anticipated. Of particular interest is the increasing horticultural usage of sedges, especially *Carex* spp., as ornamentals (Figs. 2 and 3). This indicates a need for increased research into the reproductive biology, physiology, and growth characteristics of ornamental sedges to determine which species may be safely used and where and which will likely become invasive. There is also a need for greater awareness about problems inherent in the unwise and irresponsible use of ornamental sedges and additional measures toward intervention to prevent the transportation and importation of ornamental sedges.

Because of their distributions across vast latitudinal, altitudinal, and climatic ranges and diverse habitats, populations of widely distributed weeds have been subject to a great array of environmental factors resulting in much localized natural (and artificial) selection and diversification. Thus, in general, the taxonomy of weeds is far more complex than of other plants, which is evident in the complex nomenclature of the most widely distributed weeds, e.g., *Cyperus esculentus*, *C. rotundus* (Haines & Lye, 1983), *C. polystachyos* (cf. Kükenthal, 1935–1936), and *C. sanguinolentus* (cf. Kükenthal, 1935–1936; Kern, 1974). To resolve basic questions about relationships within these taxa, there is a great need for additional morphometric, field-, and herbarium-based research into the variation and taxonomy on a worldwide basis. The increased use of molecular techniques (e.g., Muasya et al., 2000a, b, 2002) should help to stabilize nomenclature by resolving the taxonomic status and rank of certain disputed groups, e.g., the segregates of *Cyperus* and *Scirpus*. In the future, the results of molecular research will elucidate much about the pathways of introduction

Table 4. Numbers and percentages of species of Cyperaceae by genus, which have been cited as weeds and are known or suspected to be dispersed by humans (data extracted from Appendices 1 and 2).[1]

Genus	Species (incl. infrasp.)	Percent of Total
Cyperus[2]	43	39
Carex	24	22
Eleocharis	9	8
Fimbristylis	8	7
Kyllinga	6	5
Schoenoplectus	6	5
Scirpus	5	5
Rhynchospora	3	3
Fuirena	2	1
Bolboschoenus	1	1
Bulbostylis	1	1
Lepironia	1	1
Lipocarpha	1	1
Mapania	1	1
Abildgaardia	0	0
Caustis	0	0
Cladium	0	0
Courtoisina	0	0
Cymophyllus	0	0
Desmoschoenus	0	0
Eriophorum	0	0
Gahnia	0	0
Isolepis	0	0
Kobresia	0	0
Lepidosperma	0	0
Machaerina	0	0
Oreobolus	0	0
Oxycaryum	0	0
Schoenus	0	0
Scleria	0	0
Trichophorum	0	0
Uncinia	0	0
Total	111	~100

[1] Authority names for genera in Table 4 not discussed elsewhere in this paper are as follows: *Caustis* R. Br.; *Desmoschoenus* Hook f.; *Kobresia* Willd.; *Oreobolus* R. Br.; *Schoenus* L.; *Trichophorum* Pers.

[2] Includes *Diclidium*, *Juncellus*, *Mariscus*, *Pycreus*, and *Queenslandiella*.

and migration of invasive weeds. Introduction of new weeds is increasingly a problem because of the frequency and ease of long-distance and international transportation, and advances in basic research will result in molecular assays useful in detecting and stopping weeds at ports of entry and in more accurately diagnosing infestations of herbicide-resistant biotypes of weeds.

Given the economics of weed control, including indirect costs (e.g., increased cost of health care, remediation of environmental damage), every precaution should be taken to avoid tagging indigenous plants as weeds without compelling supportive evidence. Realistically and pragmatically, it is most certainly advantageous and desirable for native plants to occupy roadsides and other artificial habitats than alien weeds. There is a great need for basic research to determine the ecological tolerances and invasive potentials and limits of indigenous and nonindigenous weeds. For only through the results of such research will basic knowledge be advanced sufficiently to allow applied scientists, natural resource managers, and the public to make informed, intelligent decisions about which plants to promote, which to exclude, which to suppress, and when to suppress them.

Literature Cited

Abad, P., B. Pascual, J. V. Maroto, S. Lopez-Galarza, A. Sanbautista & J. Alagarda. 2000. Chufa (*Cyperus esculentus* L. var. *sativus* Boeck.): An unconventional crop. Studies related to application and cultivation. Econ. Bot. 54: 439–448.

Adams, C. D. 1994. Cyperaceae. Pp. 262–485 *in* G. Davidse, M. Sousa S. & A. O. Chater (editors), Flora Mesoamericana, Vol. 6: Alismataceae a Cyperaceae. Universidad Nacional Autónoma de México, México, D.F.; Missouri Botanical Garden, St. Louis; The Natural History Museum, London.

Akobundu, J. O. & C. W. Agyakwa. 1987. A Handbook of West Africa Weeds. International Institute of Tropical Agriculture, Ibadan, Nigeria.

Aleixo, M. de F. D. & I. F. M. Valio. 1976. Effect of light, temperature and endogenous growth regulators on the growth of buds of *Cyperus rotundus* L. tubers. Z. Pflanzenphysiol. 80: 336–347.

Allan, M. 1978. Weeds: The Unbidden Guests in Our Gardens. Viking Press, New York.

Baijnath, H. 1975. A study of *Cyperus alternifolius* L., sens. lat. (Cyperaceae). Kew Bull. 30: 521–526.

Bailey, L. H. 1935. The Standard Cyclopedia of Horticulture, Vols. 1–3. The Macmillan Company, New York.

—. 1949. Manual of Cultivated Plants. Macmillan Publishing Company, New York.

— & E. Z. Bailey. 1976. Hortus Third. Macmillan Publishing Company, New York.

Baker, H. G. 1965. Characteristics and modes of origin of weeds. Pp. 147–172 *in* H. G. Baker & G. L. Stebbins (editors), The Genetics of Colonizing Species. Academic Press, New York.

—. 1974. The evolution of weeds. Annual Rev. Ecol. Evol. Syst. 5: 1–24.

Ball, P. W. & A. A. Reznicek. 2002. *Carex*. Pp. 254–273 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—, — & D. F. Murray. 2002. Cyperaceae. Pp. 3–608 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

Barrentine, W. L., C. E. Snipes & R. S. Baker. 1992. Herbicide application technology. Pp. 439–514 *in* C. G. McWhorter & J. R. Abernathy (editors), Weeds of Cotton: Characterization and Control. The Cotton Foundation, Memphis.

Barros, M. 1960. Las Cyperaceas del estado de Santa Catalina. Sellowia 12: 181–450.

Baskin, J. M. & C. C. Baskin. 1978. A discussion of the growth and competitive ability of C_3 and C_4 plants. Castanea 43: 71–76.

Bayer AG. 1992. Important Crops of the World and Their Weeds, 2nd ed. Business Group Crop Protection, Bayer AG, Leverkusen, Germany.

Beal, E. O. 1977. A Manual of Marsh and Aquatic Vascular Plants of North Carolina with Habitat Data. Tech. Bull. 247. North Carolina Agricultural Research Service, Raleigh.

Bellue, M. K. 1932. Weeds of California seed rice. Monthly Bull. Calif. Dept. Agric. 21: 290–296.

Bendixen, L. E. & U. B. Nandihalli. 1987. Worldwide distribution of purple and yellow nutsedge (*Cyperus rotundus* and *C. esculentus*). Weed Technol. 1: 61–65.

Benl, G. 1937. Eigenartige verbreitungseinrichtungen bei der Cyperaceengattung *Gahnia*. Flora 131: 369–386.

Bernard, J. M. & F. K. Seischab. 1994. Life history of shoots of *Carex comosa* F. Boott. Rhodora 96: 179–189.

Bertels, A. 1957. Contribuição ao conhecimento das Ciperaceas de Pelotas (RS). Inst. Agronomico do Sol. Bol. Tecn. 17: 22–28.

Black, C. C., T. M. Chen & R. H. Brown. 1969. Biochemical basis for plant competition. Weed Sci. 17: 338–344.

Boyette, C. D. 2000. The bioherbicide approach: Using phytopathogens to control weeds. Pp. 134–152 *in* A. H. Cobb & R. C. Kirkwood (editors), Herbicides and Their Mechanisms of Action. Sheffield Academic Press, Sheffield, United Kingdom.

Brickell, C. & J. D. Zuk (editors). 1997. The American Horticultural Society A–Z Encyclopedia of Garden Plants, 1st ed. DK Publishing, Inc., New York.

Britton, N. L. 1886. A preliminary list of N. A. species of *Cyperus*, with descriptions of new forms. Bull. Torrey Bot. Club 13: 205–216.

Brooklyn Botanical Garden. 1988. Ornamental Grasses. Brooklyn Botanical Gardens, Inc., New York.

Brown, A. 1880. Ballast plants in New York City. Bull. Torrey Bot. Club 7: 122–126.

Brown, A. D. H. & B. E. Marshall. 1981. Evolutionary changes accompanying colonization in plants. Pp. 351–363 *in* G. C. E. Scudder & J. L. Reveal (editors), Evolution Today. Carnegie-Mellon Univ., Pittsburgh.

Brown, W. V. 1975. Variations in anatomy, associations, and origins in kranz tissue. Amer. J. Bot. 62: 395–402.

Browning, J., K. D. Gordon-Gray & S. G. Smith. 1995. Achene structure and taxonomy of North American *Bolboschoenus* (Cyperaceae). Brittonia 47: 433–445.

Bruhl, J. 1993. Sedge Genera of the World, Vers. 2.01. Intkey, Interactive Dataset. N.C.W. Beadle Herbarium, Univ. of New England, Armidale.

—. 1995. Sedge genera of the world: Relationships and a new classification of the Cyperaceae. Austral. Syst. Bot. 8: 125–305.

—. 2002. *Oxycaryum*. P. 140 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

Bruton, D. F. & P. M. Catling. 1982. The slender sedge (*Carex praegracilis*) new to Ottawa district: An example of contemporary plant migration. Trail & Landscape 16: 152–157.

Bryson, C. T. 1984. Weed alert: Smallflower umbrella sedge (*Cyperus difformis* L.). S. Weed Sci. Soc. Newslett. 7: 6.

—. 1985a. *Carex* weeds of Mississippi. J. Mississippi Acad. Sci. 30: 10.

—. 1985b. *Cyperus* weeds of Mississippi cotton fields. J. Mississippi Acad. Sci. 30: 10.

—. 1994. Effects of tillage and herbicide input levels on purple nutsedge (*Cyperus rotundus* L.) control in cotton. Proc. Weed Sci. Soc. Amer. 34: 75.

—. 1997. Costs and effects of tillage and herbicide inputs for purple nutsedge (*Cyperus rotundus*) control in cotton. Proc. Weed Sci. Soc. Amer. 37: 94.

—. 2003. Weed species. Pp. 1571–1588 *in* J. Plimmer (editor), Encyclopedia Agrochemicals, Vol. 3. John Wiley & Sons, New York.

— & R. Carter. 1992. Notes on *Cyperus* and *Kyllinga* (Cyperaceae) in Mississippi with records of six species new to the state. Sida 15: 119–124.

— & —. 1994. Notes on *Carex*, *Cyperus*, and *Kyllinga* (Cyperaceae) in Mississippi with records of eight species previously unreported to the state. Sida 16: 171–182.

— & —. 1995. Introduction and spread of weedy *Cyperus* species in the United States. Proc. Weed Sci. Soc. Amer. 35: 36.

— & —. 2004. Biology of pathways for invasive weeds. Weed Technol. 18: 1216–1220.

— & J. E. Hanks. 1993. Effects of spray droplet size on control of purple nutsedge (*Cyperus rotundus*). Proc. S. Weed Sci. Soc. 46: 334.

— & —. 2001. Weed shifts in Deep Hollow watershed, Leflore County, MS. Pp. 86–90 *in* R. A. Rebich & S. Knight (editors), The Mississippi Delta Management Systems Evaluation Area Project, 1995–1999. Mississippi Agricultural & Forestry Experiment Station Bulletin 377, Mississippi State.

— & P. E. Keeley. 1992. Reduced tillage systems. Pp. 323–363 *in* C. G. McWhorter & J. R. Abernathy (editors), Weeds of Cotton: Characterization and Control. The Cotton Foundation, Memphis.

— & R. F. C. Naczi. 2002. *Carex* section *Laxiflorae*. Pp. 431–440 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

— & G. D. Wills. 1991. Purple nutsedge (*Cyperus rotundus*) control with low-volume technology in cotton. Proc. S. Weed Sci. Soc. 40: 404.

—, — & P. C. Quimby Jr. 1990. Low volume application of herbicides in an invert emulsion for purple nutsedge (*Cyperus rotundus*) control. Weed Technol. 4: 907–909.

—, R. F. C. Naczi & S. McDaniel. 1992a. Notes on noteworthy records of *Carex* (Cyperaceae) from the southeastern United States. Sida 15: 125–135.

—, G. D. Wills & J. E. Hanks. 1992b. Purple nutsedge (*Cyperus rotundus* L.) control in cotton with low-volume oil application technology. Proc. Weed Sci. Soc. Amer. 32: 78.

—, J. E. Hanks & G. D. Wills. 1994a. Nutsedge (*Cyperus rotundus*) control in reduced-tillage cotton production with low-volume technology. Weed Technol. 8: 28–31.

—, J. R. MacDonald & R. Warren. 1994b. Notes on *Carex* (Cyperaceae), with *C. godfreyi* new to Alabama and *C. communis* and *C. scoparia* new to Mississippi. Sida 16: 355–361.

—, —, R. Carter & S. D. Jones. 1996. Noteworthy *Carex*, *Cyperus*, *Eleocharis*, *Kyllinga*, and *Oxycaryum* (Cyperaceae) from Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, Tennessee, and Texas. Sida 17: 501–518.

—, R. Carter, L. B. McCarty & F. H. Yelverton. 1997. *Kyllinga*, a genus of neglected weeds in the continental United States. Weed Technol. 11: 838–842.

—, N. C. Coile & J. H. Rettig. 1998. Friend or foe: Identifying *Cyperus*. Palmetto 18: 16–19.

—, C. Salisbury & W. B. McCloskey. 1999. Weeds and their control. Pp. 617–658 *in* C. W. Smith & J. T. Cothren (editors), Cotton: Origin, History, Technology and Production. John Wiley & Sons, New York.

—, K. N. Reddy & W. T. Molin. 2002. Purple nutsedge population dynamics in narrow row transgenic cotton and soybean. Proc. S. Weed Sci. Soc. 55: 169–170.

—, R. Carter & D. J. Rosen. 2003a. Deeprooted Sedge (*Cyperus entrerianus*). Proc. S. Weed Sci. Soc. 56: 370.

—, K. N. Reddy & W. T. Molin. 2003b. Purple nutsedge (*Cyperus rotundus*) population dynamics in narrow row transgenic cotton (*Gossypium hirsutum*) and soybean (*Glycine max*). Weed Technol. 17: 805–810.

Buchanan, G. A. 1992. Trends in weed control methods. Pp. 47–72 *in* C. G. McWhorter & J. R. Abernathy (editors), Weeds of Cotton: Characterization and Control. The Cotton Foundation, Memphis.

Buchholtz, K. P. 1967. Definitions of terms used in weed control. Weeds 15: 388–389.

Burkhalter, J. R. 1985. *Aletris farinosa*, *Cyperus difformis*, and *Cyperus pilosus* new for Florida. Sida 11: 247–248.

Burkill, H. M. 1985. The Useful Plants of West Tropical Africa, Vol. 1, 2nd ed. Royal Botanical Gardens, Kew.

Burkill, I. 1935. A Dictionary of the Economic Products of the Malay Peninsula, Vols. 1 & 2. Governments of the Straits Settlements and Federated Malay States, Crown Agents for the Colonies, London.

Burns, E. R. & G. A. Buchanan. 1967. Controlling wolftail (*Carex cherokeensis*) in pastures. Highlights Agric. Res. Alabama Agric. Exp. Sta. 14: 4.

—, — & A. E. Hiltbold. 1969. Absorption and translocation of 2,4-D by wolftail (*Carex cherokeensis* Schwein.). Weed Sci. 17: 401–404.

Burr, R. J. & G. F. Warren. 1971. Enhancement of herbicide activity with an isoparaffinic oil carrier. Weed Sci. 19: 701–705.

— & —. 1972. An oil carrier for increasing purple nutsedge control. Weed Sci. 20: 324–327.

Byrd, J. D., Jr. 1995a. Report of the 1994 cotton weed loss committee. Proc. Beltwide Cotton Conf., Cotton Weed Sci. Res. Conf. 18: 595–598.

—. 1995b. Mississippi cotton weed survey. Proc. Beltwide Cotton Conf., Cotton Weed Sci. Res. Conf. 18: 598–599.

Callahan, R. H., S. L. Carson & R. T. Dobbins. 1995. NAWEEDS, Computer-aided Weed Identification for North America. Illustrated User's Guide plus Computer Floppy Disk. Moscow, Idaho.

Cardenas, J., C. E. Reyes & J. D. Doll. 1972. Tropical Weeds Maleza Tropicales, Vol. 1. Instituto Colombiano Agropecuario, Bogota.

Carter, R. 1984. A Systematic Study of the New World Species of Section *Umbellati* of *Cyperus*. Ph.D. Dissertation, Vanderbilt Univ., Nashville.

—. 1990. *Cyperus entrerianus* (Cyperaceae), an overlooked species in temperate North America. Sida 14: 69–77.

—. 1993. Animal dispersal in the North American sedge, *Cyperus plukenetii* (Cyperaceae). Amer. Midl. Naturalist 129: 352–356.

—. 2003. What to do with an unknown specimen: Preparation and storage of vouchers. Proc. S. Weed Sci. Soc. 56: 372.

—. 2005. An introduction to the sedges of Georgia. Tipularia 20: 15–44.

— & C. T. Bryson. 1991a. A report of *Cyperus grayioides* and *Cyperus retroflexus* (Cyperaceae) new to Missouri and notes on other selected Missouri *Cyperus*. Sida 14: 475–481.

— & —. 1991b. A second station and new county record for *Cyperus retroflexus* (Cyperaceae) in Missouri. Missouriensis 12: 33.

— & —. 1996. *Cyperus entrerianus*: A little known aggressive sedge in the southeastern United States. Weed Technol. 10: 232–235.

— & —. 2000a. Taxonomy of weedy *Cyperus* species. P. 47 *in* Third International Weed Science Congress, Abstracts. Foz do Iguaçu, Brazil.

— & —. 2000b. Notes on the distribution, ecology, and taxonomy of *Cyperus sanguinolentus* (Cyperaceae) new to the southeastern United States, and its relation to the supposed endemic *Cyperus louisianensis*. Sida 19: 325–343.

— & —. 2001. Bloodscale sedge (*Cyperus sanguinolentus*), a new weed in the United States. Proc. Weed Sci. Soc. Amer. 41: 93.

— & C. E. Jarvis. 1986. Re-evaluation and lectotypification of *Scirpus echinatus* L. Rhodora 88: 451–456.

— & S. D. Jones. 1991. Additional records of *Cyperus entrerianus* (Cyperaceae) in the United States. Sida 14: 615–616.

— & —. 1997. Notes on the *Cyperus retroflexus* complex (Cyperaceae) with three nomenclatural proposals. Rhodora 99: 319–334.

— & R. Kral. 1990. *Cyperus echinatus* and *Cyperus croceus*, the correct names for North American *Cyperus ovularis* and *Cyperus globulosus*. Taxon 39: 322–327.

— & R. L. Mears. 2000. *Cyperus* (subg. *Queenslandiella*) *hyalinus* (Cyperaceae) new to the United States and the western hemisphere. Sida 19: 345–350.

—, C. T. Bryson & B. L. Lipscomb. 1987. *Cyperus uniflorus* (Cyperaceae) east of the Mississippi River. Sida 12: 250.

—, M. W. Morris & C. T. Bryson. 1990. Some rare or otherwise interesting vascular plants from the Delta Region of Mississippi. Castanea 55: 40–55.

—, R. L. Mears, K. C. Burks & C. T. Bryson. 1996. A report of four exotic *Cyperus* species new to Florida, U.S.A. Sida 17: 275–281.

—, D. K. Alexander, C. T. Bryson & A. Lazari. 1999. The taxonomy of *Cyperus virens* and *Cyperus drummondii* (Cyperaceae) in the southeastern United States. Sida 18: 1049–1063.

Champlin, R. L. 1994. Notes on the Rhode Island flora. Rhodora 96: 102–103.

Chandler, J. M. & F. T. Cooke. 1992. Economics of cotton losses caused by weeds. Pp. 85–116 *in* C. G. McWhorter & J. R. Abernathy (editors), Weeds of Cotton: Characterization and Control. The Cotton Foundation, Memphis.

—, A. S. Hamill & A. G. Thomas. 1984. Crop Losses Due to Weeds in Canada and the United States. Weed Science Society of America, Champaign, Illinois.

Chapman, A. W. 1889. Flora of the Southern States, 2nd ed. Ivison, Blakeman & Company, New York.

Chase, M. W., D. E. Soltis, P. S. Soltis, P. J. Rudall, M. F. Fay, W. H. Hahn, S. Sullivan, J. Joseph, M. Molvray, P. J. Kores, T. J. Givnish, K. J. Sytsma & J. C. Pires. 2000. Higher-level systematics of the monocotyledons: An assessment of current knowledge and a new classification. Pp. 3–16 *in* K. L. Wilson & D. A. Morrison (editors), Monocots: Systematics and Evolution. CSIRO Publishing, Collingwood, Victoria, Australia.

Chermezon, H. 1924. Sur la dissemination de quelques Cyperacees. Bull. Soc. Bot. France 71: 849–861.

Clarke, C. B. 1884. On the Indian species of *Cyperus*. J. Linn. Soc., Bot. 21: 1–2002.

—. 1894. Cyperaceae. Pp. 585–672 *in* J. D. Hooker (editor), The Flora of British India, Vol. VI, Pt. XIX. L. Reeve & Co., London.

—. 1900. Cyperaceae. Pp. 8–160 *in* I. Urban (editor), Symbollae Antillanae, Vol. 2. Fratres Borntraeger, Leipzig.

—. 1908. New genera and species of Cyperaceae. Bull. Misc. Inform. Kew 8: 1–196.
Clewell, A. F. 1985. Guide to the Vascular Plants of the Florida Panhandle. Univ. Presses of Florida, Tallahassee.
Coble, H. D. & J. D. Byrd. 1992. Interference of weeds in cotton. Pp. 73–84 *in* C. G. McWhorter & J. R. Abernathy (editors), Weeds of Cotton: Characterization and Control. The Cotton Foundation, Memphis.
Core, E. L. 1933. The American species of *Scleria*. Brittonia 2: 1–105.
Correll, D. S. & M. C. Johnston. 1970. Manual of the Vascular Plants of Texas. Texas Research Foundation, Renner.
Cranfill, R. 1993. *Rhynchospora*. P. 1144 *in* J. C. Hickman (editor), The Jepson Manual: Higher Plants of California. Univ. of California Press, Berkeley.
Cronk, Q. C. B. & J. L. Fuller. 1995. Plant Invaders. Chapman & Hall, London.
Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia Univ. Press, New York.
Cusick, A. W. 1984. *Carex praegracilis*: A halophytic sedge naturalized in Ohio. Michigan Botanist 23: 103–106.
Daehler, C. C. & D. R. Strong. 1997. Hybridization between introduced smooth cordgrass (*Spartina alterniflora*: Poaceae) and native California cordgrass (*S. foliosa*) in San Francisco Bay, California, USA. Amer. J. Bot. 84: 607–611.
Darby, W. J., P. Ghaliougui & L. Grivetii. 1977. Food: The Gift of Osiris, Vol. 2. Academic Press, London.
Darke, R. 1999. The Color Encyclopedia of Ornamental Grasses: Sedges, Rushes, Restios, Cattails, and Selected Bamboos. Timber Press, Portland.
Datta, S. & A. Benerjee. 1976. The weight and number of seeds produced by rice-field weeds. P. A. N. S. 22: 257–263.
De Datta, S. & H. Jereza. 1976. The use of cropping systems and land and water management to shift weed species. Philipp. J. Crop Sci. 1: 173–178.
DeFelice, M. S. 2002. Yellow nutsedge *Cyperus esculentus* L.—Snack food of the gods. Weed Technol. 16: 901–907.
— & C. T. Bryson. 2004. Interactive Encyclopedia of North American Weeds, Vers. 3.0 (DVD-ROM). Southern Weed Science Society, Champaign, Illinois.
DeFilipps, R. A. 1980a. *Scirpus*. Pp. 277–280 *in* T. G. Tutin, V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters & D. A. Webb (editors), Flora Europaea, Vol. 5. Cambridge Univ. Press, Cambridge.
—. 1980b. *Fimbristylis*. P. 284 *in* T. G. Tutin, V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters & D. A. Webb (editors), Flora Europaea, Vol. 5. Cambridge Univ. Press, Cambridge.
—. 1980c. *Cyperus*. Pp. 284–288 *in* T. G. Tutin, V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters & D. A. Webb (editors), Flora Europaea, Vol. 5. Cambridge Univ. Press, Cambridge.
Delahoussaye, A. J. & J. W. Thieret. 1967. *Cyperus* subgenus *Kyllinga* (Cypercaeae) in the continental United States. Sida 3: 128–136.
Denton, M. F. 1978. A taxonomic treatement of the Luzulae group of *Cyperus*. Contr. Univ. Michigan Herb. 11: 197–271.
Derr, J. F. & J. W. Wilcut. 1993. Control of yellow and purple nutsedge (*Cyperus esculentus* and *C. rotundus*) in nursery crops. Weed Technol. 7: 112–117.
Dickoré, W. B. 1994. Flora Karakorumensis 1. Angispermae, Monocotyledoneae. Stapfia 39: 1–298.
Dirven, J. 1970. Weed flora of fallow rice fields. Surinam. Surinaamse Landb. 18: 47–63.
Dowler, C. C., E. W. Hauser & A. W. Johnson. 1974. Crop-herbicide sequences on a southeastern coastal plain soil. Weed Sci. 22: 500–505.
Duble, R. L., E. C. Holt & G. G. McBee. 1968. The translocation of two organic arsenicals in purple nutsedge. Weed Sci. 16: 421–424.
—, — & —. 1970. Effect of ANA on synthesis and utilization of food reserves in purple nutsedge. Weed Sci. 18: 174–179.
Duke, S. O. & C. D. Boyette. 2001. Biocontrol: Use of natural foes. Pp. 31–44 *in* R. DePrado & J. V. Jorrin (editors), Uso de Herbicidas en la Agricultura del Siglo XXI. Univ. Cordoba Press, Spain.
Elliott, S. 1821. A Sketch of the Botany of South-Carolina and Georgia, Vol. 1. J. R. Schenck, Charleston.
Elmore, C. D. 1984. Perennial Vines in the Delta of Mississippi. Mississippi Agricultural and Forestry Experiment Station Bulletin 927, Mississippi State.
— & C. T. Bryson (editors). 1986–2001. Weed Identification Guide, Sets 1–7. Southern Weed Science Society, Champaign, Illinois.
— & R. Paul. 1983. Composite list of C_4 weeds. Weed Sci. 31: 686–692.
—, L. G. Heatherly & R. A. Wesley. 1989. Perennial vine control in multiple cropping systems on a clay soil. Weed Technol. 3: 282–287.
Everett, T. H. 1980–1982. The New York Botanical Garden Illustrated Encyclopedia of Horticulture, Vols. 1–10. Garland Publishing, Inc., New York.

Eyles, D. & J. Robertson. 1963. A Guide and Key to the Aquatic Plants of the Southeastern United States. U.S. Public Health Service Bulletin 186. U.S. Public Health Service, Washington, D.C.

Fagotto, F. 1987. Sand-dune fixation in Somalia. Environm. Conservation 14: 157–163.

Fernald, M. L. 1930. *Carex macrocephala* and *C. anthericoides*. Rhodora 32: 9–11.

Ferren, W. R. & A. E. Schuyler. 1980. Intertidal vascular plants of river systems near Philadelphia. Proc. Acad. Nat. Sci. Philadelphia 132: 86–120.

Fischer, B. B., A. H. Lange, J. McCaskill, B. Crampton & B. Tabraham. 1978. Growers' Weed Identification Handbook. Univ. of California, Berkeley.

Ford, B. A. & A. A. Reznicek. 2002. *Carex* section *Squarrosae*. Pp. 518–519 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

Fosberg, F. R. 1988. Vegetation of Bikini Atoll. Atoll Res. Bull. 315.

Frans, R. E. 1969. Changing ecology of weeds in cotton fields. Proc. Beltwide Cotton Prod. Mech. Conf. 23: 24–30.

Frick, K. E. 1978. Purple nutsedge (*Cyperus rotundus* L.): A case for augmentation. Pp. 141–151 *in* T. E. Freeman (editor), Proceedings of the IV International Symposium on Biological Control of Weeds. Univ. of Florida, Gainesville.

Friedman, T. & M. Horowitz. 1971. Biologically active substances in subterranean parts of purple nutsedge. Weed Sci. 19: 398–401.

Gaddy, L. L. 1986. Twelve new ant-dispersed species from the southern Appalachians. Bull. Torrey Bot. Club 113: 247–251.

Garg, D. K., L. E. Bendixen & R. S. Anderson. 1967. Rhizome differentiation in yellow nutsedge. Weed Sci. 15: 124–128.

Garoni, L. W. & W. H. Murdy. 1964. Systematic relationship of granite outcrop endemic *Cyperus granitophilus* McVaugh to *C. inflexus* Muhl. A. S. B. Bull. 11: 43.

Glaze, N. C. 1987. Cultural and mechanical manipulation of *Cyperus* spp. Weed Technol. 1: 82–83.

Godfrey, R. K. & J. W. Wooten. 1979. Aquatic and Wetland Plants of Southeastern United States: Monocotyledons. Univ. of Georgia Press, Athens.

Goetghebeur, P. 1998. Cyperaceae. Pp. 141–190 *in* K. Kubitzki (editor), Families and Genera of Vascular Plants, Vol. 4. Springer-Verlag. Berlin.

Gordon-Gray, K. D. 1995. Cyperaceae in Natal. Strelitzia 2. National Botanical Institute, Pretoria, South Africa.

Govindarajalu, E. 1975. Studies in Cyperaceae. XIV. Endomorphic evidence for placing *Cyperus hyalinus* under the new subgenus *Queenslandiella*. Reinwardtia 9: 187–195.

Graf, A. B. 1985. Exotica Series 4, Vols. 1 & 2, 12th ed. Roehrs Company Inc., East Rutherford, New Jersey.

Greenlee, J. & D. Fell. 1992. The Encyclopedia of Ornamental Grasses. Rodale Press, Emmaus, Pennsylvania.

Grichar, W. J., P. R. Nester & A. E. Colburn. 1992. Nutsedge (*Cyperus* spp.) control in peanuts (*Arachis hypogaea*) with imazethapyr. Weed Technol. 6: 396–400.

Grounds, R. 1989. Ornamental Grasses. Christopher Helm, London.

Guppy, H. 1893. The river Thames as an agent in plant dispersal. Bot. J. Linn. Soc. 30: 333–346.

Haines, R. W. & K. A. Lye. 1983. The Sedges and Rushes of East Africa. East African Natural History Society, Nairobi.

Hamilton, K. C. 1971. Repeated, foliar application of MSMA on purple nutsedge. Weed Sci. 19: 675–677.

Handel, S. N. 1976. Dispersal ecology of *Carex pedunculata* (Cyperaceae), a new North American myrmecochore. Amer. J. Bot. 63: 1071–1079.

—. 1978. New ant-dispersed species in the genera *Carex*, *Luzula*, and *Claytonia*. Canad. J. Bot. 56: 2925–2927.

Hardcastle, W. S. & R. E. Wilkinson. 1971. Reactions of several crops to dichlobenil. Weed Sci. 19: 655–658.

Hatch, S. L., K. N. Gandhi & L. E. Brown. 1990. Checklist of the Vascular Plants of Texas. MP-1655. Texas Agricultural Experiment Station, College Station.

Hauser, E. W. 1962a. Establishment of nutsedge from space-planted tubers. Weeds 10: 209–212.

—. 1962b. Development of purple nutsedge under field conditions. Weeds 10: 315–321.

—. 1963a. Effects of amitrole on purple nutsedge at different growth stages. Weeds 11: 181–183.

—. 1963b. Response of purple nutsedge to amitrole, 2,4-D, and EPTC. Weeds 11: 251–252.

Healy, A. J. & E. Edgar. 1980. Flora of New Zealand, Vol. 3. P. D. Hasselberg, Wellington.

Hennessy, E. F. F. 1985. The genus *Scleria* in southern Africa. Bothalia 15: 505–530.

Hermann, F. J. 1970. Manual of the Carices of the Rocky Mountains and Colorado Basin. Agriculture Handbook 374. U.S. Department of Agriculture, Washington, D.C.

Hesla, B. I., I. L. Tieszen & S. K. Imbamba. 1982. A systematic survey of C_3 and C_4 photosynthesis in the Cyperaceae of Kenya, East Africa. Photosynthetica 16: 196–205.

Heywood, V. H. 1993. Flowering Plants of the World. B. T. Batsford, London.

Hill, J. E., J. R. Smith Jr. & D. E. Bayer. 1994. Rice weed control: Current technology and emerging issues in temperate rice. Austral. J. Exp. Agric. 34: 1021–1029.

Hollingsworth, E. B. 1969. Effects of soil incorporation on control of *Carex* with herbicides. Proc. Weed Sci. Soc. Amer. 19: 77.

Hollis, J. 1972. Nematocide-weed interaction in rice fields. Pl. Dis. Reporter 56: 420–424.

Holm, L. G., D. L. Plucknett, J. V. Pancho & J. P. Herberger. 1977. The World's Worst Weeds: Distribution and Biology. Univ. Press of Hawaii, Honolulu.

—, J. V. Pancho, J. P. Herberger & D. L. Plucknett. 1979. A Geographical Atlas of World Weeds. John Wiley & Sons, New York.

—, J. Doll, E. Holm, J. Pancho & J. Herberger. 1997. World Weeds: Natural Histories and Distribution. John Wiley & Sons, Inc., New York.

Holt, E. C., J. A. Long & W. W. Allen. 1962. The toxicity of EPTC to nutsedge. Weeds 10: 103–105.

Holt, J. S. & D. R. Orcutt. 1991. Functional relationships of growth and competitiveness in perennial weeds and cotton (*Gossypium hirsutum*). Weed Sci. 39: 575–584.

— & —. 1996. Temperature thresholds for bud sprouting in perennial weeds and seed germination in cotton. Weed Sci. 44: 523–533.

Hooper, S. S. & D. M. Napper. 1972. Cyperaceae. Pp. 278–349 *in* F. N. Hepper (editor), Flora of West Tropical Africa. Crown Agents for Oversea Governments and Administrations, London.

Hopkins, W. G. & N. P. A. Hüner. 2004. Introduction to Plant Physiology. John Wiley & Sons, Inc., Hoboken, New Jersey.

Horak, M. J. & J. S. Holt. 1986. Isozyme variability and breeding systems in populations of yellow nutsedge (*Cyperus esculentus*). Weed Sci. 34: 538–543.

—, — & N. C. Ellstrand. 1987. Genetic variability in yellow nutsedge (*Cyperus esculentus*). Weed Sci. 35: 506–512.

Horowitz, M. 1972. Growth, tuber formation, and spread of *Cyperus rotundus* L. from single tubers. Weed Res. 12: 348–363.

Horvat, M. L. 1941. A revision of the subgenus *Mariscus* found in the United States. Catholic Univ. Amer. Biol. Ser. 33: 1–147.

Hughes, G. D. 1995. New Hawaiian plant records. II. Records of the Hawaii Biological Survey for 1994, Part 2: Notes. Bishop Mus. Occas. Pap. 42: 1–10.

Hutton, E. E. 1976. Dissemination of perigynia in *Carex pauciflora*. Castanea 41: 346–348.

Huxley, A. 1992. The Royal Horticulture Society Dictionary of Gardening. Royal Horticulture Society, Wisley.

Jacometti, G. 1912. Le erbe che infestano le risaie italiane. Congresso Risicolo Internazionale, Vercelli 4: 57–91.

Jacono, C. C. 2001. *Scleria lacustris* (Cyperaceae), an aquatic and wetland sedge introduced to Florida. Sida 19: 1163–1170.

James, L., J. Evans, M. Ralphs & R. Child (editors). 1991. Noxious Range Weeds. Westview Press, Boulder.

Jansen, L. L. 1971. Morphology and photoperiodic responses of yellow nutsedge. Weed Sci. 19: 210–219.

Johnson, D. E. 1997. Weeds of Rice in West Africa. West Africa Rice Development Association. Bouake, Cote d'Ivoire.

Jones, S. D., C. T. Bryson & J. E. Ubelaker. 1993. *Carex blanda* and *Kyllinga odorata* (Cyperaceae) new to New Mexico and a significant range extension of *Cyperus retrorsus*. Sida 15: 252–253.

—, J. K. Wipff & R. Carter. 1996. Nomenclatural combinations in *Cyperus* (Cyperaceae). Phytologia 80: 288–290.

—, — & P. M. Montgomery. 1997. Vascular Plants of Texas. Univ. of Texas Press, Austin.

Jordan, D. L. 1996. Adjuvants and growth stage affect purple nutsedge (*Cyperus rotundus*) control with chlorimuron and imazethpyr. Weed Technol. 10: 359–362.

Kantor, H. J. 1999. *Cyperus alopecuroides* Rottb. and the Egyptian Volute. Pp. 169–198 *in* Plant Ornament in the Ancient Near East. Oriental Institute, Univ. of Chicago. <http://www.oi.uchicago.edu/research/library/dissertation/kantor.html>, accessed 7 July 2008.

Kartesz, J. T. 1994. A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland, Vol. 1. Timber Press, Portland.

Keeley, P. E. 1987. Interference and interaction of purple and yellow nutsedges (*Cyperus rotundus* and *C. esculentus*) with crops. Weed Technol. 1: 74–81.

— & R. J. Thullen. 1971. Control of nutsedge with organic arsenical herbicides. Weed Sci. 19: 601–606.

—, C. H. Carter & J. H. Miller. 1972. Evaluation of the relative phytotoxicity of herbicides to cotton and nutsedge. Weed Sci. 20: 71–74.

Kern, J. H. 1974. Cyperaceae I. Pp. 435–753 *in* C. G. G. van Steenis (editor), Flora Malesiana, Vol. 7. Noordhaff, Leiden.

Kissmann, K. G. 1997. Plantas Infestantes e Nocivas: Tomo 1, 2nd ed. BASF. Seaward Corporation, West Orange, New Jersey.

Klingman, G. C., F. M. Ashton & L. J. Noordhoff. 1982. Weed Science: Principles and Practices, 2nd ed. John Wiley & Sons, Inc., New York.

Knowllton, C. H., J. A. Cushman, W. Deane & A. K.

Harrison. 1911. Reports on the flora of Boston District-VIII. Rhodora 13: 27–29.

Koyama, T. 1985. Cyperaceae. Pp. 125–405 *in* M. D. Dassanayake & F. R. Fosberg (editors), Flora of Ceylon, Vol. 5. Amerind Publishing Co. Pvt. Ltd., New Delhi.

Kral, R. 1971. A treatment of *Abildgaardia*, *Bulbostylis*, and *Fimbristylis* (Cyperaceae) for North America. Sida 4: 58–277.

—. 1980. A synopsis of *Fuirena* (Cyperaceae) for the Americas north of South America. Sida 7: 309–354.

—. 1981. Further additions to some notes on the flora of the Southern States, particularly Alabama and Middle Tennessee. Rhodora 83: 301–315.

—. 2002a. *Fuirena*. Pp. 32–37 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002b. *Fimbristylis*. Pp. 121–131 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002c. *Bulbostylis*. Pp. 131–136 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002d. *Abildgaardia*. Pp. 136–137 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002e. *Rhynchospora*. Pp. 200–239 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

Kühn, U. 1982. Cyperaceae. *In* E. Häfliger, U. Kühn, L. Hämet-Ahti, C. D. K. Cook, R. Faden & F. Speta (editors), Monocot Weeds 3. Ciba-Geigy Ltd., Basel, Switzerland.

Kükenthal, G. 1935–1936. Cyperaceae–Scirpoideae–Cypereae. Pp. 1–671 *in* A. Engler (editor), Das Pflanzenreich IV, 20 (Heft 101). Wilhelm Englemann, Leipzig.

Kukkonen, I. 2001. Cyperaceae, No. 206. Pp. 1–277 *in* S. I. Ali & M. Qaiser (editors), Flora of Pakistan. Univ. of Karachi, Karachi; Missouri Botanical Garden, St. Louis.

Kunth, C. S. 1837. Enumeratio plantarum, Vol. 2. J. G. Cottae, Stuttgart & Tübingen.

Le Bourgeois, T. & H. Merlier. 1995. Les Adventices d'Afrique Soudano-sahelienne. CIRAD-CA, Montpellier.

LeBaron, H. M. 1991. Distribution and seriousness of herbicide-resistant weed infestations worldwide. Pp. 27–43 *in* J. C. Caseley, G. W. Cussans & R. K. Atkins (editors), Herbicide Resistance in Weeds and Crops. Butterworth-Heinemann, Ltd., Oxford.

Lelong, M. G. 1988. Noteworthy monocots of Mobile and Baldwin counties, Alabama. Sida 13: 101–113.

Lin, C. I. 1968. Weeds Found on Cultivated Land in Taiwan, Vol. 1. Dept. Agronomy, College of Agriculture, National Taiwan Univ., Taipei.

Lipscomb, B. L. 1980. *Cyperus difformis* L. (Cyperaceae) in North America. Sida 8: 320–327.

Long, J. A., W. W. Allen & E. C. Holt. 1962. Control of nutsedge in bermudagrass turf. Weeds 10: 285–287.

Long, R. W. & O. Lakela. 1971. A Flora of Tropical Florida. Univ. of Miami Press, Coral Gables.

Lorenzi, H. 1982. Plantas Daninhas do Brasil: Terrestres, Aquaticas, Parasitas, Toxicas e Medicinais. Nova Odessa, São Paulo.

Lye, K. A. 1971. Studies in African Cyperaceae 2. The genus *Oxycaryum* Nees. Bot. Not. 124: 280–286.

—. 1973. Studies in African Cyperaceae 8. The taxonomic position of *Abildgaardia* Vahl and *Nemum* Hamilton. Bot. Not. 126: 325–329.

—. 1981. Studies in African Cyperaceae 19. The genera of *Anosporum* Nees and *Sorostachys* Steudel. Nordic J. Bot. 1: 186–191.

—. 1992. The history of the genus *Mariscus*. Lidia 3: 37–72.

—. 2000. Achene structure and function of structure in Cyperaceae. Pp. 615–628 *in* K. L. Wilson & D. A. Morrison (editors), Monocots: Systematics and Evolution. CSIRO Publishing, Collingwood, Victoria, Australia.

Mabberley, D. J. 1997. The Plant Book, 2nd ed. Cambridge Univ. Press, Cambridge.

Mallik, M. & K. Tesfai. 1988. Alleopathic effect of common weeds on soybean's growth and soybean–bradrhizobium symbiosis. Pl. & Soil 112: 177–182.

Martinez-Diaz, G. 1997. Allelopathy of Purple Nutsedge (*Cyperus rotundus* L.) on Cotton (*Gossypium*). Ph.D. Dissertation, Univ. of Arizona, Tuscon.

Mastrogiuseppe, J. 2002. *Carex* section *Macgocephalae*. Pp. 307–309 *in* Flora of North American Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

McGivney, M. V. 1938. A revision of the subgenus *Eucyperus* found in the United States. Catholic Univ. Amer. Biol. Ser. 26: 1–74.

McKenzie, P. M., B. Jacobs, C. T. Bryson, G. C. Tucker & R. Carter. 1998. *Cyperus fuscus* (Cyperaceae), new to Missouri and Nevada, with comments on its occurrence in North America. Sida 18: 325–333.

McNaughton, S. J. & L. L. Wolf. 1973. General Ecology. Holt, Rinehart & Winston, Inc., New York.

McWhorter, C. G. 1982. The use of adjuvants. Pp. 10–21 *in* R. H. Hodgson (editor), Adjuvants for Herbicides. Weed Science Society of America, Champaign, Illinois.

— & C. T. Bryson. 1992. Herbicide use trends. Pp. 233–294 *in* C. G. McWhorter & J. R. Abernathy (editors), Weeds of Cotton: Characterization and Control. The Cotton Foundation, Memphis.

Mears, R. & G. W. Libby. 1995. New records of *Cyperus* (Cyperaceae) from Kentucky. Castanea 60: 79–82.

Michaux, A. 1803. Flora Boreali-Americana. Levrault, Paris.

Miles, J. E., K. K. Nishimoto & O. Kawabata. 1996. Dirurnally altering temperatures stimulate sprouting of purple nutsedge (*Cyperus rotundus*) tubers. Weed Sci. 44: 122–125.

Miller, J. H. & K. V. Miller. 1999. Forest Plants of the Southeast and Their Wildlife Uses. Southern Weed Science Society, Champaign, Illinois.

Mohr, C. 1901. Plant life of Alabama. Contr. U.S. National Herb. 6: 1–921.

Moody, K. 1981. Major Weeds of Rice in South and Southeast Asia. International Rice Research Institute, Los Banos, Laguna, Philippines.

—. 1989. Weeds Reported in Rice in South and Southeast Asia. International Rice Research Institute, Manila.

Moore, L. B. & E. Edgar. 1970. Flora of New Zealand, Vol. 2. A. R. Shearer, Wellington.

Morales-Payan, J. P., R. Charudattan & W. M. Stall. 2005. Fungi for biological control of weedy Cyperaceae, with emphasis on purple and yellow nutsedges (*Cyperus rotundus* and *C. esculentus*). Outlooks on Pest Management 16: 148–155.

Muasya, A. M., J. J. Bruhl, D. A. Simpson, A. Culham & M. W. Chase. 2000a. Suprageneric phylogeny of Cyperaceae: A combined analysis. Pp. 593–601 *in* K. L. Wilson & D. A. Morrison (editors), Monocots: Systematics and Evolution. CSIRO Publishing, Collingwood, Victoria, Australia.

—, D. A. Simpson, M. W. Chase & A. Culham. 2000b. Phylogenetic relationships within the heterogenous *Scirpus* s. lat. (Cyperaceae) inferred from *rbcL* and *trnL-F* sequence data. Pp. 610–614 *in* K. L. Wilson & D. A. Morrison (editors), Monocots: Systematics and Evolution. CSIRO Publishing, Collingwood, Victoria, Australia.

—, — & —. 2002. Phylogenetic relationships in *Cyperus* L. s.l. (Cyperaceae) inferred from plastid DNA sequence data. Bot. J. Linn. Soc. 138: 145–153.

Muenscher, W. C. 1955. Weeds, 2nd ed. Cornell Univ. Press, Ithaca.

Mühlenbach, V. 1979. Contributions to the synanthropic (adventive) flora of the railroads in St. Louis, Missouri, U.S.A. Ann. Missouri Bot. Gard. 66: 1–108.

—. 1983. Supplement to the contributions to the synanthropic (adventive) flora of the railroads in St. Louis, Missouri, U.S.A. Ann. Missouri Bot. Gard. 70: 170–178.

Murray, D. S., L. M. Verhalen & R. J. Tyrl. 1992. The changing weed problem in cotton. Pp. 117–232 *in* C. G. McWhorter & J. R. Abernathy (editors), Weeds of Cotton: Characterization and Control. The Cotton Foundation, Memphis.

Naczi, R. F. C. 1984. Rare sedges discovered and rediscovered in Delaware. Bartonia 50: 31–35.

—, R. J. Driskill, E. L. Pennell, N. E. Seyfried, A. O. Tucker & N. H. Dill. 1986. New records of some rare DelMarVa sedges. Bartonia 52: 49–57.

Nees von Esenbeck, C. G. 1842. Cyperaceae. *In* C. F. P. Martius (editor), Flora Brasiliensis, Vol. 2, Pt. 1. F. Fleischer, Leipzig.

Negbi, M. 1992. A sweetmeat plant, perfume plant and their relatives: A chapter in the history of *Cyperus esculentus* L. and *C. rotundus* L. Econ. Bot. 46: 64–71.

Noda, K. & S. Eguchi. 1965. Studies on ecology of weeds on arable lands: 1. Emergence patterns of annual representative weeds which are commonly found on the paddy rice fields of south-western Japan. Bull. Kyushu Agric. Exp. Sta. 11: 153–170.

Ohwi, J. 1965. Flora of Japan. Smithsonian Institution, Washington, D.C.

O'Neill, H. T. 1938a. *Cyperus pilosus* Vahl in the United States. Rhodora 40: 74.

—. 1938b. *Cyperus oxylepis* Nees ex Steudel in the United States. Rhodora 40: 358.

—. 1946. The genus *Cyperus* in Cuba. Contr. Ocas. Mus. Hist. Nat. Colegio "De La Salle" 6: 1–15.

Ottesen, C. 1989. Ornamental Grasses. McGraw-Hill Publishing Co., New York.

Palm, C. E., W. W. Dykstra, G. R. Ferguson, R. Hansberry, W. J. Hayes Jr., L. W. Hazleton, J. G. Horsfall, E. F. Knipling, L. D. Leach, L. W. Lovvorn & G. A. Swanson. 1968. Principles of Plant and Animal Pest Control, Vol. 2: Weed Control. National Academy of Sciences, Washington, D.C.

Pappas-Fader, T., J. F. Cook, T. Butler, P. J. Lana & J. Hare. 1993. Resistance of California arrowhead and smallflower umbrella sedge to sulfonylurea herbicides. Proc. W. Soc. Weed Sci. 46: 76.

—, R. G. Turner, J. F. Cook, T. D. Butler, P. J. Lana & M. Carriere. 1994. Resistance monitoring program for aquatic weeds to sulfonylurea herbicides in

California rice fields. Proc. Rice Tech. Working Group 25: 165.
Parsons, W. T. & E. G. Cuthbertson. 1992. Noxious Weeds of Australia. Inkata Press, Melbourne.
Patterson, D. T. 1982. Shading responses of purple and yellow nutsedges (*Cyperus esculentus* and *C. rotundus*). Weed Sci. 30: 25–30.
Pedersen, T. M. 1995. Nueva combinacion in Cyperaceae. Hickenia 2: 138.
Pereira, W., G. Crabtree & R. D. William. 1987. Herbicide action on purple and yellow nutsedge (*Cyperus rotundus* and *C. esculentus*). Weed Technol. 1: 92–98.
Peterson, J. K. & H. F. Harrison Jr. 1995. Sweet potato allelopathic substance inhibits growth of purple nutsedge (*Cyperus rotundus*). Weed Technol. 9: 277–280.
Petřík, P. 2003. *Cyperus eragrostis*—A new alien species for the Czech flora and the history of its invasion of Europe. Preslia 75: 17–28.
Phatak, S. C., M. B. Calloway & C. S. Varrina. 1987. Biological control and its integration in weed management systems for purple and yellow nutsedge (*Cyperus rotundus* and *C. esculentus*). Weed Technol. 1: 84–91.
Pijl, L. van der. 1982. Principles of Dispersal in Higher Plants. Springer-Verlag, New York.
Pio Corrêa, M. 1926–1984. Dicionário das Plantas úteis do Brasil e das Exoticas Cultivadas, Vols. 1–6. Ministerio da Agricultura Instituto Brasileiro de Desenvolvimento Forestal Brazil, Imprensa Nacional, Rio de Janeiro.
Plowman, A. B. 1906. The comparative anatomy and phylogeny of Cyperaceae. Ann. Bot. (Oxford) 20: 1–37.
Radford, A. E., H. A. Ahles & C. R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill.
Radosevich, S. R. & J. S. Holt. 1984. Weed Ecology. John Wiley & Sons, New York.
Ramos, G. S., V. W. Cárdenas, P. B. Aquilar & R. P. Marín. 2004. Atlas de Malezas Arvenses del Estado de Querétaro. Universidad Autonoma de Querétaro, Querétaro, México.
Ranade, S. B. & W. Burns. 1925. The eradication of *Cyperus rotundus* L. Mem. Dept. Agric. India, Bot. Ser. 13: 99–192.
Randall, J. M. 1996. Weed control for the preservation of biological diversity. Weed Technol. 10: 370–383.
—. 1997. Defining weeds of natural areas. Pp. 18–25 *in* J. O. Luken & J. W. Thieret (editors), Management of Plant Invasions. Springer-Verlag, New York.
Ratliff, R. D. & S. E. Westfall. 1992. Restoring plant cover on high-elevation gravel areas, Sequoia National Park, California. Biol. Conservation 60: 189–195.
Ravi, N. & N. Mohanan. 2002. Common Tropical and Sub-tropical Sedges and Grasses. Science Publishers, Inc., Enfield, New Hampshire.
Reed, C. F. 1977. Economically Important Foreign Weeds. Agriculture Handbook No. 498. U.S. Department of Agriculture, Washington, D.C.
Reichard, S. H. & C. W. Hamilton. 1997. Predicting invasions of woody plants introduced into North America. Conservation Biol. 11: 193–203.
Rejmanek, M. 1996. A theory of seed plant invasiveness: The first sketch. Biol. Conservation 78: 171–181.
Reznicek, A. A. 2002. *Carex* section *Rhynchosystis*. Pp. 420–421 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.
— & P. M. Catling. 1987. *Carex praegracilis* in eastern North America: A remarkable case of rapid invasion. Rhodora 89: 205–216.
— & —. 2002. *Carex* section *Divisae*. Pp. 302–306 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.
—, — & S. M. McKay. 1976. *Carex praegracilis* W. Boott, recently adventive in southern Ontario. Canad. Field-Naturalist 90: 180–183.
—, J. E. Fairey III & A. T. Whittemore. 2002. *Scleria*. Pp. 242–251 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.
Rhoads, A. F. & W. M. Klein Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
Richburg, J. S., III, J. W. Wilcut & G. R. Wehtje. 1993. Toxicity of imazethpyr to purple (*Cyperus rotundus*) and yellow nutsedge (*C. esculentus*). Weed Technol. 7: 900–905.
—, — & —. 1994. Toxicity of AC 263,322 to purple (*Cyperus rotundus*) and yellow nutsedge (*C. esculentus*). Weed Sci. 42: 398–402.
Ridley, H. N. 1930. The Dispersal of Plants Throughout the World. L. Reeve & Co., Ltd., Ashford, United Kingdom.
Rosen, D. J., R. Carter & C. T. Bryson. 2006. The spread of *Cyperus entrerianus* (Cyperaceae) in the southeastern United States and its invasive potential in bottomland hardwood forests. S. E. Naturalist 5: 333–344.
Rothrock, P. E. 1991. The identity of *Carex albolutescens*, *C. festucacea*, and *C. longii* (Cyperaceae). Rhodora 93: 51–66.

Ryang, H., J. Chun & Y. Moon. 1978. Control of the perennial weed *Scirpus maritimus* in reclaimed paddy fields of west seashore. II. Physiological and ecological characteristics of *S. maritimus*. J. Korean Soc. Crop Sci. 23: 64–73.

Rzedowski, G. C. de & J. Rzedowski. 2004. Manual de Malezas de la Región de Salvatierra, Guanajuato. Flora del Bajío y de Regiones Adyacentes, Fascículo complementario XX. Instituto de Ecología, Veracruz, México.

Sauer, J. D. 1988. Plant Migration. Univ. of California Press, Berkeley.

Schery, R. W. 1972. Plants for Man, 2nd ed. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Schippers, P., S. J. ter Borg, J. M. van Groenendael & B. Habekotte. 1993. What makes *Cyperus esculentus* (yellow nutsedge) an invasive species? A spatial model approach. Pp. 495–504 *in* Proceedings of the Brighton Crop Protection Conference—Weeds. Brighton Crop Protection Registered Office, Farham, Surrey, England.

—, — & J. J. Bos. 1995. A revision of the infraspecific taxonomy of *Cyperus esculentus* (yellow nutsedge) with an experimentally evaluated character set. Syst. Bot. 20: 461–481.

Schroeder, J., S. H. Thomas & L. Murray. 1993. Yellow and purple nutsedge and chile peppers host southern root-knot nematode. Weed Sci. 41: 150–156.

Sculthorpe, C. 1967. The Biology of Aquatic Vascular Plants. Edward Arnold Ltd., London.

Sell, P. & G. Murrell. 1996. Flora of Great Britain and Ireland, Vol. 5. Cambridge Univ. Press, Cambridge.

Shaner, D. L. & J. L. Lyon. 1980. Interaction of glyphosate with aromatic amino acids on transpiration in *Phaseolus vulgaris*. Weed Sci. 28: 31–35.

Shear, G. M. 1985. Introduction and history of limited tillage. Pp. 1–14 *in* A. F. Wiese (editor), Weed Control in Limited-tillage Systems. Weed Science Society of America, Champaign, Illinois.

Simpson, D. A. 1992. A Revision of the *Mapania*. Royal Botanic Gardens, Kew.

—. 1993. Plant portrait 225: *Rhynchospora nervosa*. Bot. Mag. (Kew Mag.) 10: 117–121.

—. 1994. Plant portrait 236: *Cyperus prolifer* (Cyperaceae). Bot. Mag. (Kew Mag.) 11: 6–8.

— & C. A. Inglis. 2001. Cyperaceae of economic, ethnobotanical, and horticultural importance: A checklist. Kew Bull. 56: 257–360.

— & T. Koyama. 1998. Cyperaceae. Pp. 247–485 *in* T. Santisuk & K. Larsen (editors), Flora of Thailand, Vol. 6. The Forest Herbarium, Royal Forest Department, Bangkok.

Sipple, W. S. 1978. An Atlas of Vascular Plant Species Distribution Maps for Tidewater Maryland. Wetland Publ. No. 1. Maryland Department of Natural Resources, Annapolis.

Small, J. A. 1954. *Carex kobomugi* at Island Beach, New Jersey. Ecology 35: 289–291.

Small, J. K. 1933. Manual of the Southeastern Flora. Univ. of North Carolina Press, Chapel Hill.

Smith, A. H. 1867. On colonies of plants observed near Philadelphia. Proc. Acad. Nat. Sci. Philadelphia 1867: 15–24.

Smith, S. G. 2002a. *Bolboschoenus*. Pp. 37–44 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002b. *Schoenoplectus*. Pp. 44–60 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002c. *Eleocharis* ser. *Ovatae*. Pp. 102–105 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002d. *Isolepis*. Pp. 137–140 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—, A. E. Schuyler & W. J. Crins. 1993. *Scirpus*. Pp. 1146–1148 *in* J. C. Hickman (editor), The Jepson Manual: Higher Plants of California. Univ. of California Press, Berkeley.

—, J. J. Bruhl, M. S. Gonzalez-Elizondo & F. J. Menapace. 2002. *Eleocharis*. Pp. 60–120 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

Snyder, D. B. 1983. Rare New Jersey grasses and sedges. Bartonia 49: 71–72.

—. 1984. Botanical discoveries of Vincent Abraitys. Bartonia 50: 54–56.

Soejani, M., A. J. G. H. Kosteramans & G. Tjitrosoepomo. 1987. Weeds of Rice in Indonesia. Balai Pustaka, Jakarta.

Soros, C. L. & J. J. Bruhl. 2000. Multiple Evolutionary Origins of C_4 Photosynthesis in the Cyperaceae. Pp. 629–636 *in* K. L. Wilson & D. A. Morrison (editors), Monocots: Systematics and Evolution. CSIRO Publishing, Collingwood, Victoria, Australia.

Stalter, R. 1980. *Carex kobomugi* at Sandy Hook, New Jersey. Bull. Torrey Bot. Club 107: 431–432.

Standley, L. A. 1983. *Carex kobomugi* Ohwi, an adventive sedge to New England. Rhodora 85: 265–267.

—. 2002. *Carex* section *Vulpinae*. Pp. 273–278 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—, J. Cayouette & L. Bruederle. 2002. *Carex* section *Phacocystis*. Pp. 379–401 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

Stephens, J. M. 1994. Chufa *Cyperus esculentus* L. var. *sativus* Boeck. Florida Cooperative Extension Service Fact Sheet HS-583, Univ. of Florida, Gainesville.

Steward, K. K. & W. H. Ornes. 1975. The autecology of sawgrass in the Florida Everglades. Ecology 56: 162–171.

Stoller, E. W. & R. D. Sweet. 1987. Biology and life cycle of purple and yellow nutsedges (*Cyperus rotundus* and *C. esculentus*). Weed Technol. 1: 66–73.

—, D. P. Nema & V. M. Bhan. 1972. Yellow nutsedge tuber germination and seedling development. Weed Sci. 20: 93–97.

Strong, M. T. & W. L. Wagner. 1997. New and noteworthy Cyperaceae from the Hawaiian Islands. Bishop Mus. Occas. Pap. 48: 37–50.

Stuckey, J. M., T. J. Monaco & A. D. Worsham. 1980. Identifying Seedling and Mature Weeds Common in the Southeastern United States. North Carolina Agricultural Research Service and Agricultural Extension Service, North Carolina State Univ., Raleigh.

Stuckey, R. L. & T. M. Barkley. 1993. Weeds. Pp. 193–198 *in* Flora of North America Editorial Committee (editor), Flora of North America North of Mexico, Vol. 1. Oxford Univ. Press, New York.

Sumaryono & Basuki. 1986. Growth and reproduction of *Cyperus kyllingia* Endl. and *Cyperus brevifolius* (Rottb.) Hassk. *In* J. V. Pancho, S. S. Sastroutomo & S. Tjitrosemito (editors), Symposium in Weed Science Special Publication, No. 24. Institute of Tropical Biology, Bogor.

Sundell, E. & R. D. Thomas. 1988. Four new records of *Cyperus* (Cyperaceae) in Arkansas. Sida 13: 259–261.

Svenson, H. K. 1957. Cyperaceae: Tribe Scirpeae. N. Amer. Flora 18: 505–556.

—. 1979. The Flora of Cape Cod. Cape Cod Museum of Natural History, Brewster.

Swink, F. & G. Wilhelm. 1979. Plants of the Chicago Region, 3rd ed. Morton Arboretum, Lisle, Illinois.

Tachholm, V. & M. Drar. 1950. Flora of Egypt, Vol. 2. Bull. Fac. Sci. Fouad I Univ. 28: 1–475.

Tadulingam C. & G. Venkatanaryana. 1955. A Handbook of Some South Indian Weeds. Madras Gov. Press, Serial No. 38/1954. Delhi, India.

Terry, P. J. 1976. Sedge Weeds of East Africa. 1. Identification. E. African Agric. Forest. J. 42: 231–249.

—. 2001. The Cyperaceae—Still the world's worst weeds? Pp. 3–18 *in* C. R. Riches (editor), The World's Worst Weeds. British Crop Protection Council, Farnham, United Kingdom.

Thieret, J. W. 1964. More additions to the Louisiana flora. Sida 1: 294–295.

—. 1977. *Cyperus louisianensis* (Cyperaceae), a new species from southern Louisiana. Proc. Louisiana Acad. Sci. 40: 23–26.

Thomas, R. D. & C. M. Allen. 1993. Atlas of the Vascular Flora of Louisiana, Vol. I: Ferns & Fern Allies, Conifers, & Monocotyledons. Moran Colorgraphic Printing, Baton Rouge.

Thomas, W. W. 1984a. Systematics of *Rhynchospora* sect. *Dichromena*. Mem. New York Bot. Gard. 37: 1–116.

—. 1984b. Insect pollination of *Cymophyllus fraseri* (Andrews) Mackenzie. Castanea 49: 94–95.

Thullen, R. J. & P. E. Keeley. 1979. Seed production and germination in *Cyperus esculentus* and *C. rotundus*. Weed Sci. 27: 502–505.

Thumbleson, M. E. & T. K. Kommedahl. 1961. Reproductive potential of *Cyperus esculentus* by tubers. Weeds 9: 646–653.

Tietz, H. M. 1972. An Index to the Described Life Histories, Early Stages and Hosts of the Macrolepidoptera of the Continental United States and Canada. Allyn Museum of Entomology, Sarasota.

Tobe, J. D., K. C. Burks, R. W. Cantrell, M. A. Garland, M. E. Sweeley, D. W. Hall, P. Wallace, G. Anglin, G. Nelson, J. R. Cooper, D. Bickner, K. Gilbert, N. Aymond, K. Greenwood & N. Raymond. 1998. Wetland Plants: An Identification Manual. Florida Department of Environmental Protection, Tallahassee.

Torrey, J. 1836. Monograph of North American Cyperaceae. Ann. Lyceum Nat. Hist. New York 3: 249–288.

Tucker, G. C. 1983. The taxonomy of *Cyperus* (Cyperaceae) in Costa Rica and Panama. Syst. Bot. Monogr. 2: 1–85.

—. 1984. A revision of the genus *Kyllinga* Rottb. (Cyperaceae) in Mexico and Central America. Rhodora 86: 507–538.

—. 1985. The correct name for *Cyperus cayennensis* (*C. flavus*), Cyperaceae. S. W. Naturalist 30: 607–608.

—. 1987. The genera of Cyperaceae in the southeastern United States. J. Arnold Arbor. 68: 361–445.

—. 1994. Revision of the Mexican species of *Cyperus* (Cyperaceae). Syst. Bot. Monogr. 43: 1–213.

—. 2002a. *Cladium*. Pp. 44–60 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002b. *Kyllinga*. Pp. 193–194 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—. 2002c. *Lipocarpha*. Pp. 195–197 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

—, B. G. Marcks & J. R. Carter. 2002. *Cyperus*. Pp. 141–191 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

Turner, R. J., Jr. & E. Wasson (editors). 1998. Botanica. Random House Australia Pty. Ltd., Milsons Point, Sydney.

Ueno, O., M. Samejima & T. Koyama. 1989. Distribution and evolution of C_4 syndrome in *Eleocharis*, a sedge group inhabiting wet and aquatic environments, based on culm anatomy and carbon isotope ratios. Ann. Bot. (Oxford) 64: 425–438.

Uittien, H. 1932. Cyperaceae. Pp. 72–149 *in* A. Pulle (editor), Flora of Suriname. E. J. Brill, Leiden.

U.S. Army Corps of Engineers. 1999. Central and Southern Florida Project Comprehensive Review Study: Final Integrated Feasibility Report and Programmatic Environmental Impact Statement (CD-ROM). U.S. Army Corps of Engineers, Jacksonville District, Florida.

USDA. 1960. Index of Plant Diseases in the United States. Agriculture Handbook 165. U.S. Department of Agriculture Government Printing Office, Washington, D.C.

—. 1970. Selected Weeds of the United States. Agriculture Handbook 366. U.S. Department of Agriculture, Washington, D.C.

USFWS. 1988. National List of Vascular Plant Species that Occur in Wetlands. U.S. Fish and Wildlife Service Biological Report 88 (24), Washington, D.C.

Vaillant, A. 1967. Chemical control of annual weeds in rice. World Crops 19: 38–44.

Veken, P. van der. 1965. Contribution a l'embryolgraphie systématique des Cyperaceae–Cyperoideae. Bull. Jard. Bot. État. Bruxelles 35: 285–352.

Vencill, W. K., J. S. Richburg III, J. W. Wilcut & L. R. Hawf. 1995. Effect of MON-12037 on purple (*Cyperus rotundus*) and yellow (*Cyperus esculentus*) nutsedge. Weed Technol. 9: 148–152.

Verga, B., K. Moody & R. Visperas. 1977. Autecology of *Scirpus maritimus*, IV. Suggested control under field conditions. Philipp. Weed Sci. Bull. 4: 7–12.

Verga, M. & J. Sierra. 1970. Population of weed seeds in a lowland rice field. Philipp. Agric. 54: 1–7.

Vlaming, V. de & V. W. Proctor. 1968. Dispersal of aquatic organisms: Viability of seeds recovered from droppings of captive killdeer and mallard ducks. Amer. J. Bot. 55: 20–26.

Vorster, P. 1996. Justification for the generic status of *Courtoisina* (Cyperaceae). Bot. J. Linn. Soc. 121: 271–280.

Wagner, W. L. & D. R. Herbst. 1995. Contributions to the flora of Hawaii. IV. New records and name changes. Bishop Mus. Occas. Pap. 42: 13–27.

—, — & S. H. Sohmer. 1990. Manual of the Flowering Plants of Hawaii, Vol. 2. Univ. of Hawaii Press, Bishop Museum, Honolulu.

Walters, S. M. 1980. *Eleocharis*. Pp. 281–284 *in* T. G. Tutin, V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters & D. A. Webb (editors), Flora Europaea, Vol. 5. Cambridge Univ. Press, Cambridge.

Waterhouse, D. F. 1997. The Major Invertebrate Pests and Weeds of Agriculture and Plantation Forestry in the Southern and Western Pacific. ACIAR Monog. 44. Australian Centre for International Agricultural Research, Canberra.

Watkins, J. V. & T. J. Sheehan. 1975. Florida Landscape Plants. Univ. Presses of Florida, Gainesville.

Webb, D. H. & W. M. Dennis. 1981. Additions to the flora of Tennessee. Sida 9: 184–185.

—, — & T. S. Patrick. 1981. Distribution and naturalization of *Cyperus brevifolioides* (Cyperaceae) in eastern United States. Sida 9: 188–190.

Weedon, R. R. & H. A. Stephens. 1969. *Cyperus fuscus* in Nebraska and South Dakota. Rhodora 71: 433.

Westbrooks, R. G. 1998. Invasive Plants, Changing the Landscape of America: Fact Book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds, Washington, D.C.

—. 2001. Invasive species, coming to America: New strategies for biological protection through prescreening, early warning, and rapid response. Wildland Weeds 4: 5–11.

Whistler, W. A. 1994. Wayside Plants of the Islands: A Guide to the Lowland Flora of the Pacific Islands Including Hawaii, Samoa, Tonga, Tahiti, Fiji, Guam and Belau. Isle Botanica, Honolulu.

Whittemore, A. T. & A. F. Schuyler. 2002. *Scirpus*. Pp. 8–21 *in* Flora of North America Editorial Committee (editors), Flora of North America North of Mexico, Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York.

Whitwell, T. & R. Smith. 1997. Perennial kyllinga control in nursery crops. Proc. Weed Sci. Soc. Amer. 37: 28.

Wiese, A. F. 1986. Herbicide application. Pp. 1–27 *in* N. D. Camper (editor), Research Methods in Weed Science. Southern Weed Science Society, Champaign, Illinois.

Wilcut, J. W., J. S. Richburg III, E. F. Eastin, G. R. Wiley, F. R. Walls Jr. & S. Newell. 1994. Imazethapyr and paraquat systems for weed management in peanut (*Arachis hypogaea*). Weed Sci. 42: 601–607.

Williams, R. D. 1978. Photoperiod effects on the reproductive biology of purple nutsedge (*Cyperus rotundus*). Weed Sci. 26: 539–542.

Wills, G. D. 1972. Sugars, phosphorus, and iron in purple nutsedge. Weed Sci. 20: 348–350.

—. 1987. Description of purple and yellow nutsedge (*Cyperus rotundus* and *C. esculentus*). Weed Technol. 1: 2–9.

—. 1998. Comparison of purple nutsedge (*Cyperus rotundus*) from around the world. Weed Technol. 12: 491–503.

— & G. A. Briscoe. 1970. Anatomy of purple nutsedge. Weed Sci. 18: 631–635.

— & C. G. McWhorter. 1988. Effect of inorganic salts on the toxicity and translocation of glyphosate and MSMA in purple nutsedge (*Cyperus rotundus*). Weed Sci. 33: 755–761.

—, C. T. Bryson & J. E. Hanks. 1991. New low-volume application technology for purple nutsedge (*Cyperus rotundus*) control. Proc. Beltwide Cotton Prod. Res. Conf. 15: 959.

Wilson, K. L. 1981. A synopsis of the genus *Scirpus* sens. lat. in Australia. Telopea 2: 153–172.

—. 1993. Cyperaceae. Pp. 293–396 *in* G. J. Harden (editor), Flora of New South Wales, Vol. 4. New South Wales Univ. Press, Kensington.

WSSA. 1989. Composite List of Weeds. Weed Science Society of America, Champaign, Illinois.

Wunderlin, R. P. 1982. Guide to the Vascular Plants of Central Florida. Univ. Presses of Florida, Tampa.

—. 1998. Guide to the Vascular Plants of Florida. Univ. Press Florida, Gainesville.

Yelverton, F. 1996. Know your sedges. Golf Course Management 64: 56–60.

Zandstra, B. H. & R. K. Nishimoto. 1977. Movement and activity of glyphosate in purple nutsedge. Weed Sci. 25: 268–274.

—, C. K. H. Teo & R. K. Nishimoto. 1974. Response of purple nutsedge to repeated applications of glyphosate. Weed Sci. 22: 230–232.

Zeven, A. C. & P. M. Zhukovsky. 1975. Dictionary of Cultivated Plants and Their Centers of Diversity. Centre for Agricultural Publishing and Documentation, Wageningen, The Netherlands.

Zhirong, W., X. Mingyuan, M. Dehui, S. Shunzu, W. Xianfeng, Y. Chunbo, Z. Dianjing, F. Weizhuo, M. Enhui & C. Jixian. 1990. Farmland Weeds in China: A Collection of Coloured Illustrative Plates. Agricultural Publishing House, Shanghai.

Zimdahl, R. L. 1995. Introduction. Pp. 1–18 *in* A. E. Smith (editor), Handbook of Weed Management Systems. Marcel Dekker, Inc., New York.

APPENDIX 1

Known and suspected anthropogenic dispersal in Cyperaceae.

Species[1]	Method of dispersal	Source
Bolboschoenus glaucus (Lam.) S. G. Sm.	planted as waterfowl food, rice agriculture	Browning et al., 1995; Smith, 2002a
Bolboschoenus maritimus (L.) Palla	rice agriculture	Holm et al., 1997
Bolboschoenus maritimus subsp. *paludosus* (A. Nelson) T. Koyama	planted as waterfowl food	Smith, 2002a
Bolboschoenus robustus (Pursh) Soják	ornamental	Everett, 1980–1982
Bulbostylis humilis (Kunth) C. B. Clarke	wool alien	Sell & Murrell, 1996
Bulbostylis striatella C. B. Clarke	wool alien	Sell & Murrell, 1996
Carex acuta L.	ornamental	Grounds, 1989; Huxley, 1992
Carex acutiformis Ehrh.	ornamental	Huxley, 1992
Carex alba Scop.	ornamental	Huxley, 1992
Carex albula Allan	ornamental	Greenlee & Fell, 1992; Turner & Wasson, 1998; Darke, 1999
Carex appressa R. Br.	erosion control, wool alien	Huxley, 1992; Sell & Murrell, 1996; Simpson & Inglis, 2001
Carex arenaria L.	ornamental	Huxley, 1992
Carex atrata L.	ornamental	Grounds, 1989; Huxley, 1992
Carex austrina Mack.	railroad adventive	Mühlenbach, 1983
Carex baccans Nees	ornamental	Bailey, 1935; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999
Carex baldensis L.	ornamental	Huxley, 1992
Carex baltzellii Chapm. ex Dewey	ornamental	Darke, 1999
Carex berggreni Petrie	ornamental	Grounds, 1989; Huxley, 1992; Darke, 1999
Carex brevior (Dewey) Mack. ex Lunell	contaminated grass seed	Bryson et al., 1992
Carex brunnea Thunb.	ornamental	Grounds, 1989; Huxley, 1992
Carex buchananii Berggr.	ornamental	Bailey, 1935; Brooklyn Botanical Garden, 1988; Ottesen, 1989; Greenlee & Fell, 1992; Darke, 1999
Carex caryophyllea Latourr.	ornamental	Huxley, 1992; Darke, 1999
Carex cherokeensis Schwein.	hay	Bryson, pers. obs.
Carex comans Berggr.	ornamental	Everett, 1980–1982; Greenlee & Fell, 1992; Turner & Wasson, 1998; Darke, 1999
Carex conica Boott	ornamental	Bailey & Bailey, 1976; Ottesen, 1989; Greenlee & Fell, 1992; Darke, 1999
Carex crawfordii Fernald	railroad adventive	Mühlenbach, 1983
Carex crinita Lam.	ornamental	Darke, 1999
Carex curvula All.	ornamental	Huxley, 1992
Carex devia Cheeseman	wool alien	Sell & Murrell, 1996

Species[1]	**Method of dispersal**	**Source**
Carex deweyana Schwein.	wool alien	Sell & Murrell, 1996
Carex diandra Schrank	ornamental	Huxley, 1992
Carex digitata L.	ornamental	Huxley, 1992; Darke, 1999
Carex dipsacea Berggr.	ornamental	Grounds, 1989; Huxley, 1992; Turner & Wasson, 1998
Carex dissita Sol. ex Hook. f.	ornamental	Huxley, 1992
Carex divulsa Stokes subsp. *leersii* (Kneuck.) W. Koch	ornamental	Grounds, 1989
Carex dolichostachya Hayata	ornamental	Darke, 1999
Carex eburnea Boott in Hook.	ornamental	Darke, 1999
Carex elata All.	ornamental	Grounds, 1989; Ottesen, 1989; Greenlee & Fell, 1992; Huxley, 1992; Turner & Wasson, 1998; Darke, 1999
Carex exserta Mack.	revegetation	Ratliff & Westfall, 1992
Carex firma Host	ornamental	Grounds, 1989; Huxley, 1992; Darke, 1999
Carex flacca Schreb.	ornamental	Grounds, 1989; Huxley, 1992; Darke, 1999
Carex flaccosperma Dewey	ornamental	Darke, 1999
Carex flagellifera Colenso	ornamental, wool alien	Sell & Murrell, 1996; Ottesen, 1989; Greenlee & Fell, 1992; Turner & Wasson, 1998
Carex flava L.	ornamental	Ottesen, 1989
Carex gallaecica H. Lév. & Vaniot	ornamental	Bailey, 1935
Carex gaudichaudiana Kük.	ornamental	Bailey, 1935; Huxley, 1992
Carex geyeri Boott	erosion control	Hermann, 1970
Carex grayi J. Carey	ornamental	Bailey & Bailey, 1976; Grounds, 1989; Greenlee & Fell, 1992; Turner & Wasson, 1998; Darke, 1999
Carex hachijoensis Akiyama	ornamental	Grounds, 1989; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999
Carex hirta L.	ballast	Brown, 1880
Carex hoodii Boott in Hook.	erosion control	Hermann, 1970
Carex hubbardii Nelmes	wool alien	Sell & Murrell, 1996
Carex humilis Leyss.	ornamental	Huxley, 1992
Carex intumescens Rudge	ornamental	Bailey, 1935; Huxley, 1992
Carex inversa R. Br.	wool alien	Sell & Murrell, 1996
Carex kaloides Petrie	ornamental	Huxley, 1992
Carex kobomugi Ohwi	ballast, planted for dune stabilization	Champlin, 1994; Mastrogiuseppe, 2002
Carex longebrachiata Boeckeler	wool alien	Sell & Murrell, 1996
Carex longii Mack.	hay, pine-bark mulch	Bryson, pers. obs.
Carex lupulina Muhl. ex Willd.	ornamental	Darke, 1999
Carex montana L.	ornamental	Huxley, 1992; Darke, 1999

Appendix 1. Continued.

Species[1]	**Method of dispersal**	**Source**
Carex morrowii Boott	ornamental	Bailey, 1935; Bailey & Bailey, 1976; Everett, 1980–1982; Grounds, 1989; Ottesen, 1989; Greenlee & Fell, 1992; Huxley, 1992; Turner & Wasson, 1998; Darke, 1999
Carex muskingumensis Schwein.	ornamental	Brooklyn Botanical Garden, 1988; Grounds, 1989; Ottesen, 1989; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999
Carex nebrascensis Dewey	railroad adventive	Mühlenbach, 1979
Carex nigra (L.) Reichard	ornamental	Ottesen, 1989; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999
Carex nudata W. Boott in S. Watson	ornamental	Greenlee & Fell, 1992; Turner & Wasson, 1998; Darke, 1999
Carex oklahomensis Mack.	hay, highway construction	Bryson et al., 1992, 1996
Carex ornithopoda Willd.	ornamental	Grounds, 1989; Ottesen, 1989; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999
Carex oshimensis Nakai	ornamental	Grounds, 1989; Darke, 1999
Carex pallescens L.	ornamental	Darke, 1999
Carex paniculata L.	ornamental	Huxley, 1992; Heywood, 1993
Carex pansa L. H. Bailey	ornamental	Greenlee & Fell, 1992; Darke, 1999
Carex pendula Huds.	ornamental	Bailey & Bailey, 1976; Everett, 1980–1982; Grounds, 1989; Ottesen, 1989; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999; Reznicek, 2002
Carex pensylvanica Lam.	ornamental	Darke, 1999
Carex petriei Cheeseman	ornamental	Grounds, 1989; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999
Carex phyllocephala T. Koyama	ornamental	Grounds, 1989; Greenlee & Fell, 1992; Darke, 1999
Carex pilulifera L.	ornamental	Grounds, 1989; Darke, 1999
Carex plantaginea Lam.	ornamental	Bailey & Bailey, 1976; Grounds, 1989; Greenlee & Fell, 1992; Huxley, 1992
Carex praegracilis W. Boott	highway construction and maintenance, ornamental	Reznicek et al., 1976; Bruton & Catling, 1982; Cusick, 1984; Reznicek & Catling, 1987; Darke, 1999
Carex pseudocyperus L.	ornamental	Brooklyn Botanical Garden, 1988; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999
Carex riparia Curtis	ornamental	Bailey, 1935; Everett, 1980–1982; Grounds, 1989; Huxley, 1992; Darke, 1999
Carex scaposa C. B. Clarke	ornamental	Huxley, 1992
Carex secta Boott	wool alien	Sell & Murrell, 1996
Carex siderosticta Hance	ornamental	Grounds, 1989; Greenlee & Fell, 1992; Huxley, 1992; Darke, 1999
Carex solandri Boott	ornamental, wool alien	Sell & Murrell, 1996; Darke, 1999

Species[1]	Method of dispersal	Source
Carex spectabilis Dewey	erosion control	Hermann, 1970
Carex spissa L. H. Bailey	ornamental	Greenlee & Fell, 1992; Turner & Wasson, 1998; Darke, 1999
Carex stricta Lam.	ornamental	Ottesen, 1989; Darke, 1999
Carex sylvatica Huds.	ornamental	Brooklyn Botanical Garden, 1988; Greenlee & Fell, 1992; Huxley, 1992
Carex temnolepis Franch.	ornamental	Greenlee & Fell, 1992
Carex tereticaulis F. Muell.	wool alien	Sell & Murrell, 1996
Carex testacea Sol. ex Boott	ornamental	Greenlee & Fell, 1992; Turner & Wasson, 1998; Darke, 1999
Carex texensis (Torr.) L. H. Bailey	ornamental	Greenlee & Fell, 1992
Carex trifida Cav.	ornamental	Huxley, 1992
Carex tumulicola Mack.	ornamental	Greenlee & Fell, 1992; Turner & Wasson, 1998; Darke, 1999
Carex umbrosa Host	ornamental	Huxley, 1992
Carex uncifolia Cheeseman	ornamental	Grounds, 1989; Huxley, 1992
Carex uruguensis Boeckeler	erosion control	Pio Corrêa, 1926–1984
Carex vilmorini Mottet	ornamental	Greenlee & Fell, 1992
Carex virgata Boott ex Hook. f.	wool alien	Sell & Murrell, 1996
Carex vulpina L.	ornamental	Huxley, 1992
Carex vulpinoidea Michx.	possibly introduced with fodder or other seed, wool alien	Sell & Murrell, 1996
Caustis dioica R. Br.	ornamental	Simpson & Inglis, 2001
Cymophyllus fraserianus (Ker Gawl.) Kartesz & Gandhi	ornamental	Bailey, 1935; Bailey & Bailey, 1976; Everett, 1980–1982; Grounds, 1989; Huxley, 1992; Turner & Wasson, 1998; Darke, 1999
Cyperus adenophorus Schrad.	ornamental	Everett, 1980–1982
Cyperus aggregatus (Willd.) Endl.	ballast, wool alien	Britton, 1886; Mohr, 1901; Horvat, 1941; Sell & Murrell, 1996; Tucker et al., 2002
Cyperus albostriatus Schrad.	ornamental, naturalized ornamental	Bailey, 1935; Bailey & Bailey, 1976; Everett, 1980–1982; Greenlee & Fell, 1992; Wilson, 1993; Brickell & Zuk, 1997; Turner & Wasson, 1998; Darke, 1999
Cyperus alopecuroides Rottb.	contaminant of nursery stock	Carter et al., 1996
Cyperus alternifolius L. subsp. *flabelliformis* Kük.	garden escape, naturalized ornamental	Bailey, 1935; Kern, 1974; Bailey & Bailey, 1976; Brickell & Zuk, 1997; Everett, 1980–1982; Burkill, 1985; Koyama, 1985; Wagner et al., 1990; Greenlee & Fell, 1992; Huxley, 1992; Sell & Murrell, 1996; Turner & Wasson, 1998; Darke, 1999
Cyperus bulbosus Vahl	ornamental	Simpson & Inglis, 2001
Cyperus capitatus Vand.	erosion control	Simpson & Inglis, 2001
Cyperus chordorrhizus Chiov.	erosion control, revegetation	Simpson & Inglis, 2001

Appendix 1. Continued.

Species[1]	Method of dispersal	Source
Cyperus clarus S. T. Blake	wool alien	Sell & Murrell, 1996
Cyperus compressus L.	ballast, ornamental	Smith, 1867; Britton, 1886; Bailey, 1935; Huxley, 1992; Gordon-Gray, 1995
Cyperus congestus Vahl	ornamental, wool alien	Huxley, 1992; Sell & Murrell, 1996
Cyperus conglomeratus Rottb.	erosion control, ornamental	Bailey, 1935; Burkill, 1985
Cyperus croceus Vahl	ballast, wool alien	Smith, 1867; Britton, 1886; Sell & Murrell, 1996
Cyperus cyperinus (Retz.) Suringar	ornamental, wool alien	Huxley, 1992; Sell & Murrell, 1996
Cyperus dactylotes Benth.	wool alien	Sell & Murrell, 1996
Cyperus difformis L.	rice agriculture	Holm et al., 1977; Lipscomb, 1980; Wagner et al., 1990
Cyperus echinatus (L.) A. W. Wood	wool alien	Sell & Murrell, 1996
Cyperus elegans L.	ornamental	Darke, 1999
Cyperus entrerianus Boeckeler	highway construction and maintenance, rice agriculture	Carter, 1990; Carter & Bryson, 1996
Cyperus eragrostis Lam.	naturalized ornamental, wool and grass-seed alien	Grounds, 1989; Huxley, 1992; Sell & Murrell, 1996; Brickell & Zuk, 1997; Darke, 1999
Cyperus erythrorhizos Muhl.	ornamental	Huxley, 1992
Cyperus esculentus L.	cultivated for tubers, wool alien	Bailey, 1935; Bailey & Bailey, 1976; Holm et al., 1977; Sell & Murrell, 1996; Turner & Wasson, 1998; Darke, 1999; Miller & Miller, 1999
Cyperus fertilis Boeckeler	ornamental	Bailey, 1935; Huxley, 1992
Cyperus filicinus Vahl	ornamental	Huxley, 1992
Cyperus fuscus L.	ballast	Smith, 1867; Britton, 1886
Cyperus giganteus Vahl	water purification	Pio Corrêa, 1926–1984
Cyperus gracilis R. Br.	ground cover	Hughes, 1995
Cyperus gunnii Hook. f.	wool alien	Sell & Murrell, 1996
Cyperus haspan L.	ornamental, rice agriculture	Holm et al., 1997; Everett, 1980–1982; Darke, 1999
Cyperus hyalinus Vahl	air traffic	Carter & Mears, 2000
Cyperus imbricatus Retz.	ballast	McGivney, 1938
Cyperus iria L.	rice agriculture	Holm et al., 1977; Koyama, 1985
Cyperus jeminicus Rottb.	erosion control	Simpson & Inglis, 2001
Cyperus laevigatus L.	ballast	Radford et al., 1968
Cyperus ligularis L.	ballast	Mohr, 1901; Horvat, 1941
Cyperus longus L.	ornamental	Bailey, 1935; Brickell & Zuk, 1997; Darke, 1999
Cyperus lucidus R. Br.	ornamental	Bailey, 1935
Cyperus luzulae (L.) Rottb. ex Retz.	wool alien	Sell & Murrell, 1996
Cyperus natalensis Hochst.	ornamental	Bailey, 1935

Species[1]	Method of dispersal	Source
Cyperus odoratus L.	railroad adventive	Mühlenbach, 1983
Cyperus owanii Boeckeler	naturalized ornamental	Bailey & Bailey, 1976; Huxley, 1992
Cyperus papyrus L.	naturalized ornamental	Bailey, 1935; Bailey & Bailey, 1976; Everett, 1980–1982; Grounds, 1989; Wagner et al., 1990; Greenlee & Fell, 1992; Huxley, 1992; Wilson, 1993; Brickell & Zuk, 1997; Turner & Wasson, 1998; Darke, 1999
Cyperus pilosus Vahl	rice agriculture	McGivney, 1938; Wagner et al., 1990
Cyperus planifolius Rich.	ballast	Horvat, 1941
Cyperus plukenetii Fernald	attachment to clothing	Carter, 1993
Cyperus prolifer Lam.	naturalized ornamental	Bailey & Bailey, 1976; Everett, 1980–1982; Greenlee & Fell, 1992; Huxley, 1992; Carter et al., 1996; Brickell & Zuk, 1997; Darke, 1999
Cyperus pulcher Thunb.	recommended for cultivation in water gardens	Gordon-Gray, 1995
Cyperus reflexus Vahl	wool alien	Sell & Murrell, 1996
Cyperus retroflexus Buckley	ballast?	Horvat, 1941
Cyperus rigidifolius Steud.	wool alien	Sell & Murrell, 1996
Cyperus rotundus L.	agriculture, animals, ballast, machinery, wool alien	Smith, 1867; Britton, 1886; Holm et al., 1977; Sell & Murrell, 1996; Miller & Miller, 1999
Cyperus rutilans (C. B. Clarke) Maiden & Betche	wool alien	Sell & Murrell, 1996
Cyperus sanguinolentus Vahl	highway construction and maintenance, rice agriculture	Carter & Bryson, 2000b
Cyperus sexangularis Nees	water gardens	Gordon-Gray, 1995
Cyperus sphacelatus Rottb.	ballast	Britton, 1886; Mohr, 1901; McGivney, 1938
Cyperus sporobolus R. Br.	wool alien	Sell & Murrell, 1996
Cyperus stoloniferus Retz.	erosion control	Burkill, 1935
Cyperus strigosus L.	ornamental	Bailey, 1935
Cyperus subumbellatus Kük.	ornamental	Simpson & Inglis, 2001
Cyperus surinamensis Rottb.	ballast	Britton, 1886
Cyperus tenuis Sw.	wool alien	Sell & Murrell, 1996
Cyperus textilis Thunb.	cultivated, presumably as an ornamental	Gordon-Gray, 1995
Cyperus umbellatus Benth.	ballast	Brown, 1880
Cyperus ustulatus A. Rich.	wool alien	Sell & Murrell, 1996
Cyperus vaginatus R. Br.	wool alien	Sell & Murrell, 1996
Desmoschoenus spiralis (A. Rich.) Hook. f.	ornamental	Grounds, 1989
Eleocharis acicularis (L.) Roem. & Schult.	rice agriculture, ornamental	Bailey, 1935; Bailey & Bailey, 1976; Everett, 1980–1982; Holm et al., 1997; Turner & Wasson, 1998; Darke, 1999

Appendix 1. Continued.

Species[1]	Method of dispersal	Source
Eleocharis dulcis Trin. ex Hensch.	cultivated for tubers (Chinese water chestnut), rice agriculture	Kern, 1974; Bailey & Bailey, 1976; Everett, 1980–1982; Gordon-Gray, 1995; Brickell & Zuk, 1997; Holm et al., 1997; Huxley, 1992; Turner & Wasson, 1998; Darke, 1999
Eleocharis interstincta (Vahl) Roem. & Schult.	ornamental	Bailey, 1935
Eleocharis lanceolata Fernald	rice agriculture	Smith, 2002c
Eleocharis macrostachya Britton	construction equipment	Bryson, pers. obs.
Eleocharis montevidensis Kunth	ornamental	Brickell & Zuk, 1997
Eleocharis nodulosa (Roth) Schult.	wool casual	Sell & Murrell, 1996
Eleocharis ovata (Roth) Roem. & Schult.	ornamental	Bailey, 1935
Eleocharis pachycarpa E. Desv. in C. Gay	sheep industry	Svenson, 1957
Eleocharis palustris (L.) Roem. & Schult.	ornamental, rice agriculture	Huxley, 1992; Holm et al., 1997
Eleocharis parvula (Roem. & Schult.) Link ex Bluff, Nees & Schauer	ornamental	Everett, 1980–1982
Eleocharis pusilla R. Br.	ornamental	Grounds, 1989
Eleocharis vivipara Link	ornamental	Everett, 1980–1982; Huxley, 1992
Eriophorum angustifolium Honck.	ornamental	Everett, 1980–1982; Grounds, 1989; Huxley, 1992; Turner & Wasson, 1998; Darke, 1999
Eriophorum chamissonis C. A. Mey.	ornamental	Huxley, 1992
Eriophorum gracile W. D. J. Koch ex Roth	ornamental	Darke, 1999
Eriophorum latifolium Hoppe	ornamental	Everett, 1980–1982
Eriophorum vaginatum L.	ornamental	Grounds, 1989; Huxley, 1992; Darke, 1999
Eriophorum virdicarinatum (Engelm.) Fernald	ornamental	Everett, 1980–1982; Grounds, 1989; Huxley, 1992; Darke, 1999
Eriophorum virginicum L.	ornamental	Darke, 1999
Eriophorum scheuchzeri Hoppe	ornamental	Huxley, 1992
Fimbristylis annua (All.) Roem. & Schult.	rice agriculture	Kral, 1971; Holm et al., 1977; Kral, 2002b
Fimbristylis cymosa R. Br.	revegetation	Fosberg, 1988
Fimbristylis decipiens Kral	rice agriculture	Kral, 1971
Fimbristylis dichotoma (L.) Vahl	rice agriculture	Kral, 2002b
Fimbristylis miliacea (L.) Vahl	rice agriculture, soil improvement	Burkill, 1935; Kral, 1971; Holm et al., 1977; Koyama, 1985; Kral, 2002b
Fimbristylis pauciflora R. Br.	soil improvement	Burkill, 1935
Fimbristylis spadicea Vahl	ballast	Smith, 1867
Fimbristylis squarrosa Vahl	ballast	Kral, 2002b

Species[1]	Method of dispersal	Source
Fimbristylis tomentosa Vahl	rice agriculture	Kral, 2002b
Fimbristylis umbellaris (Lam.) Vahl	soil improvement	Burkill, 1935
Fimbristylis vahlii (Lam.) Link	ballast	Smith, 1867
Fuirena squarrosa Michx.	ballast	Smith, 1867
Fuirena umbellata Rottb.	erosion control	Burkill, 1935
Gahnia procera J. R. Forst. & G. Forst.	ornamental	Grounds, 1989
Isolepis cernua (Vahl) Roem. & Schult.	ornamental	Bailey, 1935; Everett, 1980–1982; Grounds, 1989; Greenlee & Fell, 1992; Huxley, 1992; Turner & Wasson, 1998; Darke, 1999
Isolepis nodosa (Rottb.) R. Br.	ornamental	Turner & Wasson, 1998
Isolepis prolifera (Rottb.) R. Br.	ornamental	Huxley, 1992
Isolepis setacea (L.) R. Br.	ornamental	Huxley, 1992
Kobresia pygmaea C. B. Clarke in Hook. f.	erosion control	Dickoré, 1994
Kyllinga brevifolia Rottb.	pine-bark mulch, rice agriculture, turfgrass sod, wool alien	Koyama, 1985; Bryson & Carter, 1992; Sell & Murrell, 1996; Holm et al., 1997; Bryson et al., 1997
Kyllinga erecta Schumach.	wool alien	Sell & Murrell, 1996
Kyllinga gracillima Miq.	turfgrass sod	Bryson et al., 1997
Kyllinga nemoralis (J. R. Forst. & G. Forst.) Dandy ex Hutch. & Dalziel	ornamental	Bailey, 1935
Kyllinga odorata Vahl	wool alien, turfgrass sod	Sell & Murrell, 1996; Bryson et al., 1997
Kyllinga squamulata Thonn. ex Vahl	turfgrass sod	Bryson et al., 1997
Lepironia articulata (Retz.) Domin	fibers in sails and as packing material	Mabberley, 1997
Lipocarpha maculata (Michx.) Torr.	ballast	Smith, 1867
Lipocarpha micrantha (Vahl) G. C. Tucker	ballast	Smith, 1867
Machaerina sinclairii (Hook. f.) Koyama	ornamental	Grounds, 1989
Mapania cuspidata (Miq.) Uittien	ornamental	Bailey, 1935; Simpson, 1992; Simpson & Inglis, 2001
Mapania mannii C. B. Clarke	ornamental	Simpson, 1992; Simpson & Inglis, 2001
Mapania palustris (Hassk. ex Steud.) Fern.-Vill.	ornamental	Simpson, 1992; Simpson & Inglis, 2001
Mapania pandanophylla (F. Muell.) K. Schum.	ornamental	Bailey, 1935
Oreobolus pectinatus Hook. f.	ornamental	Grounds, 1989
Rhynchospora alba (L.) Vahl	ornamental	Bailey, 1935
Rhynchospora colorata (L.) H. Pfeiff.	ornamental	Simpson & Inglis, 2001
Rhynchospora corymbosa (L.) Britton	revegetation, soil improvement	Burkill, 1935

Appendix 1. Continued.

Species[1]	**Method of dispersal**	**Source**
Rhynchospora fusca (L.) W. T. Aiton	ornamental	Bailey, 1935
Rhynchospora nervosa (Vahl) Boeckeler	ornamental	Huxley, 1992; Simpson 1993; Simpson & Inglis, 2001
Rhynchospora nervosa subsp. *ciliata* T. Koyama	ornamental	Huxley, 1992
Schoenoplectus acutus (Muhl. ex J. M. Bigelow) Á. Löve & D. Löve	ornamental	Everett, 1980–1982
Schoenoplectus californicus (C. A. Mey.) Soják	erosion control	Smith et al., 1993
Schoenoplectus grossus (L. f.) Palla	rice agriculture	Holm et al., 1997
Schoenoplectus heterochaetus (Chase) Soják	ornamental	Everett, 1980–1982
Schoenoplectus lacustris (L.) Palla	ornamental	Bailey, 1935; Everett, 1980–1982
Schoenoplectus lacustris subsp. *validus* (Vahl) T. Koyama	ornamental	Everett, 1980–1982; Turner & Wasson, 1998
Schoenoplectus mucronatus (L.) Palla	rice agriculture, planted as waterfowl food	Holm et al., 1997; Smith, 2002b
Schoenoplectus tabernaemontani (C. C. Gmel.) Palla	ornamental	Everett, 1980–1982; Grounds, 1989; Greenlee & Fell, 1992; Huxley, 1992; Turner & Wasson, 1998; Darke, 1999
Schoenus pauciflorus (Hook. f.) Hook. f.	ornamental	Grounds, 1989; Huxley, 1992
Scirpus atrovirens Willd.	ornamental	Bailey, 1935; Darke, 1999
Scirpus cyperinus (L.) Kunth	ornamental	Everett, 1980–1982; Huxley, 1992; Darke, 1999
Scirpus divaricatus Elliott	railroad adventive	Mühlenbach, 1979
Scirpus georgianus R. M. Harper	railroad adventive	Mühlenbach, 1983
Scirpus holoschoenus L.	ornamental	Bailey, 1935; Huxley, 1992; Brickell & Zuk, 1997
Scirpus pallidus (Britton) Fernald	accidental transport	Whittemore & Schuyler, 2002
Scirpus pendulus Muhl.	accidental transport	Whittemore & Schuyler, 2002
Scirpus sylvaticus L.	ornamental	Huxley, 1992
Trichophorum alpinum (L.) Pers.	ornamental	Huxley, 1992
Uncinia divaricata W. Boott	ornamental	Grounds, 1989
Uncinia egmontiana Hamlin	ornamental	Grounds, 1989; Greenlee & Fell, 1992; Huxley, 1992
Uncinia rubra Colenso ex Boott	ornamental	Grounds, 1989; Huxley, 1992; Brickell & Zuk, 1997
Uncinia uncinata (L. f.) Kük.	ornamental	Grounds, 1989; Greenlee & Fell, 1992; Brickell & Zuk, 1997; Turner & Wasson, 1998

[1] Plant nomenclature follows *Flora of North America,* volume 23; plant names were also verified through the Missouri Botanical Garden w[3] TROPICOS VAST database (rev. 1.5) (http://mobot.mobot.org/W3T/Search/vast.html) and the International Plant Names Index (http://www.ipni.org/index.html). A more inclusive list of names cited in the references is available from the authors.

APPENDIX 2

Cyperaceous weeds of the world with data on habit, habitat, and distribution.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Abildgaardia ovata (Burm. f.) Kral	Holm et al., 1979; Soerjani et al., 1987; Moody, 1989; Kukkonen, 2001	P	pastures, rice fields	AFR, ASI, AUS, CAR, EUR, IND, NA, PI, SA
Bolboschoenus affinis (Roth) Drobow	Kukkonen, 2001	P	rice fields	EUR, IND
Bolboschoenus caldwellii (V. J. Cook) Soják	Kern, 1974; Simpson & Inglis, 2001	P	aquatic, irrigation ditches	AUS, PI
Bolboschoenus fluviatilis (Torr.) Soják	Holm et al., 1979; WSSA, 1989	P	aquatic	ASI, AUS, NA
Bolboschoenus maritimus (L.) Palla	Kern, 1974; Reed, 1977; Kühn, 1982; Moody, 1989; Holm et al., 1997; Johnson, 1997; Kissman, 1997	P	aquatic, crops, rice fields	AFR, ASI, CAR, EUR, IND, NA, PI, SA
Bolboschoenus planiculmis (F. Schmidt) T. V. Egorova	Zhirong et al., 1990	P	wetlands, rice fields	ASI
Bulbostylis barbata (Rottb.) C. B. Clarke	Ohwi, 1965; Lin, 1968; Reed, 1977; Godfrey & Wooten, 1979; Holm et al., 1979; Kühn, 1982; Moody, 1989; Le Bourgeois & Merlier, 1995; Simpson & Inglis, 2001	A	crops, cultivated fields, fallow fields, rice fields, waste places	AFR, ASI, AUS, CAR, IND, NA, PI, SA
Bulbostylis capillaris (L.) C. B. Clarke	Godfrey & Wooten, 1979; Lorenzi, 1982; Moody, 1989; Kissman, 1997	A	roadsides, waste places	NA, SA
Bulbostylis ciliatifolia (Elliott) Fernald	Godfrey & Wooten, 1979	A	fallow fields, roadsides, waste places	CAR, NA
Bulbostylis densa (Wall.) Hand.-Mazz.	Ohwi, 1965; Reed, 1977; Kühn, 1982; Moody, 1989; Kukkonen, 2001; Simpson & Inglis, 2001	A	aquatic biotypes, crops, cultivated fields, rice fields, waste places	AFR, ASI, AUS, IND, PI
Bulbostylis filamentosa (Vahl) C. B. Clarke	Healy & Edgar, 1980	P		AFR
Bulbostylis hispidula (Vahl) R. W. Haines	Kühn, 1982; Le Bourgeois & Merlier, 1995; Simpson & Inglis, 2001	A	aquatic biotypes, crops, cultivated fields, grasslands	AFR
Bulbostylis hispidula subsp. *pyriformis* (Lye) R. W. Haines	Gordon-Gray, 1995	A	pioneers or exposed areas, weeds of cultivation	AFR
Bulbostylis humilis (Kunth) C. B. Clarke	Gordon-Gray, 1995	A	gardens, potted plants	AFR
Bulbostylis puberula (Poir.) Kunth	Holm et al., 1979; Soerjani et al., 1987; Moody, 1989		rice fields	IND
Carex acuta L.	Holm et al., 1979	P		EUR
Carex albolutescens Schwein.	WSSA, 1989	P	moist soils	NA
Carex albula Allan	Moore & Edgar, 1970; Simpson & Inglis, 2001	P	crops, grasslands	PI

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Carex aquatilis Wahlenb.	Holm et al., 1979; WSSA, 1989	P	stream margins, wetlands	ASI, NA
Carex atherodes Spreng.	Holm et al., 1979; WSSA, 1989	P	wetlands	NA
Carex aureolensis Steud.	Bryson, pers. obs.	P	crop borders, lawns, pastures, waste places	NA
Carex baccans Nees	Holm et al., 1979	P		PI
Carex biwensis Franch.	Reed, 1977	P	aquatic	ASI
Carex blanda Dewey	Bryson, 1985a; DeFelice & Bryson, 2004	P	lawns, waste places	NA
Carex bonariensis Desf.	Holm et al., 1979; Kissman, 1997	P		SA
Carex breviculmis R. Br.	Moore & Edgar, 1970; Moody, 1989; Simpson & Inglis, 2001	P	rice fields, gardens, grasslands	ASI, AUS, PI
Carex brevicuspis C. B. Clarke	Lin, 1968; Reed, 1977	P		ASI
Carex brizoides L.	Reed, 1977; Kühn, 1982	P	crops, grasslands	ASI, EUR
Carex brongniartii Kunth	Holm et al., 1979	P		SA
Carex buchananii Berggr.	Moore & Edgar, 1970; Simpson & Inglis, 2001	P	grasslands	PI
Carex canescens L.	Holm et al., 1979	P	wetlands	EUR
Carex cherokeensis Schwein.	WSSA, 1989; DeFelice & Bryson, 2004	P	lawns, pastures	NA
Carex comans Berggr.	Moore & Edgar, 1970; Simpson & Inglis, 2001	P	gardens, pastures	PI
Carex comosa Boott	Bryson, pers. obs.	P	wetlands	NA
Carex coriacca Hamlin	Moore & Edgar, 1970; Simpson & Inglis, 2001	P	grasslands	PI
Carex dietrichiae Boeckeler	Holm et al., 1979	P		SA
Carex dimorpholepis Steud.	Ohwi, 1965	P	wet fields	ASI
Carex dispalata Boott ex A. Gray	Reed, 1977	P	aquatic, wet/low places	ASI
Carex disticha Huds.	Holm et al., 1979	P		EUR
Carex divisa Huds.	Holm et al., 1979; Kukkonen, 2001	P	gardens, rice fields	AFR, ASI, AUS (New Zealand), EUR, IND, NA
Carex divulsa Stokes	Holm et al., 1979	P	grasslands	EUR, PI, SA
Carex eurycarpa T. Holm	Holm et al., 1979; WSSA, 1989	P		NA
Carex fedia Nees	Moody, 1989	P	rice fields	ASI
Carex flagellifera Colenso	Healy & Edgar, 1980; Parsons & Cuthbertson, 1992; Simpson & Inglis, 2001	P	pastures	PI

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Carex foliosa D. Don	Moody, 1989; Kukkonen, 2001	P	rice fields	ASI, IND
Carex frankii Kunth	WSSA, 1989	P	crop borders, lawns, pastures, waste places	NA
Carex gayana E. Desv.	Kissman, 1997	P		SA
Carex glauca Scop.	Holm et al., 1979	P		ASI
Carex glaucescens Elliott	WSSA, 1989	P	pastures, roadsides, waste places	NA
Carex graeffeana Boeckeler	Holm et al., 1979	P		PI
Carex heterostachya Bunge	Zhirong et al., 1990	P	field borders, wetlands	ASI
Carex hirta L.	Kühn, 1982	P	crops, grasslands, waste places	AFR, ASI, EUR, NA
Carex hudsonii A. Benn.	Holm et al., 1979	P		EUR
Carex inversa R. Br.	Healey & Edgar, 1980; Simpson & Inglis, 2001	P	gardens	PI
Carex iynx Nelmes	Healy & Edgar, 1980; Simpson & Inglis, 2001	P	grasslands	PI
Carex kobomugi Ohwi	Small, 1954; Svenson, 1979; Stalter, 1980; Standley, 1983	P	sandy beaches	ASI, NA
Carex lacustris Willd.	Holm et al., 1979; WSSA, 1989	P	ditches, roadsides, wetlands	NA
Carex lasiocarpa Ehrh.	Holm et al., 1979; Kühn, 1982; WSSA, 1989; Simpson & Inglis, 2001	P	aquatic biotypes	ASI, EUR, NA
Carex leavenworthii Dewey	Bryson, 1985a	P	lawns, waste places	NA
Carex leporina L.	Holm et al., 1979; Kühn, 1982	P	grasslands, waste places	AFR, ASI, EUR
Carex longebrachiata Boeckeler	Reed, 1977; Simpson & Inglis, 2001	P	grasslands, wet places	AUS, PI
Carex longii Mack.	Bryson, 1985a	P	lawns, pastures, waste places	NA
Carex louisianica L. H. Bailey	WSSA, 1989	P	ditches, right-of-ways, roadsides, wetlands	NA
Carex lucida Boott	Reed, 1977	P	low places/ elevations	PI
Carex lupulina Muhl. ex Willd.	Holm et al., 1979; WSSA, 1989	P	ditches, roadsides, wetlands	NA
Carex macrorrhiza Boeckeler	Kissman, 1997	P		SA
Carex maorica Hamlin	Moore & Edgar, 1970; Simpson & Inglis, 2001	P	aquatic, irrigation ditches	PI
Carex maximowiczii Miq.	Reed, 1977	P	wet places	ASI
Carex myosurus Nees	Holm et al., 1979	P		AUS, PI

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Carex nebrascensis Dewey	USDA, 1970; Holm et al., 1979; WSSA, 1989	P	pastures, roadsides	NA
Carex nigra (L.) Reichard	Holm et al., 1979	P	stream and lake margins, wetlands	EUR, NA
Carex notha Kunth	Moody, 1989	P	rice fields	ASI
Carex nubigena D. Don ex Tilloch & Taylor	Holm et al., 1979; Moody, 1989	P	rice fields	ASI
Carex oklahomensis Mack.	Bryson et al., 1992, 1994b, 1996; Standley, 2002	P	pastures, roadsides, waste places	NA
Carex ovalis Gooden.	Kühn, 1982; Simpson & Inglis, 2001	P	forests, grasslands, waste places	EUR, NA
Carex pallescens L.	WSSA, 1989	P	lawns, waste places	ASI, EUR, NA, PI
Carex panicea L.	Kühn, 1982	P	aquatic biotypes, crops, grasslands	AFR, ASI, EUR, NA, PI
Carex paniculata L.	Reed, 1977; Holm et al., 1979; Kühn, 1982; Simpson & Inglis, 2001	P	aquatic biotypes, waste places	AFR, ASI, AUS, EUR
Carex philocrena V. I. Krecz	Moody, 1989	P	rice fields	ASI
Carex praegracilis W. Boott	Reznicek et al., 1976; Swink & Wilhelm, 1979; Bruton & Catling, 1982; Reznicek & Catling, 1987	P	waste places, roadsides	NA
Carex pruinosa Boott	Moody, 1989	P	rice fields	ASI
Carex pumila Thunb.	Lin, 1968; Holm et al., 1979	P		ASI, PI
Carex pycnostachya Kar. & Kir.	Kukkonen, 2001	P	rice fields	ASI, IND
Carex remota L.	Holm et al., 1979	P		ASI
Carex rigescens (Franch.) V. I. Krecz.	Zhirong et al., 1990	P	lawns, orchards, waste places	ASI
Carex riparia Curtis	Holm et al., 1979	P		EUR
Carex rostrata Stokes ex With.	WSSA, 1989	P	wetlands	
Carex sahnii Ghildyal & U. C. Bhattach.	Moody, 1989	P	rice fields	ASI
Carex senta Boott	Holm et al., 1979; WSSA, 1989	P	stream and river margins, wetlands	NA
Carex sororia Kunth	Kissman, 1997	P		SA
Carex spicata Huds.	Bryson, pers. obs.	P		ASI, EUR, NA
Carex testacea Sol. ex Boott	Parsons & Cuthbertson, 1992; Simpson & Inglis, 2001	P	pastures	PI
Carex thunbergii Steud.	Ohwi, 1965; Reed, 1977	P	aquatic, rice fields	ASI
Carex uruguensis Boeckeler	Kissman, 1997	P	pastures, roadsides	SA
Carex verrucosa Muhl.	WSSA, 1989	P	roadsides, wet areas	NA
Carex vulpina L.	Holm et al., 1979	P		EUR
Carex vulpinoidea Michx.	Moore & Edgar, 1970; Godfrey & Wooten, 1979; Simpson & Inglis, 2001	P	pastures, old fields, waste places	EUR, NA, PI, SA

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cladium jamaicense Crantz	Holm et al., 1979	P	aquatic	NA
Cladium mariscus (L.) Pohl	Holm et al., 1979; Kühn, 1982; Moody, 1989; Simpson & Inglis, 2001	P	aquatic biotypes, rice fields	AFR, ASI, EUR, IND, NA, PI, SA
Courtoisina cyperoides (Roxb.) Soják	Simpson & Koyama, 1998; Simpson & Inglis, 2001	A	rice fields	AFR, ASI, IND
Cyperus acuminatus Torr. & Hook.	DeFelice & Bryson, 2004	A	field borders, pastures, roadsides, wet clay soils	NA
Cyperus aggregatus (Willd.) Endl.	Holm et al., 1979; Kühn, 1982; Lorenzi, 1982; WSSA, 1989; Wilson, 1993; Kissman, 1997; Simpson & Inglis, 2001	P	crops, sandy soil, waste places	AUS, CAR, NA, SA
Cyperus albostriatus Schrad.	Healy & Edgar, 1980; Simpson & Inglis, 2001	P	gardens, waste places	AUS, PI
Cyperus alopecuroides Rottb.	Holm et al., 1979; Kühn, 1982; Moody, 1989; Carter et al., 1996; Bryson et al., 1998; Simpson & Inglis, 2001	P	aquatic biotypes, rice fields	AFR, ASI, AUS, IND, NA, PI, SA
Cyperus alternifolius L. subsp. *flabelliformis* Kük.	Kern, 1974; Holm et al., 1979; Kühn, 1982; Moody, 1989; Kissman, 1997; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	aquatic biotypes, rice fields, waste places	AFR, ASI, EUR, IND, NA, PI, SA
Cyperus alulatus J. Kern	Moody, 1989; Kukkonen, 2001	A	rice fields	ASI, IND
Cyperus amabilis Vahl	Holm et al., 1979; Kühn, 1982; Le Bourgeois & Merlier, 1995; Simpson & Inglis, 2001	A	grasslands, waste places	AFR, ASI, IND, SA
Cyperus amuricus Maxim.	Ohwi, 1965; Reed, 1977; Holm et al., 1979	A/P	cultivated fields, waste places, wet places	ASI
Cyperus arenarius Retz.	Simpson & Inglis, 2001	P	unspecified	ASI, IND
Cyperus articulatus L.	Holm et al., 1979; Kühn, 1982; Moody, 1989; WSSA, 1989; Kissman, 1997; Bryson et al., 1998; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields	AFR, ASI, AUS, IND, NA, SA
Cyperus babakan Steud.	Kern, 1974; Holm et al., 1979; Soerjani et al., 1987; Moody, 1989	P	rice fields	ASI, IND, PI
Cyperus bifax C. B. Clarke	Koyama, 1985; Moody, 1989; Wilson, 1993	P	ditches, irrigated cultivation, open wet ground, rice fields	ASI, AUS, IND
Cyperus boreohemisphaericus Lye	Simpson & Inglis, 2001		crops	AFR
Cyperus bulbosus Vahl	Terry, 1976; Reed, 1977; Holm et al., 1979; Moody, 1989; Kukkonen, 2001; Simpson & Inglis, 2001	P	grasslands, rice fields	AFR, ASI, AUS, IND
Cyperus castaneus Willd.	Holm et al., 1979; Moody, 1989	A	rice fields	ASI

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cyperus cephalotes Vahl	Soerjani et al., 1987; Moody, 1989	P	rice fields	ASI, IND
Cyperus compactus Retz.	Kern, 1974; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Kukkonen, 2001; Simpson & Inglis, 2001	P	aquatic biotypes, crops, ditches, rice fields, waste places, wet places	ASI, AUS, IND, PI
Cyperus compressus L.	Ohwi, 1965; Lin, 1968; Kern, 1974; Godfrey & Wooten, 1979; Kühn, 1982; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Wagner & Herbst, 1995; Bryson et al.,1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002; DeFelice & Bryson, 2004	A	crops, fallow rice fields, gardens, grasslands, lawns, roadsides, waste places	AFR, ASI, AUS, IND, NA, PI, SA
Cyperus congestus Vahl	Healey & Edgar, 1980; Wilson, 1993; Gordon-Gray, 1995; Simpson & Inglis, 2001	P	cultivation, damp ground, disturbed areas, ditches, gardens, roadsides	AFR, AUS
Cyperus conglomeratus Rottb.	Moody, 1989; Simpson & Inglis, 2001	P	crops, rice fields	AFR, IND
Cyperus corymbosus Rottb.	Holm et al., 1979; Moody, 1989; Simpson & Inglis, 2001	P	rice fields	ASI, IND, SA
Cyperus crassipes Vahl	Reed, 1977; Holm et al., 1979	P		AFR
Cyperus croceus Vahl	Godfrey & Wooten, 1979; WSSA, 1989; Bryson et al., 1998	P	pastures, turf, waste places	CAR, NA, SA
Cyperus cuspidatus Kunth	Kern, 1974; Godfrey & Wooten, 1979; Kühn, 1982; Moody, 1989; WSSA, 1989; Kukkonen, 2001; Simpson & Inglis, 2001	A	aquatic biotypes, crops, fallow fields, rice fields, sandy fields, waste places, wet places	AFR, ASI, AUS, IND, NA, PI, SA
Cyperus cyperinus (Retz.) Suringar	Lin, 1968; Reed, 1977; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	cultivated lands, gardens, rice fields, waste places	ASI, IND, PI
Cyperus cyperoides (L.) Kuntze	Kern, 1974; Terry, 1976; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Zhirong et al., 1990; Gordon-Gray, 1995; Le Bourgeois & Merlier, 1995; Johnson, 1997; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001	P	crops, disturbed sites, fallow fields, fields, gardens, grasslands, rice fields, roadsides, waste places	AFR, ASI, AUS, CAR, IND, PI
Cyperus cyperoides subsp. *macrocarpus* (Kunth) Lye	Terry, 1976	P	crops	AFR
Cyperus denudatus L. f.	Simpson & Inglis, 2001	P	rice fields	AFR
Cyperus diandrus Torr.	Holm et al., 1979	A	wet areas	NA
Cyperus diaphanus Schrad. ex Roem. & Schult.	Kern, 1974; Moody, 1989	A	rice fields	ASI, IND, PI

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cyperus difformis L.	Ohwi, 1965; Lin, 1968; Kern, 1974; Terry, 1976; Reed, 1977; Holm et al., 1977, 1979; DeFilipps, 1980c; Moody, 1981; Kühn, 1982; Koyama, 1985; Akobundu & Agyakwa, 1987; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Zhirong et al., 1990; Gordon-Gray, 1995; Johnson, 1997; Kissman, 1997; Bryson et al., 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002; Carter, 2005	A	aquatic biotypes, crops, grasslands, rice fields	AFR, ASI, AUS, EUR, IND, NA, PI, SA
Cyperus diffusus Vahl	Cardenas et al., 1972; Reed, 1977; Holm et al., 1979; Moody, 1989; Kissman, 1997; Simpson & Koyama, 1998; Simpson & Inglis, 2001; DeFelice & Bryson, 2004	P	gardens, low elevations, rice fields, warm regions	ASI, CAR, IND, PI, SA
Cyperus digitatus Roxb.	Kern, 1974; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields, waste places	AFR, ASI, AUS, IND, NA, PI, SA
Cyperus dilatatus Schumach.	Simpson & Inglis, 2001	P	cultivated fields, gardens	AFR
Cyperus distans L. f.	Kern, 1974; Terry, 1976; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Gordon-Gray, 1995; Johnson, 1997; Kissman, 1997; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	aquatic biotypes, crops, grasslands, rice fields, waste places	AFR, ASI, AUS, CAR, EUR, IND, NA, PI, SA
Cyperus distinctus Steud.	Carter, pers. obs.	P	ditches, roadsides, waste places	CAR, NA
Cyperus dives Delile	Gordon-Gray, 1995	P	sugarcane fields	AFR
Cyperus dubius Rottb.	Moody, 1989; Gordon-Gray, 1995; Simpson & Inglis, 2001	P	open rice fields, sandy sites	AFR, IND
Cyperus duclouxii E. G. Camus	Zhirong et al., 1990	P		ASI
Cyperus echinatus (L.) A. W. Wood	WSSA, 1989; Bryson et al., 1998	P	ditches, pastures, roadsides, waste places	NA
Cyperus elatus L.	Kern, 1974; Soerjani et al., 1987; Moody, 1989; Simpson & Inglis, 2001	P	rice fields	ASI, IND, PI
Cyperus elegans L.	Bryson et al., 1998	P	waste places	CAR, NA
Cyperus entrerianus Boeckeler	Kissman, 1997; Carter, 1990; Carter & Jones, 1991; Bryson & Carter, 1994, 1996; Bryson et al., 1998; Simpson & Inglis, 2001; DeFelice & Bryson, 2004	P	crops, pastures, roadsides	NA, SA

Appendix 2. Continued.

Species[1]	**Source**	**Habit**[2]	**Habitat**	**Distribution**[3]
Cyperus eragrostis Lam.	Holm et al., 1979; Parsons & Cuthbertson, 1992; Wilson, 1993; Gordon-Gray, 1995; Kissman, 1997; Bryson et al., 1998; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P/A?	disturbed or fallow areas, pastures, rice fields, roadsides	AFR, AUS, EUR, NA, PI, SA
Cyperus erythrorhizos Muhl.	Holm et al., 1979; Moody, 1989; WSSA, 1989; Bryson et al., 1998; DeFelice & Bryson, 2004	A	rice fields, wet areas	ASI, NA
Cyperus esculentus L.	USDA, 1970; Kern, 1974; Terry, 1976; Holm et al., 1977; Godfrey & Wooten, 1979; Holm et al., 1979; Kühn, 1982; Lorenzi, 1982; Moody, 1989; WSSA, 1989; Gordon-Gray, 1995; Le Bourgeois & Merlier, 1995; Johnson, 1997; Kissman, 1997; Bryson et al., 1998; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; DeFelice & Bryson, 2004; Rzedowski & Rzedowski, 2004; Carter, 2005	P	crops, fields, irrigated fields, pastures, rice fields, turf, waste places	AFR, ASI, AUS, CAR, EUR, IND, NA, PI, SA
Cyperus exaltatus Retz.	Holm et al., 1979; Koyama, 1985; Moody, 1989; Johnson, 1997; Kukkonen, 2001; Simpson & Inglis, 2001	P	low wet sites, rice fields	AFR, AUS, IND
Cyperus fasciculatus Elliott	Holm et al., 1979			ASI
Cyperus flavescens L.	Holm et al., 1979; Soerjani et al., 1987; Gordon-Gray, 1995; Johnson, 1997; Kukkonen, 2001	A	crops, pastures, rice fields, roadside ditches, seeps, turf, waste places	AFR, ASI, CAR, EUR, IND, NA, SA
Cyperus flavicomus Michx.	Godfrey & Wooten, 1979; Holm et al., 1979; Johnson, 1997; Bryson et al., 1998	A	crops, pastures, rice fields, turf, waste places	AFR, ASI, NA, SA
Cyperus flavidus Retz.	Lin, 1968; Kern, 1974; Reed, 1977; Holm et al., 1979; Moody, 1989; Zhirong et al., 1990; Simpson & Koyama, 1998; Simpson & Inglis, 2001	A/P	crops, fallow fields, rice fields, wet places	AFR, ASI, AUS, IND, PI
Cyperus floribundus (Kük.) R. Carter & S. D. Jones	Carter & Jones, 1997; Carter, pers. obs.	A/P	agricultural fields, disturbed sites, roadsides	NA
Cyperus foliaceus C. B. Clarke	Simpson & Inglis, 2001	A	rice fields	AFR
Cyperus friburgensis Boeckeler	Kissman, 1997	P		SA
Cyperus fulvus R. Br.	Holm et al., 1979	P		SA
Cyperus fuscus L.	Holm et al., 1979; WSSA, 1989; Zhirong et al., 1990; Kukkonen, 2001; Simpson & Inglis, 2001	A	crops, moist fields, rice fields, wet areas	AFR, ASI, EUR, NA

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cyperus giganteus Vahl	Kissman, 1997	P		SA
Cyperus glaber L.	Kukkonen, 2001	A	moist fields	ASI, EUR, IND
Cyperus glomeratus L.	Zhirong et al., 1990; Kukkonen, 2001	A/P	rice fields, wetlands	ASI, EUR, IND
Cyperus gracilis R. Br.	Holm et al., 1979	P		AUS, PI
Cyperus gracilinux C. B. Clarke	Holm et al., 1979	P		AFR
Cyperus grandibulbosus C. B. Clarke	Terry, 1976; Simpson & Inglis, 2001	P	unspecified	AFR
Cyperus hakonensis Franch. & Sav.	Holm et al., 1979			ASI
Cyperus haspan L.	Ohwi, 1965; Lin, 1968; Kern, 1974; Holm et al., 1979; Kühn, 1982; Koyama, 1985; Akobundu & Agyakwa, 1987; Soerjani et al., 1987; Moody, 1989; Zhirong et al., 1990; Johnson, 1997; Kissman, 1997; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A/P	grasslands, crops, aquatic biotypes, rice fields	AFR, ASI, AUS, IND, NA, PI, SA
Cyperus hermaphroditus (Jacq.) Standl.	Holm et al., 1979; Kissman, 1997	P		NA, SA
Cyperus hyalinus Vahl	WSSA, 1989; Simpson & Inglis, 2001	A	gardens, turf	AFR, ASI, AUS, IND, NA
Cyperus imbricatus Retz.	Kern, 1974; Reed, 1977; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Zhirong et al., 1990; Kissman, 1997; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields	AFR, ASI, CAR, IND, NA, PI, SA
Cyperus intactus Vahl	Gordon-Gray, 1995	A/P	disturbed grasslands	AFR
Cyperus iria L.	Ohwi, 1965; Lin, 1968; Kern, 1974; Holm et al., 1977, 1979; Moody, 1981; Kühn, 1982; Lorenzi, 1982; Koyama, 1985; Akobundu & Agyakwa, 1987; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Zhirong et al., 1990; Gordon-Gray, 1995; Johnson, 1997; Kissman, 1997; Bryson et al., 1998; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002; DeFelice & Bryson, 2004; Carter, 2005	A/P	aquatic biotypes, crops, rice fields, waste places	AFR, ASI, AUS, CAR, EUR, IND, NA, PI, SA
Cyperus javanicus Houtt.	Holm et al., 1979; Moody, 1989	P	rice fields	ASI, IND, PI
Cyperus laetus J. Presl & C. Presl	Holm et al., 1979; Kissman, 1997	P		SA
Cyperus laevigatus L.	Holm et al., 1979; Kühn, 1982; Moody, 1989; Simpson & Inglis, 2001	P	aquatic biotypes, rice fields	AFR, ASI, AUS, CAR, EUR, IND, NA, PI, SA

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cyperus lanceolatus Poir.	Holm et al., 1979; Lorenzi, 1982; Akobundu & Agyakwa, 1987; Johnson, 1997; Kissman, 1997	P	ditches, rice fields, roadsides	AFR, NA, SA
Cyperus latifolius Poir.	Simpson & Inglis, 2001	P	pastures	AFR
Cyperus lecontei Torr. ex Steud.	WSSA, 1989; Bryson et al., 1998	P	shorelines, waste places	NA
Cyperus ligularis L.	Holm et al., 1979; Kissman, 1997	P		AFR, ASI, NA, SA
Cyperus longibracteatus (Cherm.) Kük.	Akobundu & Agyakwa, 1987	P	forests, rice fields	AFR
Cyperus longus L.	Terry, 1976; Holm et al., 1979; Moody, 1989; Kukkonen, 2001; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields	AFR, ASI, EUR, IND
Cyperus luzulae (L.) Rottb. ex Retz.	Cardenas et al., 1972; Holm et al., 1979; Lorenzi, 1982; Moody, 1989; Kissman, 1997; Simpson & Inglis, 2001	P	cultivated fields, rice fields	SA
Cyperus macrostachyos Lam.	Moody, 1989		rice fields	IND
Cyperus malaccensis Lam.	Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Simpson & Inglis, 2001	P	aquatic biotypes, cultivated fields, rice fields	ASI, AUS, IND, PI
Cyperus mapanioides C. B. Clarke	Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	crops, cultivated fields	AFR
Cyperus maranguensis K. Schum.	Terry, 1976; Holm et al., 1979; Simpson & Inglis, 2001	P	cultivated fields	AFR
Cyperus meyenianus Kunth	Kissman, 1997	P		SA
Cyperus michelianus (L.) Link. subsp. *pygmaeus* (Rottb.) Asch. & Graebn.	Kern, 1974; Holm et al., 1979; Soerjani et al., 1987; Moody, 1989; Zhirong et al., 1990; Kukkonen, 2001; Simpson & Inglis, 2001	A	ditches, cultivated fields, fallow rice fields, gardens, rice fields	AFR, ASI, AUS, EUR, IND, PI
Cyperus microiria Steud.	Ohwi, 1965; Holm et al., 1979; Moody, 1989	A	crops, cultivated fields, rice fields, wetlands	ASI, IND, NA
Cyperus mirus C. B. Clarke	Wilson, 1993	P	gardens	AUS
Cyperus mitis Steud.	Moody, 1989		rice fields	ASI
Cyperus mutisii (Kunth) Andersson	Holm et al., 1979	P		NA, SA
Cyperus nipponicus Franch. & Sav.	Reed, 1977; Holm et al., 1979	A	crops, waste places	ASI
Cyperus niveus Retz.	Reed, 1977; Moody, 1989	P	open forests, rice fields, wet places	ASI, IND
Cyperus novae-hollandiae Boeckeler	Holm et al., 1979			AUS
Cyperus nutans Vahl	Kern, 1974; Moody, 1989; Simpson & Inglis, 2001	P	crops, rice fields	AFR, ASI, IND, PI
Cyperus obtusiflorus Vahl	Simpson & Inglis, 2001	P	gardens	AFR

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cyperus ochraceus Vahl	Bryson et al., 1996, 1998	P	ditches, roadsides, waste places	CAR, NA, SA
Cyperus odoratus L.	Lin, 1968; Cardenas et al., 1972; Kern, 1974; Holm et al., 1979; Kühn, 1982; Lorenzi, 1982; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Wagner et al., 1990; Kissman, 1997; Bryson et al., 1998; Simpson & Koyama, 1998; Simpson & Inglis, 2001; DeFelice & Bryson, 2004	A/P	aquatic biotypes, crops, rice fields, taro paddies, waste places	AFR, ASI, AUS, CAR, EUR, IND, NA, PI, SA
Cyperus oxylepis Nees ex Steud.	Godfrey & Wooten, 1979; WSSA, 1989; Bryson et al., 1996, 1998	P	mechanically disturbed sites, waste places, roadsides	NA
Cyperus pangorei Rottb.	Holm et al., 1979; Moody, 1989	P	rice fields	AFR, IND
Cyperus papyrus L.	Holm et al., 1979; Simpson & Inglis, 2001	P	aquatic	AFR, NA
Cyperus pilosus Vahl	Lin, 1968; Kern, 1974; Reed, 1977; Soerjani et al., 1987; Moody, 1989; Zhirong et al., 1990	P	crops, rice fields, waste places	ASI, IND, NA, PI
Cyperus platystylis R. Br.	Kern, 1974; Soerjani et al., 1987; Moody, 1989	P	rice fields	ASI, AUS, IND, PI
Cyperus pohlii (Nees) Steud.	Kissman, 1997	P		SA
Cyperus polystachyos Rottb.	Lin, 1968; Kern, 1974; Reed, 1977; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Kissman, 1997; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A/P	aquatic biotypes, crops, fallow rice fields, grasslands, waste places, wet places	AFR, ASI, AUS, EUR, IND, NA, PI, SA
Cyperus polystachyos var. *texensis* (Torr.) Fernald	WSSA, 1989; Bryson et al., 1998	A/P	crops, grasslands, lawns, rice fields, roadsides, waste places, wet places	NA
Cyperus procerus Rottb.	Kern, 1974; Holm et al., 1979; Soerjani et al., 1987; Moody, 1989	P	rice fields	ASI, AUS, IND, PI
Cyperus prolifer Lam.	WSSA, 1989; Carter et al., 1996; Bryson et al., 1998	P	aquatic	AFR, NA
Cyperus prolixus Kunth	Kissman, 1997	P	aquatic	NA, SA
Cyperus pseudosomaliensis Kük.	Simpson & Inglis, 2001	P	gardens	AFR
Cyperus pseudovegetus Steud.	WSSA, 1989; Bryson et al., 1998; Ramos et al., 2004	P	field borders, pastures, wet soil	NA, SA
Cyperus pulcherrimus Willd. ex Kunth	Kern, 1974; Holm et al., 1979; Soerjani et al., 1987; Moody, 1989	P	rice fields	ASI, IND, PI

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cyperus pumilus L.	Kern, 1974; Holm et al.,1979; Soerjani et al., 1987; Moody, 1989; Kukkonen, 2001; Ravi & Mohanan, 2002	A	disturbed sandy soils, fallow fields, rice fields, waste lands	AFR, ASI, AUS, CAR, IND, NA, PI
Cyperus puncticulatus Vahl	Ravi & Mohanan, 2002	A	rice fields	ASI, IND
Cyperus pustulatus Vahl	Johnson, 1997; Simpson & Inglis, 2001	A	aquatic, rice fields	AFR
Cyperus radians Nees & Meyen	Holm et al., 1979; Kühn, 1982; Moody, 1989; Simpson & Inglis, 2001	P	aquatic biotypes, rice fields, waste places	ASI, PI
Cyperus reduncus Hochst. ex Boeckeler	Holm et al., 1979; Simpson & Inglis, 2001	A		AFR
Cyperus reflexus Vahl	Kissman, 1997	P	pastures, waste places	NA, SA
Cyperus remotispicatus S. S. Hooper	Simpson & Inglis, 2001		rice fields	AFR
Cyperus retroflexus Buckley	Carter et al., 1987; Carter & Bryson, 1991a, b; Carter & Jones, 1997	P	sandy waste places	NA
Cyperus retrorsus Chapm.	WSSA, 1989; Bryson et al., 1998	P	grasslands, turf, waste places	NA
Cyperus rigidifolius Steud.	Terry, 1976; Holm et al., 1979; Gordon-Gray, 1995; Simpson & Inglis, 2001	P	crops, disturbed grassland, gardens, lawns	AFR
Cyperus rotundus L.	Elliott, 1821; Lin, 1968; USDA, 1970; Cardenas et al., 1972; Kern, 1974; Terry, 1976; Holm et al., 1977; Godfrey & Wooten, 1979; Holm et al., 1979; Moody, 1981, 1989; Kühn, 1982; Lorenzi, 1982; Koyama, 1985; Soerjani et al., 1987; WSSA, 1989; Zhirong et al., 1990; Wilson, 1993; Hughes, 1995; Le Bourgeois & Merlier, 1995; Johnson, 1997; Kissman, 1997; Waterhouse, 1997; Bryson et al., 1998; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002; DeFelice & Bryson, 2004; Ramos et al., 2004; Rzedowski & Rzedowski, 2004; Carter, 2005	P	crops, gardens, field crops, grasslands, lawns, pastures, rice fields, roadsides, taro, turf, waste places	AFR, ASI, AUS, CAR, EUR, IND, NA, PI, SA
Cyperus rubicundus Vahl	Moody, 1989		rice fields	IND
Cyperus sanguinolentus Vahl	Lin, 1968; Kern, 1974; Reed, 1977; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Zhirong et al., 1990; Carter & Bryson, 2000b; Kukkonen, 2001; Simpson & Inglis, 2001	A/P	aquatic biotypes, crops, grasslands, rice fields, wet places	AFR, ASI, AUS, IND, NA, PI
Cyperus schweinfurthianus Boeckeler	Holm et al., 1979	P		AFR

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cyperus seemannianus Boeckeler	Holm et al., 1979			PI
Cyperus serotinus Rottb.	Reed, 1977; Holm et al., 1979; Kühn, 1982; Moody, 1989; Zhirong et al., 1990; Kukkonen, 2001; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields, wet places	AFR, ASI, EUR, IND, NA
Cyperus seslerioides Kunth	Holm et al., 1979	P		NA
Cyperus soyauxii Boeckeler	Simpson & Inglis, 2001	P	cultivated fields	AFR
Cyperus sphacelatus Rottb.	Kern, 1974; Reed, 1977; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Carter et al., 1996; Johnson, 1997; Kissman, 1997; Bryson et al., 1998; Simpson & Koyama, 1998; Simpson & Inglis, 2001	A/P	aquatic biotypes, crops, grasslands, rice fields, waste places	AFR, ASI, AUS, IND, NA, PI, SA
Cyperus squarrosus L.	Holm et al., 1979; Kühn, 1982; Moody, 1989; Le Bourgeois & Merlier, 1995; Kukkonen, 2001; Simpson & Inglis, 2001	A	aquatic biotypes, crops, forests, gardens, grasslands, rice fields, waste places	AFR, ASI, AUS, EUR, IND, NA, SA
Cyperus stenophyllus J. V. Suringar	Moody, 1989		rice fields	PI
Cyperus stoloniferus Retz.	Moody, 1989	P	rice fields	ASI
Cyperus strigosus L.	Holm et al., 1979; Moody, 1989; WSSA, 1989; Bryson et al., 1998; Simpson & Inglis, 2001; DeFelice & Bryson, 2004	P	crops, pastures, roadsides, wet areas	ASI, EUR, NA, PI
Cyperus substramineus Kük.	Kern, 1974; Moody, 1989; Ravi & Mohanan, 2002	A/P	rice fields	ASI, IND
Cyperus sulcinux C. B. Clarke	Kern, 1974; Moody, 1989	A	fields, rice fields, roadsides	ASI, AUS, IND, PI
Cyperus surinamensis Rottb.	WSSA, 1989; Kissman, 1997; Bryson et al., 1998	A/P		SA
Cyperus tegetiformis Roxb.	Holm et al., 1979; Moody, 1989		rice fields	AFR, ASI, IND
Cyperus tegetum Roxb.	Holm et al., 1979; Moody, 1989		rice fields	ASI, IND
Cyperus tenellus L. f.	Moore & Edgar, 1970; Simpson & Inglis, 2001		gardens, irrigation ditches	AFR, AUS, PI
Cyperus tenuiculmis Boeckeler	Kern, 1974; Holm et al., 1979; Soerjani et al., 1987; Moody, 1989; Simpson & Inglis, 2001	P	fallow fields, gardens, grasslands, rice fields	AFR, ASI, AUS, PI
Cyperus tenuis Sw.	Holm et al., 1979; Johnson, 1997; Simpson & Inglis, 2001	P	rice fields	SA
Cyperus tenuispica Steud.	Kern, 1974; Holm et al., 1979; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A/P	cultivated fields, rice fields, wet places	AFR, ASI, IND, PI
Cyperus trialatus (Boeckeler) J. Kern	Kern, 1974; Holm et al., 1979; Moody, 1989	P	rice fields, roadsides	ASI, IND, PI

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Cyperus truncatus C. A. Mey. ex Turcz.	Holm et al., 1979			ASI
Cyperus uncinatus Poir.	Holm et al., 1979; Moody, 1989; Simpson & Inglis, 2001		rice fields	PI
Cyperus ustulatus A. Rich.	Moore & Edgar, 1970; Terry, 1976; Simpson & Inglis, 2001		pastures	PI
Cyperus virens Michx.	WSSA, 1989; Kissman, 1997; Bryson et al., 1998	P		NA, SA
Cyperus vorsteri K. L. Wilson	Gordon-Gray, 1995	P	aggressive weed in parks and gardens	AFR
Cyperus zollingeri Steud.	Kern, 1974; Holm et al.,1979; Moody, 1989; Simpson & Inglis, 2001	A	crops, rice fields, roadsides	AFR, ASI, AUS, PI
Eleocharis acicularis (L.) Roem. & Schult.	Ohwi, 1965; Lin, 1968; Kern, 1974; Holm et al., 1979, 1997; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Simpson & Inglis, 2001	P	aquatic biotypes, crops, grasslands, rice fields	AFR, ASI, AUS, EUR, IND, NA, PI, SA
Eleocharis acuta R. Br.	Holm et al., 1979	P		AUS
Eleocharis acutangula (Roxb.) Schult.	Lin, 1968; Kern, 1974; Reed, 1977; Holm et al., 1979; Kühn, 1982; Koyama,1985; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields	AFR, ASI, AUS, IND, NA, PI, SA
Eleocharis albida Torr.	Carter, 2005	P	disturbed saltmarsh, ditches	CAR, NA
Eleocharis atropurpurea (Retz.) Kunth	Kern, 1974; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A	aquatic biotypes, crops, rice fields	AFR, ASI, AUS, EUR, IND, NA, PI, SA
Eleocharis attenuata (Franch. & Sav.) Palla	Holm et al.,1979; Moody, 1989	P/A?	rice fields	ASI
Eleocharis baldwinii (Torr.) Chapm.	WSSA, 1989	A	wet places	NA
Eleocharis cellulosa Torr.	Holm et al.,1979; WSSA,1989	P	brackish wet places	CA, NA, SA
Eleocharis complanata Boeckeler	Johnson, 1997	P	rice fields	AFR
Eleocharis congesta D. Don	Lin, 1968; Kern, 1974; Holm et al., 1979; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; Kukkonen, 2001; Simpson & Inglis, 2001	A/P	rice fields	ASI, IND
Eleocharis dulcis Trin. ex Hensch.	Lin, 1968; Reed, 1977; Holm et al., 1979, 1997; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	P	aquatic biotypes, crops, fallow fields, rice fields	AFR, ASI, AUS, CAR, IND, NA, PI
Eleocharis elegans (Kunth) Roem. & Schult.	Kühn, 1982; Lorenzi, 1982; Kissman, 1997; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields	CAR, NA, PI, SA

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Eleocharis equisetina J. Presl & C. Presl	Holm et al., 1979	P		ASI, AUS, PI
"*Eleocharis erecta* Schumac."	Holm et al., 1979			AFR
Eleocharis filiculmis Kunth	Reed, 1977; Kühn, 1982; Lorenzi, 1982	P	aquatic, wet places	AFR, NA, SA
Eleocharis flavescens (Poir.) Urb. var. *flavescens*	Holm et al., 1979; Walters, 1980	A/P	rice fields	CAR, EUR, NA, SA
Eleocharis flavescens var. *olivacea* (Torr.) Gleason	Walters, 1980	A/P	rice fields	EUR, NA
Eleocharis geniculata (L.) Roem. & Schult.	Cardenas et al., 1972; Kern, 1974; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Wagner et al., 1990; Kissman, 1997; Waterhouse, 1997; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A	aquatic biotypes, crops, grasslands, moist areas, rice fields, taro paddies	AFR, ASI, AUS, EUR, IND, NA, PI, SA
Eleocharis interstincta (Vahl) Roem. & Schult.	Holm et al., 1979	P		NA, SA
Eleocharis kuroguwai Ohwi	Holm et al., 1979	P		ASI
Eleocharis macbarronii K. L. Wilson	Wilson, 1993	P	rice fields	AUS
Eleocharis macrostachya Britton		P		NA
Eleocharis mamillata H. Lindb.	Holm et al., 1979	P		ASI
Eleocharis montana (Kunth) Roem. & Schult.	Holm et al., 1979	P	disturbed sites, wet ditches	CAR, NA, SA
Eleocharis montevidensis Kunth	Carter, 2005	P	crops, wet ditches	NA, SA
Eleocharis multicaulis Sm.	Holm et al., 1979			EUR
Eleocharis mutata (L.) Roem. & Schult.	Holm et al., 1979; Simpson & Inglis, 2001	P	rice fields	SA
Eleocharis obtusa (Willd.) Schult.	Holm et al., 1979; Walters, 1980; Moody, 1989; WSSA, 1989; Carter, 2005	A(P)	crops, rice fields, wet places	EUR, NA, PI (Hawaii)
Eleocharis ochrostachys Steud.	Soerjani et al., 1987; Moody, 1989	P	rice fields	ASI
Eleocharis ovata (Roth) Roem. & Schult.	Holm et al., 1979	A(P)	crops, wet places	ASI, EUR, NA
Eleocharis palustris (L.) Roem. & Schult.	Holm et al., 1979, 1997; Kühn, 1982; Moody, 1989; WSSA, 1989; Simpson & Inglis, 2001	P	aquatic biotypes, rice fields	AFR, ASI, CAR, EUR, IND, NA, SA
Eleocharis parodii Barros	Wilson, 1993	P	rice fields	AUS
Eleocharis parvula (Roem. & Schult.) Link ex Bluff, Nees & Schauer	Holm et al., 1979; WSSA, 1989; Carter, 2005	P		AFR, ASI, EUR, NA, SA
Eleocharis pellucida J. Presl & C. Presl	Reed, 1977; Kühn, 1982; Zhirong et al., 1990	A/P	aquatic biotypes, crops	ASI, IND, PI
Eleocharis philippinensis Svenson	Kern, 1974; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	rice fields	ASI, AUS, PI

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Eleocharis plantaginoidea W. F. Wight	Holm et al., 1979			IND
Eleocharis quadrangulata (Michx.) Roem. & Schult.	Elliott, 1821; Holm et al., 1979; WSSA, 1989; Carter, 2005	P	pond shores, rice fields	NA
Eleocharis quinqueflora (Hartmann) O. Schwarz	Moody, 1989	P	rice fields	IND
Eleocharis radicans (Poir.) Kunth	Wagner et al., 1990	P	taro paddies	CAR, NA, PI (Hawaii), SA
Eleocharis retroflexa (Poir.) Urb.	Kern, 1974; Holm et al., 1979; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A	rice fields	ASI, AUS, IND, SA
Eleocharis rostellata Torr.	WSSA, 1989	P	wet places	CAR, NA
Eleocharis sellowiana Kunth	Kissman, 1997			SA
Eleocharis sphacelata R. Br.	Holm et al., 1979	P		AUS
Eleocharis spiralis R. Br.	Moody, 1989	P	rice fields	ASI, IND
Eleocharis subtilis Boeckeler	Holm et al., 1979			CAR
Eleocharis tetraquetra Nees	Holm et al., 1979; Moody, 1989; Zhirong et al., 1990	P	rice fields	ASI, IND
Eleocharis tuberosa Schult.	Holm et al., 1979			ASI
Eleocharis valleculosa Ohwi f. *setosa* (Ohwi) Kitag.	Zhirong et al., 1990	P	rice fields, wetlands	ASI
Eleocharis variegata (Poir.) C. Presl	Holm et al., 1979; Moody, 1989			ASI
Eleocharis vivipara Link	WSSA, 1989	P	wet places	NA
Eleocharis wichurae Boeckeler	Reed, 1977	P?	wet places	ASI
Eleocharis wolfii A. Gray	Holm et al., 1979; Moody, 1989	P	rice fields, wet places	ASI, NA
Eleocharis yokoscensis (Franch. & Sav.) Ts. Tang & F. T. Wang	Zhirong et al., 1990	P	rice fields, wetlands	ASI
Fimbristylis acuminata Vahl	Kern, 1974; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	P	aquatic biotypes, crops, rice fields	ASI, AUS, IND, PI
Fimbristylis aestivalis (Retz.) Vahl	Lin, 1968; Kern, 1974; Reed, 1977; Holm et al., 1979; Kühn, 1982; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; Zhirong et al., 1990; Wagner et al., 1990; Simpson & Koyama, 1998; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A	aquatic biotypes, crops, rice fields, taro paddies	ASI, AUS, IND, PI, SA
Fimbristylis albicans Nees	Moody, 1989		rice fields	IND

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Fimbristylis alboviridis C. B. Clarke	Soerjani et al., 1987; Moody, 1989		rice fields	ASI, IND
Fimbristylis anisoclada Ohwi	Kern, 1974; Moody, 1989	P	rice fields	ASI, IND, PI
Fimbristylis annua (All.) Roem. & Schult.	Kral, 1971; Cardenas et al., 1972; Godfrey & Wooten, 1979; Holm et al., 1979; Moody, 1989; WSSA, 1989; DeFelice & Bryson, 2004; Carter, 2005	A	rice fields	ASI, EUR, NA, PI, SA
Fimbristylis argentea (Rottb.) Vahl	Moody, 1989; Ravi & Mohanan, 2002	P	rice fields	ASI, IND
Fimbristylis autumnalis (L.) Roem. & Schult.	Holm et al., 1979; Lorenzi, 1982; Kühn, 1982; WSSA, 1989; Kissman, 1997; Simpson & Inglis, 2001	A	aquatic biotypes, crops, rice fields	AFR, ASI, IND, NA, SA
Fimbristylis bisumbellata (Forssk.) Bubani	Kern, 1974; Holm et al., 1979; DeFilipps, 1980b; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Kukkonen, 2001	A	cultivated fields, rice fields	AFR, AUS, EUR, IND, PI
Fimbristylis caesia Miq.	Kern, 1974; Moody, 1989	A?	edges of rice fields, roadsides	PI
Fimbristylis caroliniana (Lam.) Fernald	Kral, 1971	P	disturbed soil, waste lands	CAR, NA
Fimbristylis castanea (Michx.) Vahl	Kral, 1971	P	disturbed soil, waste lands	CAR, NA
Fimbristylis cinnamometorum (Vahl) Kunth	Moody, 1989	A/P	rice fields	IND
Fimbristylis complanata (Retz.) Link	Kern, 1974; Holm et al., 1979; Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields	ASI, IND, PI
Fimbristylis cymosa R. Br.	Holm et al., 1979; Moody, 1989; Waterhouse, 1997	P	rice fields, sweet potato, taro	ASI, PI
Fimbristylis decipiens Kral	Kral, 1971; Godfrey & Wooten, 1979	A	disturbed soil, waste lands	NA
Fimbristylis dichotoma (L.) Vahl	Lin, 1968; Kral, 1971; Kern, 1974; Holm et al., 1977, 1979; Godfrey & Wooten, 1979; Kühn, 1982; Lorenzi, 1982; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Zhirong et al., 1990; Gordon-Gray, 1995; Kissman, 1997; Waterhouse, 1997; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002; Carter, 2005	A/P	aquatic biotypes, crops, grasslands, lawns, rice fields, sugarcane and tea plantations, waste places, wetlands	AFR, ASI, AUS, EUR, IND, NA, PI, SA
Fimbristylis dipsacea (Rottb.) C. B. Clarke	Kern, 1974; Moody, 1989; Ravi & Mohanan, 2002	A	rice fields	AFR, ASI, PI
Fimbristylis dura (Zoll. & Moritz) Merr.	Kern, 1974; Moody, 1989	P	rice fields	ASI, IND, PI

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Fimbristylis eragrostis (Nees) Hance	Moody, 1989	P	rice fields	ASI
Fimbristylis falcata (Vahl) Kunth	Moody, 1989	P	rice fields	IND
Fimbristylis ferruginea (L.) Vahl	Reed,1977; Holm et al.,1979; Kühn, 1982; Akobundu & Agyakwa, 1987; Moody, 1989; Johnson, 1997; Simpson & Inglis, 2001	A/P	aquatic biotypes, rice fields, waste places	ASI, AUS, EUR, IND, PI, SA
Fimbristylis globulosa (Retz.) Kunth	Kern, 1974; Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields	ASI, IND, PI
Fimbristylis griffithii Boeckeler	Soerjani et al., 1987; Moody, 1989	A	rice fields	ASI
Fimbristylis hispidula (Vahl) Kunth	Kühn, 1982	A/P	aquatic biotypes, crops, grasslands	ASI, NA, PI, SA
Fimbristylis koidzumiana Ohwi	Lin, 1968; Reed, 1977; Holm et al., 1979	A	crops, wet places	ASI
Fimbristylis littoralis Gaudich.	Kern, 1974; Moody, 1981, 1989; Akobundu & Agyakwa, 1987; Johnson, 1997	A/P	rice fields	pantropical
Fimbristylis merrillii J. Kern	Kern, 1974; Moody, 1989	A	rice fields	ASI, AUS, PI
Fimbristylis miliacea (L.) Vahl	Ohwi, 1965; Lin, 1968; Kral, 1971; Kern, 1974; Reed, 1977; Holm et al., 1977, 1979; Kühn, 1982; Lorenzi, 1982; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Zhirong et al., 1990; Kissman, 1997; Waterhouse, 1997; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002; DeFelice & Bryson, 2004; Carter, 2005	A/B	aquatic biotypes, crops, rice fields, wet places	AFR, ASI, AUS, CAR, IND, NA, PI, SA
Fimbristylis nutans (Retz.) Vahl	Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001	P	rice fields	ASI, AUS, IND
Fimbristylis pauciflora R. Br.	Moody, 1989; Wilson, 1993; Simpson & Inglis, 2001	P/A?	rice fields	ASI, AUS, IND, PI
Fimbristylis polytrichoides (Retz.) R. Br.	Moody, 1989	P	rice fields	AFR, AUS, IND
Fimbristylis quinquangularis (Vahl) Kunth	Holm et al., 1979; Koyama, 1985; Moody, 1989; Kukkonen, 2001	A/B	rice fields	AFR, ASI, IND
Fimbristylis schoenoides (Retz.) Vahl	Kern, 1974; Holm et al., 1979; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001; Carter, 2005	A/P	rice fields	ASI, AUS, IND, NA

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Fimbristylis sericea R. Br.	Moody, 1989		rice fields	ASI, AUS, IND
Fimbristylis squarrosa Vahl	Holm et al., 1979; Moody, 1989; Kukkonen, 2001	A	rice fields	AFR, ASI, EUR, IND, SA
Fimbristylis stauntoni Debeaux & Franch.	Zhirong et al., 1990	A	rice fields, wetlands	ASI
Fimbristylis stolonifera C. B. Clarke	Moody, 1989		rice fields	ASI
Fimbristylis subbispicata Nees & Meyen	Holm et al., 1979; Moody, 1989		rice fields	ASI, IND
Fimbristylis tenera Roem. & Schult.	Holm et al., 1979; Moody, 1989	A/P	rice fields	IND
Fimbristylis tetragona R. Br.	Kern, 1974; Holm et al., 1979; Koyama, 1985; Moody, 1989	P	rice fields	ASI, AUS, IND, PI
Fimbristylis thonningiana Boeckeler	Holm et al., 1979			AFR
Fimbristylis tomentosa Vahl	Kern, 1974; Soerjani et al., 1987; Moody, 1989; Carter, 2005	A	rice fields	AFR, ASI, AUS, NA, PI
Fimbristylis tristachya R. Br.	Holm et al., 1979; Moody, 1989		rice fields	AFR, ASI
Fimbristylis turkestanica (Regel) B. Fedtsch.	Kukkonen, 2001	P	fields, gardens	AFR, ASI, EUR, IND
Fimbristylis verrucifera (Maxim.) Makino	Reed, 1977	A	wet places	ASI
Fuirena breviseta (Coville) Coville	WSSA, 1989	P		NA
Fuirena ciliaris (L.) Roxb.	Ohwi, 1965; Kern, 1974; Holm et al., 1979; Kühn, 1982; Akobundu & Agyakwa, 1987; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A	aquatic biotypes, crops, grasslands, rice fields	AFR, ASI, AUS, IND, PI
Fuirena pumila (Torr.) Spreng.	WSSA, 1989	A		NA
Fuirena scirpoidea Michx.	WSSA, 1989	P		NA
Fuirena simplex Vahl	WSSA, 1989	A/P		NA
Fuirena squarrosa Michx.	WSSA, 1989	P		NA
Fuirena stricta Steud. subsp. *chlorocarpa* (Ridl.) Lye	Johnson, 1997; Simpson & Inglis, 2001	P	rice fields	AFR
Fuirena umbellata Rottb.	Kern, 1974; Holm et al., 1979; Kühn, 1982; Akobundu & Agyakwa, 1987; Soerjani et al., 1987; Moody, 1989; Johnson, 1997; Ravi & Mohanan, 2002	P	aquatic biotypes, ditches, grasslands, rice fields	AFR, ASI, AUS, IND, PI, SA
Isolepis carinata Hook. & Arn. ex Torr.	Godfrey & Wooten, 1979; WSSA, 1989	A	crops, grasslands, waste places	NA
Kyllinga aurata Nees	Holm et al., 1979	P		AFR

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Kyllinga brevifolia Rottb.	Lin, 1968; Cardenas et al., 1972; Kern, 1974; Godfrey & Wooten, 1979; Kühn, 1982; Lorenzi, 1982; Koyama, 1985; Soerjani et al., 1987; WSSA, 1989; Zhirong et al., 1990; Wagner et al., 1990; Wilson, 1993; Gordon-Gray, 1995; Holm et al., 1997; Kissman, 1997; Waterhouse, 1997; Bryson et al., 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002; Carter, 2005	P	crops, disturbed sites, fallow fields, gardens, grasslands, pastures, rice fields, turf, waste places	AFR, ASI, AUS, CAR, EUR, IND, NA, PI, SA
Kyllinga bulbosa P. Beauv.	Akobundu & Agyakwa, 1987	P	rice fields	AFR
Kyllinga colorata (L.) Druce	Zhirong et al., 1990	P		ASI
Kyllinga erecta Schumach.	Terry, 1976; Holm et al., 1979; Kühn, 1982; Akobundu & Agyakwa, 1987; Gordon-Gray, 1995; Johnson, 1997; Simpson & Inglis, 2001	P	crops, cultivated lands, grasslands, rice fields, waste places	AFR, ASI, IND, PI
Kyllinga gracillima Miq.	WSSA, 1989; Bryson et al., 1998; Simpson & Inglis, 2001	P	crops, grasslands, turf, waste places	ASI, NA
Kyllinga melanosperma Nees	Moody, 1989	P	rice fields	IND, PI
Kyllinga nemoralis (J. R. Forst. & G. Forst.) Dandy ex Hutch. & Dalziel	Holm et al., 1979; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Wagner et al., 1990; Waterhouse, 1997; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	P	crops, gardens, grasslands, lawns, pastures, plantations, rice fields, roadsides, turf, waste places	AFR, ASI, AUS, IND, PI, SA
Kyllinga odorata Vahl	Terry, 1976; Godfrey & Wooten, 1979; Holm et al., 1979; Lorenzi, 1982; Moody, 1989; Wilson, 1993; Gordon-Gray, 1995; Kissman, 1997; Bryson et al., 1998; Simpson & Inglis, 2001; Carter, 2005	P	damp sandy ground, disturbed grassland, gardens, pastures, lawns, rice fields, turf, waste places	AFR, ASI, AUS, NA, PI, SA
Kyllinga polyphylla Willd. ex Kunth	Holm et al., 1979; Moody, 1989; Waterhouse, 1997; Simpson & Inglis, 2001	P	agricultural land, crops, pastures, rice fields, roadsides, turf, waste places	AFR, ASI, PI
Kyllinga pumila Michx.	Holm et al., 1979; Akobundu & Agyakwa, 1987; WSSA, 1989; Le Bourgeois & Merlier, 1995; Johnson, 1997; Bryson et al., 1998; Simpson & Inglis, 2001	A	crops, pastures, turf, rice fields, waste places	AFR, CAR, NA, SA

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Kyllinga squamulata Thonn. ex Vahl	Terry, 1976; Akobundu & Agyakwa, 1987; WSSA, 1989; Le Bourgeois & Merlier, 1995; Bryson et al., 1998; Simpson & Inglis, 2001; Carter, 2005	A	cultivated lands, turf, waste places	AFR, ASI, CAR, IND, NA
Kyllinga triceps Rottb.	Kern, 1974; Moody, 1989; Le Bourgeois & Merlier, 1995; Simpson & Inglis, 2001	P	sandy lawn	AFR, ASI, AUS, IND, PI
Lepidosperma chinense Nees & Meyen	Kern, 1974	P	rice fields	ASI, PI
Lepironia articulata (Retz.) Domin	Moody, 1989	P	rice fields	ASI
Lipocarpha chinensis (Osbeck) J. Kern	Lin, 1968; Kern, 1974; Reed, 1977; Holm et al., 1979; Kühn, 1982; Koyama, 1985; Soerjani et al., 1987; Johnson, 1997; Simpson & Inglis, 2001	A/P	aquatic biotypes, crops, grasslands, rice fields, waste wet places	AFR, ASI, AUS, IND
Lipocarpha maculata (Michx.) Torr.	Carter, pers. obs.	A	disturbed wet sites, ditches roadsides	NA, SA
Lipocarpha microcephala (R. Br.) Kunth	Kern, 1974; Holm et al., 1979	A	rice fields, sugarcane fields	ASI, AUS, IND
Lipocarpha squarrosa (L.) Goetgh.	Kern, 1974; Moody 1989; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A/P?	crops, cultivated land, rice fields, wet fields	AFR, ASI, AUS, IND
Mapania cuspidata (Miq.) Uittien	Moody, 1989	P	rice fields	ASI
Oxycaryum cubense (Poepp. & Kunth) Palla	Holm et al., 1979; Simpson & Inglis, 2001	P	aquatic, floating mats	AFR, CAR, NA, SA
Rhynchospora aurea Vahl	Kissman, 1997	P		SA
Rhynchospora caduca Elliott	Wagner et al., 1990; Wagner & Herbst, 1995	P	pastures	NA, PI (Hawaii)
Rhynchospora cephalotes (L.) Vahl	Kissman, 1997	P		SA
Rhynchospora colorata (L.) H. Pfeiff.	WSSA, 1989	P	wet places	NA
Rhynchospora corniculata (Lam.) A. Gray	WSSA, 1989; DeFelice & Bryson, 2004	P	ditches, wet places	NA
Rhynchospora corymbosa (L.) Britton	Kern, 1974; Holm et al., 1979; Kühn, 1982; Lorenzi, 1982; Koyama, 1985; Akobundu & Agyakwa, 1987; Soerjani et al., 1987; Moody, 1989; Johnson, 1997; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	P	aquatic biotypes, crops, rice fields, waste places, wet places	AFR, ASI, AUS, IND, PI, SA
Rhynchospora fascicularis (Michx.) Vahl	Godfrey & Wooten, 1979	P	pastures, roadsides	CAR, NA, SA
Rhynchospora globularis (Chapm.) Small	Godfrey & Wooten, 1979; WSSA, 1989	P	disturbed areas, roadsides	CAR, NA, PI (Hawaii), SA
Rhynchospora glomerata (L.) Vahl	Godfrey & Wooten, 1979	P	pastures, roadsides	NA

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Rhynchospora holoschoenoides (Rich.) Herter	Simpson & Inglis, 2001	P	rice fields	AFR, SA
Rhynchospora inexpansa (Michx.) Vahl	Godfrey & Wooten, 1979	P	pastures, roadsides	NA
Rhynchospora latifolia (Baldwin) W. W. Thomas	WSSA, 1989	P	wet places	NA
Rhynchospora longisetis R. Br.	Moody, 1989	A	rice fields	ASI
Rhynchospora microcarpa Baldwin ex A.Gray	Godfrey & Wooten, 1979	P	pastures, roadsides	CAR, NA
Rhynchospora nervosa (Vahl) Boeckeler	Cardenas et al., 1972; Reed, 1977; Kühn, 1982; Lorenzi, 1982; Kissman, 1997; Simpson & Inglis, 2001	P	crops, grasslands, low elevations, wet places	CAR, NA, SA
Rhynchospora radicans H. Pfeiff. subsp. *microcephala* (Bertero ex Spreng.) W. W. Thomas	Strong & Wagner, 1997	A/P	cultivated lands	CAR, PI (Hawaii), SA
Rhynchospora rubra (Lour.) Makino	Holm et al., 1979; Moody, 1989	A/P	rice fields	ASI
Rhynchospora submarginata Kük.	Kern, 1974; Moody, 1989	A	rice fields	ASI, AUS, IND, PI
Rhynchospora tenuis Link	Holm et al., 1979			SA
Rhynchospora wightiana (Nees) Steud.	Kern, 1974; Moody, 1989	A	fallow rice fields, rice fields	ASI, IND, PI
Schoenoplectus acutus (Muhl. ex J. M. Bigelow) Á. Löve & D. Löve	USDA, 1970; Holm et al., 1979; Kühn, 1982; Moody, 1989; WSSA, 1989; DeFelice & Bryson, 2004	P	aquatic biotypes	ASI, NA
Schoenoplectus americanus (Pers.) Volkart ex Schinz & R. Keller	Holm et al., 1979; WSSA, 1989	P		NA
Schoenoplectus articulatus (L.) Palla	Kern, 1974; Holm et al., 1979; Soerjani et al., 1987; Moody, 1989; Simpson & Koyama, 1998; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A/P	rice fields, swampy fallow fields	AFR, ASI, AUS
Schoenoplectus californicus (C. A. Mey.) Soják	Holm et al., 1979; WSSA, 1989; Kissman, 1997	P	wet places	NA, PI, SA
Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J. Raynal	Moody, 1989	P	rice fields	IND
Schoenoplectus erectus (Poir.) Palla ex J. Raynal	Holm et al., 1979; Kühn, 1982	A	aquatic biotypes, wet places	AFR, ASI, AUS, EUR, IND, NA, PI, SA
Schoenoplectus grossus (L. f.) Palla	Kern, 1974; Holm et al., 1979, 1997; Soerjani et al., 1987; Moody, 1989	P	ditches, rice fields	ASI, AUS, PI

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Schoenoplectus juncoides (Roxb.) Palla	Lin, 1968; Kern, 1974; Holm et al., 1979; DeFilipps, 1980a; Koyama, 1985; Soerjani et al., 1987; Moody, 1989; Zhirong et al., 1990; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001	A	aquatic biotypes, crops, rice fields	AFR, ASI, EUR, IND, PI
Schoenoplectus lacustris (L.) Palla	Holm et al., 1979; Moody, 1989; Simpson & Inglis, 2001	P	aquatic biotypes	AFR, ASI, EUR, PI
Schoenoplectus lacustris (L.) Palla × *S. triqueter* (L.) Palla	Kukkonen, 2001	P	rice fields	ASI, IND
Schoenoplectus lateriflorus (J. F. Gmel.) Lye	Kern, 1974; Soerjani et al., 1987; Moody, 1989; Kukkonen, 2001	A	rice fields	ASI, AUS, IND
Schoenoplectus litoralis (Schrad.) Palla	Holm et al., 1979; Kühn, 1982; Simpson & Inglis, 2001	P	aquatic biotypes	AFR, ASI, AUS, EUR, IND, PI
Schoenoplectus mucronatus (L.) Palla	Kern, 1974; Reed, 1977; Holm et al., 1979, 1997; Kühn, 1982; Soerjani et al., 1987; Moody, 1989; WSSA, 1989; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; DeFelice & Bryson, 2004	P	aquatic biotypes, ditches, rice fields, wet places	AFR, ASI, AUS, EUR, IND, NA, PI
Schoenoplectus pungens (Vahl) Palla	Moore & Edgar, 1970; Simpson & Inglis, 2001	P	aquatic, unspecified	AUS, CAR, EUR, NA, PI, SA
Schoenoplectus roylei (Nees) Ovcz. & Czukav.	Moody, 1989; Kukkonen, 2001; Simpson & Inglis, 2001	A	ditches, rice fields	AFR, IND
Schoenoplectus senegalensis (Hochst. ex Steud.) Palla ex J. Raynal	Akobundu & Agyakwa, 1987; Johnson, 1997	A	rice fields	AFR
Schoenoplectus supinus (L.) Palla	Moody, 1989; Simpson & Koyama, 1998; Kukkonen, 2001; Simpson & Inglis, 2001; Ravi & Mohanan, 2002	A	rice fields	ASI, AUS, IND
Schoenoplectus tabernaemontani (C. C. Gmel.) Palla	Reed, 1977; WSSA, 1989; Zhirong et al., 1990	P	aquatic, brackish water	AFR, ASI, AUS, EUR, IND, NA
Schoenoplectus triqueter (L.) Palla	Reed, 1977; Holm et al., 1979; Kühn, 1982; Moody, 1989; Zhirong et al., 1990; Kukkonen, 2001; Simpson & Inglis, 2001	P	aquatic biotypes, rice fields	AFR, ASI, EUR, IND, PI
Schoenoplectus wallichii (Nees) T. Koyama	Lin, 1968; Kern, 1974; Reed, 1977; Holm et al., 1979; Moody, 1989	P	rice fields, wet places	ASI, IND
Scirpodendron ghaeri (Gaertn.) Merr.	Moody, 1989	P	rice fields	ASI
Scirpus atrovirens Willd.	Holm et al., 1979; WSSA, 1989	P	roadsides, wet places	NA
Scirpus cyperinus (L.) Kunth	Holm et al., 1979; WSSA, 1989; Carter, 2005	P	roadsides, wet places	NA

Appendix 2. Continued.

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Scirpus giganteus Kunth	Kissman, 1997	P		SA
Scirpus holoschoenus L.	Reed, 1977; Holm et al., 1979; Kühn, 1982	P	crops, waste places	AFR, ASI, EUR, IND
Scirpus michelianus L.	Moody, 1989; Zhirong et al., 1990	A	farmland, field borders, rice fields	ASI, IND
Scirpus pendulus Muhl.	Holm et al., 1979	P	roadsides, wet places	AUS, NA
Scirpus sylvaticus L.	Holm et al., 1979	P		EUR
Scirpus triangulatus Roxb.	Holm et al., 1979	P		AUS
Scleria bancana Miq.	Holm et al., 1979; Moody, 1989		rice fields	ASI
Scleria biflora Roxb.	Kern, 1974; Koyama, 1985; Moody, 1989	A	rice fields, roadsides, tea plantations	ASI, IND, PI
Scleria boivinii Steud.	Holm et al., 1979			AFR
Scleria bracteata Cav.	Holm et al., 1979; Kissman, 1997			SA
Scleria canescens Boeckeler	Holm et al., 1979			NA, SA
Scleria caricina (R. Br.) Benth.	Simpson & Koyama, 1998; Simpson & Inglis, 2001		rice fields	PI
Scleria depressa (C. B. Clarke) Nelmes	Johnson, 1997	P	rice fields	AFR
Scleria lacustris C. Wright	Tobe et al.,1998; Wunderlin, 1998; Jacono, 2001	A	aquatic waste places, wet places	AFR, CAR, NA, SA
Scleria laevis Retz.	Kern, 1974; Holm et al., 1979; Moody, 1989; Ravi & Mohanan, 2002	P	fallow rice fields	ASI, AUS, IND, PI
Scleria lithosperma (L.) Sw.	Holm et al., 1979; Kühn, 1982; Moody, 1989; Simpson & Inglis, 2001	P	aquatic biotypes, crops, rice fields, waste places, wet places	AFR, ASI, IND, PI, SA
Scleria melaleuca Rchb. ex Schltdl. & Cham.	Cardenas et al., 1972; Holm et al., 1979; Lorenzi, 1982; Moody, 1989	P		CAR, SA
Scleria myriocarpa Steud.	Holm et al., 1979			SA
Scleria naumanniana Boeckeler	Akobundu & Agyakwa, 1987	P	forest clearings, wet areas	AFR
Scleria novae-hollandiae Boeckeler	Kern, 1974; Moody, 1989	A	fallow rice fields, rice fields	AUS, IND, PI
Scleria oblata S. T. Blake	Holm et al., 1979; Moody, 1989	P	rice fields	ASI
Scleria poaeformis Retz.	Holm et al., 1979; Moody, 1989	P	rice fields	ASI, AUS, IND
Scleria polycarpa Boeckeler	Holm et al., 1979	P		PI
Scleria purpurascens Steud.	Holm et al., 1979; Moody, 1989	P	rice fields	ASI

Species[1]	Source	Habit[2]	Habitat	Distribution[3]
Scleria rugosa R. Br.	Kern, 1974; Koyama, 1985; Moody, 1989	A	rice fields	ASI, AUS, IND, PI
Scleria scindens Nees	Reed, 1977	P		CAR
Scleria scrobiculata Nees & Meyen	Holm et al., 1979; Moody, 1989	P	rice fields	PI
Scleria sumatrensis Retz.	Holm et al., 1979; Kühn, 1982; Moody, 1989; Simpson & Inglis, 2001	A	aquatic biotypes, crops, forests, rice fields	ASI, AUS, IND, PI
Scleria tessellata Willd. var. *sphaerocarpa* E. A. Rob.	Kühn, 1982; Moody, 1989; Le Bourgeois & Merlier, 1995; Simpson & Inglis, 2001	A	aquatic biotypes, grasslands, rice fields, wet places	AFR, ASI, AUS, IND, PI, SA
Scleria verrucosa Willd.	Akobundu & Agyakwa, 1987	P	wet areas	AFR

[1] Plant nomenclature follows *Flora of North America*, volume 23; plant names were also verified through the Missouri Botanical Garden w[3]TROPICOS VAST database (rev. 1.5) (http://mobot.mobot.org/W3T/Search/vast.html) and the International Plant Names Index (http://www.ipni.org/index.html). A more inclusive list of names cited in the references is available from the authors.

[2] A = annual; B = biennial; P = perennial; supplemental data from Kükenthal (1935–1936), Kern (1974), Holm et al. (1977, 1997), Haines and Lye (1983), Koyama (1985), Soerjani et al. (1987), Wilson (1993), Gordon-Gray (1995), Lye (1995), Simpson and Inglis (2001), Kukkonen (2001), and *Flora of North America*, volume 23.

[3] AFR = Africa including Madagascar; ASI = Asia; AUS = Australia; CAR = Caribbean Islands; EUR = Europe; IND = Indian subcontinent including Sri Lanka; NA = North America; PI = Pacific Islands; SA = South America.

CONTRIBUTIONS TO THE FLORA OF GEORGIA, U.S.A.

RICHARD CARTER[1,4], W. WILSON BAKER[2], M. WAYNE MORRIS[3]

Abstract. Additions to the flora of Georgia, U.S.A., and other noteworthy records are reported. Voucher specimen data are cited to document species from Georgia previously not known to occur in the state; additional records of poorly known or infrequently collected native and exogenous naturalized species; and additional populations of rare, threatened, and endangered species or species otherwise listed by the Georgia Department of Natural Resources. Data on the status of protected plants, special concern plants, and watched plants as indicated by the Georgia Department of Natural Resources are provided, and exogenous taxa are denoted. One hundred seventy-seven species are reported, of which 59 are putative state records and 68 are exogenous.

Keywords: flora, floristics, Georgia, range extensions, vascular plants, noteworthy plants, rare plants, invasive weeds.

Venard (1969) compiled a comprehensive list of published botanical work pertaining to Georgia. While it is beyond the scope of this paper to update that work, below we review some of the highlights of Georgia's floristic botany, with particular emphasis on published research since Venard's 1969 compilation. Other than Stephen Elliott's *Sketch* (1816–1821, 1821–1824) no comprehensive flora of the state has been published. However, Roland Harper's remarkable contributions to the knowledge of Georgia's flora in the first decade of the 20th Century aside (Harper 1900a, 1900b, 1901, 1903a, 1903b, 1904, 1905a, 1905b, 1906a, 1906b, 1909, 1910), there have been a number of important works dealing with various taxonomic groups, i.e., McVaugh and Pyron (1951), Russell and Duncan (1972), Muir (1979), Bruce et al. (1980), and Snyder and Bruce (1986), or with specific geographical regions of the state, i.e., Thorne (1949a, 1949b, 1951), Faircloth (1971), and Lane (1976). Other works with broader geographical coverage also bear substantially on the flora of Georgia, i.e., Chapman (1860, 1889, 1897), Small (1903, 1913, 1933), Radford et al. (1968), Duncan (1975), Godfrey and Wooten (1979, 1981), and Godfrey (1988). Notable too are Robert Kral's (1983) comprehensive treatment of rare flora of the southeastern United States and compilations on Georgia's rare plants by Patrick et al. (1995) and Chafin (2007). Moreover, numerous florulas of smaller areas such as counties or state parks have been published since Venard (1969), i.e., Lipps and De Selm (1969), Bostick (1971), Jones (1974), Leslie and Burbanck (1979), Coile (1981), Duncan (1982), Houle (1987), Coile and Jones (1988), Howel (1991), Drew et al. (1998), Stiles and Howel (1996, 1998), Zomlefer et al. (2008), Echols and Zomlefer (in press). Also, during this period nu-

Colleagues kindly confirmed the identities of duplicate specimens as follows: Dr. Robert Kral (VDB), *Asimina pygmaea* and *A.* × *nashii*; Dr. Charles Bryson (SWSL) and Dr. Rob Naczi (DOV), *Carex annectens*, *C. chapmanii*, *C. floridana*, and *C. godfreyi*; Dr. Kelly Allred (NMCR), *Bothriochloa* spp.; Dr. Richard Spellenberg (NMC), *Boerhaavia diffusa* and its status as new state record; and Dr. John Nelson (USCH), *Pycnanthemum floridanum*. Dr. Rob Naczi determined duplicate specimens of *Carex gholsonii*. Mr. John B. Jensen, Senior Wildlife Biologist, Georgia Department of Natural Resources, Nongame Conservation Section, graciously shared site data on his *Rhexia salicifolia* site and granted permission to report our voucher specimens. Mr. Greg Lee and Mr. Paul Schoenfeld secured clearance for us to publish data on records from Moody Air Force Base and Kings Bay Submarine Base, respectively. Support for field research was provided to the first author through grants and contracts from the following agencies and organizations: Georgia Department of Natural Resources, Natural Heritage Program; Georgia Botanical Society; USDA-APHIS. through University of Georgia (Tifton); US Department of Defense through the Georgia Department of Natural Resources, Grant No. 1995CCD002; US Fish & Wildlife Service; US Department of Defense, Department of the Air Force, through The Nature Conservancy of Georgia, Contract No. M6700491D0010-5W01; the US Army through the Nature Conservancy of Georgia; and the Faculty Research Fund of Valdosta State University. The Botany Department, University of Florida, provided financial support to M.W. Morris. The constructive reviews of Dr. Loran Anderson (FSU) and Dr. Alan Weakley (NCU) improved this paper.

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merous reports of new state records or significant range extensions have appeared, i.e., Norsworthy (1966), Faircloth (1970, 1975, 1981), Duncan (1971, 1985), Duncan and Funderburk (1972), Bostick (1977), Duncan and Duncan (1978), Dennis (1980), Kral (1981), Carter and Faircloth (1986), Hunt (1986), Whetstone et al. (1987), Broyles and Wyatt (1988), Coile (1988), Bridges and Orzell (1989), Carter (1990), Matthews et al. (1991), Stiles and Howel (1994), Ruter et al. (1995), Bryson et al. (1996), Sorrie (1998), Carter et al. (1999), Carter and Bryson (2000), Holmes (2000), Townsend et al. (2000), McMillan et al. (2002), and Jenkins and McMillan (2005). Since 1980, several checklists and atlases based upon voucher specimens housed primarily at the University of Georgia Herbarium (GA) have been published: Duncan and Kartesz (1981), Coile and Jones (1985), Jones and Coile (1988), and most recently Sweeney and Giannasi (2000).

Our purpose herein is to provide data from voucher specimens documenting for Georgia (1) species previously not known to occur in the state, (2) additional records of poorly known or infrequently collected native and exogenous naturalized species, and (3) additional populations of rare, threatened, or endangered species. Recent lists of protected plants, special concern plants, and watched plants compiled by the Georgia Department of Natural Resources Natural Heritage Program (Patrick et al. 1995; Anonymous 2007) were used to determine the status of species reported on herein, and it is anticipated that data reported herein will be useful in revising those lists.

Following is an alphabetical annotated list of noteworthy contributions to the flora of Georgia. Tropicos (Missouri Botanical Garden 2008) was used to confirm authority citations and synonymy. Based upon voucher specimens, the atlases of Jones and Coile (1988) for dicots and Sweeney and Giannasi (2000) for pteridophytes and monocots have been our primary means for determining which taxa have previously been documented for the state. Names for physiographic provinces mostly follow Bruce et al. (1980). As indicated, voucher specimens for the records reported herein are housed primarily at Valdosta State University Herbarium (VSC), with duplicates distributed elsewhere. Duplicates yet to be distributed are indicated "others tbd." Herbarium acronyms follow Holmgren and Holmgren (1998). Author abbreviations follow Brummitt and Powell (1992). Other abbreviations and symbols are keyed in Table 1.

TABLE 1. Key to symbols denoting species status and rank.

State status according to Georgia Department of Natural Resources (Anonymous 2007)	
E	Listed as endangered; species in danger of extinction throughout all or part of its range
T	Listed as threatened; species likely to become an endangered species in the foreseeable future throughout all or parts of its range
R	Listed as rare; species may not be endangered or threatened but should be protected because of scarcity
U	Listed as unusual (and thus deserving of special consideration); plants subject to commercial exploitation
State rank according to Georgia Department of Natural Resources (Anonymous 2007)	
S	Listed among plant species of special concern
W	Listed among watched plant species
S1	Critically imperiled in state because of extreme rarity (5 or fewer occurrences)
S2	Imperiled in state because of rarity (6 to 20 occurrences)
S3	Rare or uncommon in state (21 to 100 occurrences)
SN	Regularly occurring, usually migratory and typically nonbreeding species
SR	Reported from state, but without persuasive documentation (precise site records or verification of taxonomy lacking)
SU	Possibly in peril in state but status uncertain; need more information on threats or distribution
SH	Of historical occurrence in state, perhaps not verified in past 20 years, but suspected to be extant
SNR	State not ranked
?	Denotes questionable rank; best guess given whenever possible (e.g. S3?)
Miscellaneous symbols and abbreviations	
*****	Putative first record for Georgia
†	Exogenous taxon
EPPC	Listed among invasive exotic plants in Florida (FLEPPC 2007)
FNW	Federal Noxious Weed (Anonymous 2006)

†***Acmella pusilla*** (Hook. & Arn.) R.K. Jansen (Asteraceae)

U.S.A. GEORGIA. **Chatham Co.:** Garden City, 0.2 mi W jct Hwy GA 307 and Hwy GA 21, beween Export Blvd and Hwy GA 21, mowed lawn of business along E side Hwy GA 307, 32° 07.583'N 81°10.4233'W, plants stoloniferous, forming mats, locally common, 13 Jul 2006, *R. Carter 16944* (VSC, others tbd).—This South American native has long been known from Florida (Wunderlin & Hansen 2003; Wunderlin & Hansen 2008). Although Jones and Coile (1988) did not record it from Georgia, more recently Strother (2006d) mapped it in the southeastern states from Florida to North Carolina. Weedy associates at the Chatham County site were *Axonopus affinis* Chase, *Cynodon dactylon* (L.) Pers., *Dichondra carolinensis* Michx., *Diodia virginiana* L., *Eragrostis minor* Host, *Gamochaeta chionesthes* G.L. Nesom, *Oxalis corniculata* L., *Paspalum notatum* Flüggé, *Phyllanthus urinaria* L., *Scutellaria racemosa* Pers., and *Trifolium repens* L. Herein, we report voucher specimen data confirming the naturalization of *A. pusilla* in Georgia.

Aeschynomene viscidula Michx. (Fabaceae) – S(S1?)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, vic. dock and boat ramp, 30°49'18"N 81°32'40"W, edge of open mowed area along bluff, plants prostrate, local, flowers yellow, 1 Jul 1996, *R. Carter 12976* (VSC, others tbd).—Jones and Coile (1988) map *A. viscidula* only in McIntosh County. Herein, we report voucher specimen data for an additional county in Georgia.

Agalinis georgiana (C.L. Boynton) Pennell (Scrophulariaceae)

U.S.A. GEORGIA. **Lowndes Co.:** 2.48 air mi WSW of Kinderlou, 30°46.543'N 83°24.057'W, ridge flat, locally common, 6 Sep 2007, *R. Carter 18008 and W.W. Baker* (VSC, others tbd). **Thomas Co.:** Thomasville, Greenwood Plantation, Big Woods, well-drained upland, annually burned pineland, mostly longleaf, amongst wiregrass, 15 Sep 1980, *R. Komarek s.n.* (TTRS); Thomasville, between Pinetree Blvd and Hwy US 319 west bypass, Leabo property, conservation easement, 30° 49.426'N 84°00.558'W, longleaf pine-wiregrass savanna, local, 15 Sep 2006, *W.W. Baker s.n.* (FSU, VSC), 17 Sep 2006, *R. Carter 17215, W.W. Baker and G. Nelson* (VSC); Wade Tract, 30.76072°N 84.002854°W, locally abundant, 22 Sep 2008, *W.W. Baker s.n.* (FSU, TTRS, VSC). **Worth Co.:** 4.35 air mi NNW Anderson City, W of Old Hwy 33, Jeffords Tract, 31.43393°N 83.86999°W, lower slope along drain just upslope from bog, *Pinus palustris-Aristida stricta* community, 11 Sep 2008, *R. Carter 18529 and W.W. Baker* (VSC).—Pennell (1935) described the range of this species as southern Georgia, southern Alabama, and northern Florida, indicating the type locality in Dooly County, Georgia. Jones and Coile (1988) do not include it for Georgia. Herein, we report recent collections of this poorly known and rare taxon from three counties in southcentral Georgia. W.W. Baker initially found the Leabo population in Thomas County in September 2006 but saw no plants there during 2007. The Lowndes County population was a component of a frequently burned (but 1–2 year rough) community with *Aristida stricta* Michx., *Diospyros virginiana* L., *Eupatorium compositifolium* Walter, *Pinus palustris* Mill., *Pteridium aquilinum* (L.) Kuhn, *Quercus falcata* Michx., *Q. nigra* L., *Q. pumila* Walter, *Q. stellata* Wangenh., *Rhus copallinum* L., *Toxicodendron pubescens* Mill., and *Vernonia angustifolia* Michx. Although *A. georgiana* has no official status or listing in Georgia (cf. Patrick et al. 1995; Anonymous 2007), we are in agreement with Hays (2002) that it should be accorded such.

†****Alternanthera pungens*** Kunth (Amaranthaceae)

U.S.A. GEORGIA. **Sumter Co.:** N side of Americus, E of Hwy US 19 at jct Rucker St, 32.08967°N 84.23963°W, gravelly parking area in vacant lot, 1 Sep 2008, *R. Carter 18519* (VSC, others tbd). **Tift Co.:** field border, 15 Aug 2005, *B. Tankensley s.n.* (VSC).—These voucher specimen data comprise the first report of this tropical American, prostrate "sticker weed" from Georgia (cf. Jones & Coile 1988; Clemants 2003).

†***Ambrosia psilostachya*** DC. (Asteraceae)

U.S.A. GEORGIA. **Camden Co.:** Coleraine, ca. 100 m S jct Hwy GA 40 and Coleraine main entrance road, 30°50.298'N 81°53.967'W, flatwoods, locally common in clearing and along road, 27 Oct 2006, *R. Carter 17366 and W.W. Baker* (VSC, others tbd).—This perennial ragweed is native to the Great Plains Region of the central United States and is sporadically introduced into the eastern states (Cronquist 1980). Although Jones and Coile (1988) did not record the species from Georgia, more recently Strother (2006a) maps it widely throughout much of the United States, including Georgia. Thus, it would appear *A. psilostachya* has rapidly dispersed throughout the eastern United States in the past few decades. Herein, we report voucher specimen data confirming the occurrence of this species in Georgia.

Amphicarpum muhlenbergianum (Schult.) Hitchc. (Poaceae) – W(S3?)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, 30°49'00"N 81°32' 45"W, mechanically disturbed reddish brown loam along west bank of Etowah Pond, locally common, 28 Aug 1996, *R. Carter 13601* (VSC); Kings Bay Submarine Base, ca. 300 m SE Franklin Gate, 30°46'48"N 81°34'25"W, low flatwoods, locally common in clearing and along roadside, 11 Oct 1996, *R. Carter 13884* (VSC). **Charlton Co.:** Coleraine, 1.23 air mi NW Coleraine historical site (Old Town of Coleraine), 30°50.585'N 81°55.083'W, locally abundant in ditch along edge of recently clearcut flatwoods, 27 Oct 2006, *R. Carter 17364 and W.W. Baker* (VSC). **Cook Co.:** ca. 1 mi NW of Cecil, vic. Cecil Bay, locally common, 4 Jun 2001, *R. Carter 14505* (VSC). **Lanier Co.:** Moody Air Force Base, Winnersville Bombing Range, ca. 100 m NE jct Moore Loop and crash trail 13, 30°58' 26"N, 83°08' 34"W, margin of isolated pond, 17 Sep 1994, *R. Carter 12256* (VSC, others tbd); Moody Air Force Base, Winnersville Bombing Range, ca. 0.5 mi SE observation tower at W end Moore Loop, 30°58' 35"N, 83°08' 51"W, margin of crescent shaped depression, 30 Sep 1994, *R. Carter 12279* (VSC).—The distribution of this species has been poorly documented in Georgia, and its congener, *A. amphicarpon* (Pursh) Nash, although known from the Carolinas and Florida, has not been recorded for Georgia (Sweeney & Giannasi 2000; Wipff 2003a). Sweeney and Giannasi (2000) map *A. muhlenbergianum* from only two Georgia counties, Baker and Jenkins. Its distribution in Georgia is apparently limited to the coastal plain where it occurs in moist sandy soils along the margins of ponds and shallow depressions in the ecotone transitional to the adjacent pine flatwoods. Flowering and fruiting appear to be stimulated by mechanical soil disturbance associated with modern silvicultural practices, suggesting fire dependence. In Camden County the following woody associates were noted: *Bejaria racemosa* Vent., *Ilex glabra* (L.) A. Gray, *Lyonia lucida* (Lam.) K. Koch, *Morella cerifera* (L.) Small, *Persea palustris* (Raf.) Sarg., *Pinus elliottii* Engelm., *Quercus nigra*, and *Serenoa repens* (W. Bartram) Small.

Angelica dentata (Chapm. ex Torr. & A. Gray) J.M.Coult. & Rose (Apiaceae) – S(S2?)

U.S.A. GEORGIA. **Berrien Co.:** sandridge by Hwy US 129, 0.8 mi N Alapaha jct Hwy US 129N and Hwy US 82, 1 Oct 1994, *R. Carter 12287* (VSC). **Brooks Co.:** 4.1 mi W of Barney, dry, upland pine woods and mixed hardwoods, 1 Sep 1969, *W.R. Faircloth 6075* (VSC); N of Nankin, Knights Ferry Rd, 1.2 mi E jct with Madison Hwy (GA 333), 30°50.841'N 83°18.202'W, mesic flatwoods with *Pinus palustris* and *Aristida stricta*, infrequent and local, 3 Nov 2004, *R. Carter 15838* (VSC). **Lanier Co.:** 2.5 mi WSW of Lakeland, open pine woodland alongside US-221, 12 Oct 1967, *W.R. Faircloth 4946, G. Loyd and J. Golden* (VSC); 0.7 mi S Lanier-Berrien county line on unpaved secton of Hwy GA 64, 15 Oct 1976, *R. Kerby* 52 (VSC). **Lowndes Co.:** 1.8 mi NW of N Valdosta Exit on I-75, open pinewoods, 9 Oct 1970, *R. Volosen* 11 (VSC); ca. 7.25 air mi SSE Valdosta city center, 30°45.733'N 83°22.559'W, ca. 2.2 mi S jct Rocky Ford Rd and Hwy US 84, sandy flatwoods, locally common, 22 Nov 2003, *R. Carter 15301* (VSC).—Jones and Coile (1988) map this species from only three counties in southern Georgia: Cook, Grady and Worth. These voucher specimen data add four more Georgia counties to the distribution of *A. dentata*, an inhabitant of periodically burned longleaf pine-wiregrass savannas, habitat that has been severely reduced and continues to be imperiled by conversion to silviculture, agriculture and real estate development.

†****Anthriscus caucalis*** M. Bieb.

A. scandicina Mansf.

U.S.A. GEORGIA. **Lumpkin Co.:** fescue pasture, 4 Jun 2009, *Scott Sheppard s.n.* (VSC).— Occurring sporadically in the northeastern U.S. (Gleason & Cronquist 1991) and also known from

California (Constance 1993), this Eurasian native has been reported in the southeastern U.S. from Virginia (Fernald 1950), Tennessee (Rogers & Bowers 1973), and South Carolina (Hill & Horn 1997). Neither Jones and Coile (1988) nor Weakley (2008) record bur-chervil from Georgia.

Apteria aphylla (Nutt.) Barnhart ex Small (Burmanniaceae) – W(S3)

U.S.A. GEORGIA. **Camden Co.:** ca. 11.75 air mi NNE of St. Marys waterfront, 30°53'23"N 81°32' 28"W, ecotone of hammock and bayswamp adjacent to salt marsh, 5 Oct 1995, *R. Carter 12854* (VSC); 4.38 air mi ESE Woodbine jct Hwys US 17 and GA 110, 30°57.330'N 81°39.067'W, locally common in mesic maritime forest, 1 Sep 2006, *R. Carter 17187 and W.W. Baker* (VSC). **Grady Co.:** 5.7 mi SSE of Whigham, west-facing slope of unnamed tributary of Farmer's Spring Branch, 17 Dec 1994, *W.R. Faircloth 8935* (VSC). **Lowndes Co.:** Valdosta, "South Forty" ESE Joree Mill Pond, locally common, 13 Aug 1993, *R. Carter 11170* (VSC); 1.3 air mi SW jct I-75 and Hwy GA 94, 1.7 air mi NW jct I-75 and Hwy US 84, S of Troupville and W of Valdosta, 30°49'45"N 83°20' 35"W, Valdosta USGS quadr., 10 Aug 1996, *R. Carter 13455 and S. Jones* (VSC).—Sweeney and Giannasi (2000) report *A. aphylla* from only four Georgia counties: Echols, Glynn, Early and Randolph. Herein, we provide additional county records of this easily overlooked species, which is probably more common than herbarium vouchers would indicate. At the Lowndes County site, *A. aphylla* was found near the base of a mesic slope with *Fagus grandifolia* Ehrh., *Magnolia grandiflora* L., *Morella cerifera*, *Symplocos tinctoria* (L.) L'Hér., and *Styrax grandifolius* Aiton. In Camden County, it was a component of the mesic maritime hammock and an ecotone between hammock and bayswamp adjacent to salt marsh, where it was associated with *Arundinaria gigantea (Walter) Muhl.*, *Ilex cassine* L., *I. opaca* Aiton, *Liquidambar styraciflua* L., *Mitchella repens* L., *Quercus hemisphaerica* W. Bartr. ex Willd., *Q. nigra*, and *Q. virginiana* Miller.

†****Arachis prostrata*** Benth. (Fabaceae)

U.S.A. GEORGIA. **Charlton Co.:** SSE of Moniac, 0.1 mi N jct Hwy GA 121 and GA 185, along Hwy GA 121, UTM 17 390585E 3360050N (NAD27), dense colony along roadside, 8 Jun 2006, *R. Carter 16750 and W.W. Baker* (VSC, others tbd).—Native to Brazil, *A. prostrata* was introduced as a ground cover in warmer parts of the southeastern United States and is occasionally naturalized in Florida (Wunderlin & Hansen 2003; Wunderlin & Hansen 2008). This species has not been previously reported to be naturalized in Georgia.

†****Ardisia crenata*** Sims (Myrsinaceae)

U.S.A. GEORGIA. **Lowndes Co.:** NE Valdosta, SE quadrant jct Oak St Ext. and Lake Laurie Dr, vic. Mt. Zion A.M.E. Church, disturbed mesic woods along W side of wetland, USGS Hahira East quadr., UTM 17 281928E 3419384N (NAD83/WGS84), locally common, 26 Jul 2006, *R. Carter 17094* (VSC, others tbd); Valdosta, Valdosta State University, vic. city bike trail along S bank One Mile Branch, between Sustella Ave and Wainwright St, UTM 17 280214E 3414480N (NAD83/WGS84), degraded slope forest, urban woodlot, 4 Mar 2007, *R. Carter 17423* (VSC). **Thomas Co.:** Thomasville, ca. 100 m S jct Pinetree Blvd and Millpond Rd, on Millpond Rd, 30.81291°N 83.96429°W, mixed pine-hardwoods, local, 12 Jun 2008, *R. Carter 18401 and W.W. Baker* (VSC).—In Florida, coral berry is listed as a Category I invasive exotic weed (FLEPPC 2007). This shrub was introduced from Asia as an ornamental in part because of bright red fruits, which unfortunately are dispersed by birds (Bailey 1949; Langeland & Burks 1998). Singhurst et al. (1997) reported it as well established and having "completely dominated the shrub-undershrub layers" in beech-magnolia communities of eastern Texas. It is also established in Louisiana (Reese 1992), and Judd (2003) reported it naturalized in Alachua County, Florida. In southern Georgia, *A. crenata* is naturalized in mesic flatwoods and on slopes and in floodplains in urban areas, where it appears to have substantial invasive potential.

Asimina ×nashii Kral (Annonaceae)

U.S.A. GEORGIA. **Ware Co.:** 5.9 mi N of Waycross, just N of Jamestown, sandridge N of Satilla River and W of Jamestown Road, flowering specimen, 26 Apr 1987, *R. Carter and W.K. George 5400* (GA, IBE, MO, NY, US, VDB, VSC); fruiting specimen, 18 Aug 1988, *R. Carter 7333* (GA, VDB, VSC, others tbd).—This hybrid (*A. incana* × *A. longifolia* var. *longifolia*) is infrequent in the outer coastal plain of Georgia (Kral 1997). The plant reported above was about 2 m tall, and its flowers were indeed spectacular and pleasantly fragrant, as described by Kral (1960, 1997).

Asimina pygmaea (W. Bartram) Dunal – S S1?)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, along western boundary, ca. 100 m W of western fringe of Etowah Pond, ca. 600 m SW Etowah Park dock and launch, 30°49'00"N 81°32'49"W, USGS Harrietts Bluff 7.5' quadr., elev. 15–20 m, locally common, 2 Jul 1996, *R. Carter 13007* (VDB, VSC); Kings Bay Submarine Base, ca. 300 m S of perimeter road along northern boundary of base, W of golf course, ca. 0.75 air mi N of golf course club house, 30°50'03"N 81°33'27"W, USGS Harrietts Bluff 7.5' quadr., elev. 20–25 ft, local, 9 Jul 1996, *R. Carter 13196* (VSC); Clarks Bluff, 30°46.349'N 81° 46.515'W, narrow sandy ridge with *Pinus palustris* and *Aristida stricta*, local, rare, 14 Sep 2007, *R. Carter 18107 and W.W. Baker* (VSC). **Charlton Co.:** Okefenokee National Wildlife Refuge, Billys Island, common, 24 Sep 1988, *R. Carter and M.W. Morris 7722* (VSC); 9.1 mi W of St. George jct Hwys GA 94 and 23, pond cypress depression along N side of Hwy GA 94, plants local, 27 May 1989, *R. Carter 7869 and M.W. Morris* (VSC, others tbd).—These data provide additional documentation for *A. pygmaea*, a low shrub that reaches the northern limit of its distribution in southeastern Georgia (Kral 1960, 1997), where it occurs in slash or longleaf pine dominated flatwoods. Common associates include *Asimina* sp., *Bejaria racemosa*, *Ilex glabra*, *Lyonia ferruginea* (Walter) Nutt., *L. fruticosa* (Michx.) G.S. Torr., *L. lucida*, *Morella cerifera*, *Persea palustris*, *Pinus elliottii*, *P. palustris Mill.*, *Pteridium aquilinum*, *Quercus chapmanii* Sarg., *Q. geminata* Small, *Q. hemisphaerica*, *Q. incana* W. Bartr., *Q. minima* (Sarg.) Small, *Q. myrtifolia* Willd., *Q. nigra*, *Q. virginiana*, *Rhus copallinum*, *Serenoa repens*, *Vaccinium arboreum* Marshall, *V. corymbosum* L., and *V. myrsinites* Lam.

†****Asparagus setaceus*** (Kunth) Jessop (Asparagaceae)

U.S.A. GEORGIA. **Camden Co.:** St. Marys, vic. public boat ramp at E end of Meeting St, 30° 43.937'N 81°32.394'W, infrequent, 18 Aug 2006, *R. Carter 17152 and W.W. Baker* (VSC). **Lowndes Co.:** Valdosta, 2418 Winding Way, 30°51'59.11"N 83°18'49.45"W, epiphytic on pindo palm, 10 Nov 2008, *R. Carter 18732* (VSC, others tbd).—This species was introduced from Africa as an ornamental and has previously been reported as naturalized in California and Florida in the United States (Straley & Utech 2002) and is listed for Cumberland Island, Georgia (Hunt & Langeland 2008). Although in Camden County, we observed *A. setaceus* only in open disturbed areas, it appeared to be naturalized and spreading locally. In Lowndes County, the plants are epiphytic on pindo palm and were apparently established from seeds dispersed there by birds after they consumed the bright red fruits. Herein, we report voucher specimen data to substantiate the naturalization of this species in Georgia.

Aster elliottii Torr. & A. Gray (Asteraceae)
Symphyotrichum elliottii (Torr. & A. Gray) G.L. Nesom

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, 0.125 mi N jct U.S.S. James Madison Rd and U.S.S. Benjamin Franklin Rd, along E side U.S.S. James Madison Rd, with *Taxodium ascendens*, *Salix* sp., *Nyssa biflora*, *Persea palustris*, *Morella cerifera*, *Baccharis halimifolia*, 25 Oct 1996, *R. Carter 13957* (VSC, others tbd). **Charlton Co.:** 2.86 mi W of St. George, 30°31.271'N 82° 05.141'W, ditch and backslope along Hwy GA 94, local in sticky clay, 10 Nov 2003, *R. Carter 15294 and R. Kral* (VSC, others tbd). **Echols Co.:** sandy bank of Tom's Creek at Hwy GA 94 bridge, about 4.5 mi E of Tarver, flatwoods, 27 Oct 1984, *R. Carter and W.R. Faircloth s.n.* (VSC).—Although this species is widely distributed in southeastern United States (Cronquist 1980), it is apparently infrequent to rare in the Georgia coastal plain, previously mapped in only Chatham and Pickens counties by Jones and Coile (1988).

Balduina atropurpurea R.M. Harper – R

U.S.A. GEORGIA. **Worth Co.:** 1.6 mi W Sylvester jct Hwy US 82 and Hwy GA 33, 31°32.157' N 83°51.690'W, powerline right-of-way N of Hwy US 82, open boggy slope, local, 26 Sep 2007, *R. Carter 18140 and W.W. Baker* (VSC); Arrowhead Farm, long narrow seepage slope along SW margin of pond head, 31°21.917'N 83°47.865'W, locally common, 27 Sep 2007, *R. Carter 18157 and W.W. Baker* (VSC); 4.35 air mi NNW Anderson City, W of Old Hwy 33, Jeffords Tract, 31.430329°N 83.869458°W, bog along edge of drain within recently burned *Pinus palustris-Aristida stricta* community, plants locally common, 11 Sep 2008, *R. Carter 18532 and W.W. Baker* (VSC).—These voucher data provide additional localities for this rare composite.

†**Boerhavia diffusa** L. (Nyctaginaceae)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, mowed shoulder along N side U.S.S. Henry L. Stimson Dr, ca. 50 m W jct U.S.S. Kamehameha Ave, 30°47'58"N 81°31'44"W, plants local, fruits viscid, clinging to clothing, 8 Jul 1996, *R. Carter 13145* (NMC, VDB, VSC). **Charlton Co.:** Folkston, ruderal strip along W side Hwy US 1, between Hwy and parking lot, 30°49.714'N 82°00.319'W, locally common, 31 Aug 2006, *R. Carter 17174 and W. Baker* (VSC, others tbd). **Decatur Co.:** Bainbridge, W side of city, near jct W Dothan Rd and N Thomas St, 30°55.059'N 84°35.737'W, locally abundant, 16 Aug 2007, *R. Carter 17984 and R. Kral* (VSC, others tbd). **Early Co.:** Blakely, 25 m S jct Columbia St and Church St, commercial lot along Church St, 31.37517°N 84.93611°W, locally abundant, 16 Oct 2008, *R. Carter 18687* (VSC, others tbd).—These voucher specimen data include documentation for the first record (*Carter 13145*) of this species in Georgia (R. Spellenberg, personnal communication). Plant habit (stems decumbent) and habitat in Georgia are similar to that reported for coastal South Carolina by Porcher (1978).

†**Boehmeria nivea** (L.) Gaudich. (Urticaceae)

U.S.A. GEORGIA. **Lowndes Co.:** Valdosta, Winding Way, UTM 17 278797E 3416859N (NAD27), weed in residential yard, locally common, 27 Sep 2003, *R. Carter 15099* (VSC).—Known as ramie, *B. nivea* is grown commercially in Asia as a source of bast fibers (Schery 1972). Wunderlin and Hansen (2008) map *B. nivea* in southern and central peninsular Florida. Herein, we provide the first documentation of this species in Georgia.

†**Bothriochloa hybrida** (Gould) Gould (Poaceae)

U.S.A. GEORGIA. **Brooks Co.:** 8.5 mi W Quitman jct Hwys US 84 and US 221, right-of-way along S side Hwy US 84, near mile marker 2, 30°47.576'N 083°42.159'W, elev. ca. 150 ft, plants forming large clumps, locally common, 2 Aug 2007, *R. Carter 17902* (NMCR, VSC, others tbd). **Decatur Co.:** 100 m E of Climax city limit, N side Hwy US 84, 30°52.545'N 84°25.299'W, 16 Aug 2007, *R. Carter 17981 and R. Kral* (VSC, others tbd). **Dooly Co.:** S of Unadilla, 2.4 mi S jct Hwy I-75 and Hwy US 41, between milemarker 118 and 119, 32.21432°N 83.74532°W, shoulder of northbound lane Hwy I-75, 1 Sep 2008, *R. Carter 18514* (VSC, others tbd). **Dougherty Co.:** 1.6 mi N of Baker-Dougherty county line, along W side Hwy GA 91, 31°27.237'N 84°15.476'W, locally common, plants forming large clumps, 07 Aug 2007, *R. Carter 17953 and W.W. Baker* (VSC, others tbd). **Muscogee Co.:** I-185, between milemarker 11 and 12, 32.56506°N 84.96180°W, locally abundant and frequent in median and along roadside, 16 Oct 2008, *R. Carter 18696* (VSC, others tbd). **Peach Co.:** vic. Byron, jct Hwy I-75 and Hwy GA 49 (exit 149), 32.65684°N 83.74392°W, shoulder of northbound lane Hwy I-75, 1 Sep 2008, *R. Carter 18513* (VSC, others tbd). **Randolph Co.:** 8.6 mi S Cuthbert jct Hwy US 82 and Hwy US 27, ca. mile-marker 3, 31.66117°N 84.82865°W, locally abundant and common along stretches of mowed roadside, 16 Oct 2008, *R. Carter 18688* (VSC, others tbd). **Thomas Co.:** 5.07 air mi N Ochlocknee, 31°02.729'N 84°04.177'W, 0.2 mi N jct Hwy US 19 and Midway Church Rd, locally abundant in Hwy US 19 median, 7 Aug 2007, *R. Carter 17960 and W.W. Baker* (VSC, others tbd). **Tift Co.:** Tifton, jct Hwy I-75 and S Central Ave, vic. exit 60, disturbed sandy clay along exit ramp from Hwy I-75 southbound, W side Hwy I-75, 31.43062°N 83.51778°W, 1 Sep 2008, *R. Carter 18502* (VSC, others tbd). **Turner Co.:** Hwy I-75, between milemarkers 85 and 86, vic. Wardlow Rd overpass, 31.75588°N 83.66680°W, 1 Sep 2008, *R. Carter 18510* (VSC, others tbd). **Worth Co.:** 0.1 mi E of Poulan, along overpass of Hwy US 82, 31.51200°N 83.77601°W, locally abundant, 2 Sep 2008, *R. Carter 18526* (VSC, others tbd).—This conspicuous grass ranges from central Mexico through Texas into southwestern Louisiana (Allred 2003b). Carter observed this species from his automobile along highways US 84 and US 82 in southern Georgia for several years before stopping to collect it in 2007. The long silky trichomes and long awns characteristic of the propagules make *B. hybrida* well adapted to wind-dispersal along highways and railroads, and it appears to be dispersing thusly in Georgia. Widely introduced into the middle-south (e.g., Mississippi, Alabama, Florida, Georgia, Tennessee), *B. laguroides* (DC.) Herter has narrower panicles and slenderer culms that are usually geniculate (Allred 2003b). These data comprise the first report *B. hybrida* from east of the Mississippi River and indicate it is widespread and well established along roadsides in Georgia.

†****Bothriochloa ischaemum*** (L.) Keng

U.S.A. GEORGIA. **Camden Co.:** 9.6 air mi S Atkinson jct Hwy US 82 and Old GA Hwy 259, 31°05.204'N 81°52.896'W, roadside along Old Hwy GA 259, locally common, 23 Sep 2006, *R. Carter 17281 and W.W. Baker* (NMCR, VSC, others tbd). **Decatur Co.:** 2.15 mi W Climax town center, Hwy US 84, ca. 350 m W jct Hidden Springs Rd, 30.88376°N 84.46531°W, 19 Sep 2008, *R. Carter 18555* (VSC, others tbd).—Native to the Old World, this grass was introduced for livestock forage and erosion control, is widely distributed in the southwestern United States, and is naturalized in Louisiana, southern Arkansas, Mississippi, southern Alabama and Florida in the southeast (Allred 2003b).

†***Bothriochloa laguroides*** (DC.) Herter subsp. ***torreyana*** (Steud.) Allred

U.S.A. GEORGIA. **Tift Co.:** E Tifton, jct Hwy US 319 and Hwy US 82, 31.44615°N 83.48867°W, mowed roadside along Hwy US 82, locally common, 21 Aug 2008, *R. Carter 18501, W.W. Baker and G. Nelson* (VSC, others tbd).—Although long known from northern Georgia, these voucher data provide the first documentation of this introduced weed in the Coastal Plain region of the state (cf. Jones & Coile 1988; Sweeney & Giannasi 2000).

Botrychium lunarioides (Michx.) Sw. (Ophioglossaceae)

U.S.A. GEORGIA. **Brooks Co.:** ca. 1.0 mi N of Morven, Mt. Zion Campground Methodist Church, 30.9607°N 83.4991°W, cemetery, locally occasional, 15 Mar 2002, *R. Carter 14622 and A. Rollins* (VSC). **Charlton Co.:** S Moniac, W of Hwy GA 185, Moniac Cemetery, 30°30.646'N 82° 13.479'W, 16 Mar 2006, *R. Carter 16363 and W.W. Baker* (VSC, others tbd). **Thomas Co.:** ca. 4.0 air mi NW Boston, jct Eason Crossing Rd and Summerhill Rd, Summerhill Baptist Church, 30.8345° N 83.8342°W, cemetery, local, 15 Mar 2002, *R. Carter 14624 and A. Rollins* (VSC).—This infrequently encountered grapefern occurs sporadically in the Piedmont and Coastal Plain of Georgia and was reported from only Decatur, Echols, and Lanier counties in southern Georgia (Snyder & Bruce 1986; Sweeney & Giannasi 2000).

Brickellia cordifolia Elliott (Asteraceae) – T

U.S.A. GEORGIA. **Grady Co.:** Mistletoe Plantation, between Meridian Rd and Ochlocknee River, 30°41.455'N 84°15.369'W, rolling upland, oldfield land, locally common, 17 Sep 2006, *R. Carter 17218, W.W. Baker and G. Nelson* (VSC, others tbd).—These data provide documentation of *B. cordifolia* from the Tallahassee Red Hills region of Georgia, all other Georgia records are in a narrow corridor along the Georgia-Alabama state line from middle Georgia south to the Georgia-Florida boundary (cf. Chafin 2007). The following woody associates were noted: *Pinus taeda* L., *P. echinata* Mill., *Carya glabra* (Mill.) Sweet, *Liquidambar styraciflua*, and *Prunus serotina* Ehrh.

Callirhoe papaver (Cav.) A. Gray (Malvaceae) – S (S2S3)

U.S.A. GEORGIA. **Mitchell Co.:** E of Baconton, 100–200 m E jct Jackson Dairy Rd and Stagecoach Rd, slope along S side Jackson Dairy Rd, 31° 21.649'N 84°06.117'W, locally common, 18 Jun 2004, *R. Carter 15370* (VSC). **Thomas Co.:** ca. 6.1 air mi NE of Ochlocknee, ca. 0.7 air mi NNE of jct Palmer Rd and Pummy Rd, 31°02.269'N 84° 00.031'W, slope with *Pinus palustris, P. taeda, Aristida stricta* and *Schizachyrium tenerum*, local, 25 Jul 2007, *R. Carter 17833 and W.W. Baker* (VSC).—These data document recent voucher collections of this rare mallow, including a new Georgia county record (cf. Jones & Coile 1988).

****Callitriche peduncolosa*** Nutt. (Callitrichaceae)

C. nuttallii Torr.

U.S.A. GEORGIA. **Camden Co.:** Jerusalem, ca. 100 m S jct Owens Ferry Rd and Bailey Mill Rd, W side Bailey Mill Rd, 30°58.435'N 81°50.574'W, plowed field, exposed loam, forming small inconspicuous mats with *Sphaerocarpus* sp. and *Callitriche peploides*, locally common, 14 May 2007, *R. Carter 17429* (VSC, others tbd).—This species ranges from Alabama to Texas and Arkansas in the United States and southward to Central America and is also known from Kentucky and central

Florida (Godfrey & Wooten 1981; Wunderlin & Hansen 2008). These data document the first collection of *C. pedunculosa* from Georgia.

*****Carex annectens*** (E.P. Bicknell) E.P. Bicknell (Cyperaceae)

U.S.A. GEORGIA. **Camden Co.:** Jerusalem, jct Owens Ferry Road and Bailey Mill Road, 30° 58.566'N 081°50.551'W, ditch along Owens Ferry Road, plants locally common, cespitose, 29 Apr 2006, *R. Carter 16547* (DOV, SWSL, VSC).—Although Russell and Duncan (1972) indicate its distribution in Georgia includes the Upper Coastal Plain, Piedmont, and Ridge and Valley physiographic regions, Sweeney and Giannasi (2000) do not map this species for Georgia, nor does Standley (2002) include Georgia in its distribution. These voucher specimen data document the occurrence of *C. annectens* in Georgia.

Carex chapmanii Steud.

U.S.A. GEORGIA. **Camden Co.:** ca. 5.0 air mi ESE Burnt Fort, vic. Jim Baileys Mill, USGS Jerusalem quadr., 30°55.438'N 081°49.259'W, floodplain forest and adjacent clearing along Satilla River; with *Acer rubrum*, *Taxodium distichum*, *Celtis laevigata*, *Carya glabra*, *Quercus nigra*, *Sabal palmetto*, *Liquidambar styraciflua*, *Juniperus* sp., plants in loose rhizomatous clumps, locally common, 29 Apr 2006, *R. Carter 16530* (VSC, others tbd); USGS Harrietts Bluff quadr., UTM 17 448143E 3412439N (WGS84/NAD83), ca. 8.8 mi N St. Marys waterfront, Crooked River State Park, mesic maritime forest adjacent to salt marsh, local, 25 Mar 2006, *R. Carter 16406* (ctb, DOV, VSC).; USGS Woodbine quadr., ca. 0.9 mi E of Ceylon, 30°57.53'N 81°38.14'W (WGS84/NAD83); hydric hammock, edge of mucky creek bottom, 7 Apr 2006, *R. Carter 16458 and W.W. Baker* (ctb, DOV, VSC); ca. 0.5 air mi N Rains Landing, USGS Boons Lake quadr., 31°00.347'N 81°54.197'W, beech-magnolia bluff along E bank Satilla, near end of 3R Fishcamp Rd, gently sloping terrace near base of bluff, locally common, 9 Jun 2006, *R. Carter 16796 and W.W. Baker* (VSC, others tbd). **Charlton Co.:** Traders Hill Recreation Area, hardwood slope with sandy creek bottom along St. Marys River, 30°46.988'N 82°01.490'W, occasional, 8 Jun 2006, *R. Carter 16765 and W.W. Baker* (VSC, others tbd).—Although not recorded for Georgia by Sweeney and Giannasi (2000), Bryson and Naczi (2002) include Georgia within the range of this species. *Carex chapmanii* forms loose rhizomatous clumps and is occasional to locally common on slightly elevated sites in and along the edges of hydric hammocks, mesic maritime forests, and mesic slopes and terraces along streams. These data document the first voucher collections of *C. chapmanii* from southeastern Georgia.

*****Carex collinsii*** Nutt. – S(S2)

U.S.A. GEORGIA. **Taylor Co.:** 6.1 mi S of Butler by Hwy GA 137, Atlantic white cedar swamp along Little Whitewater Creek, local under dense canopy of white cedar, 25 May 1991, *R. Carter 8672 and M.W. Morris* (MICH, VSC, others tbd); 4.3 mi N of Butler by Hwy GA 137, vicinity of Beaver Creek, periodically disturbed powerline right-of-way, plants in peat at edge of bay swamp, 26 May 1991, *R. Carter 8788 and M.W. Morris* (VSC, others tbd).—Neither Russell and Duncan (1972) nor Jones and Coile (1988) reported *Carex collinsii* for Georgia. The Taylor County record mapped by Sweeney and Giannasi (2000) is based upon *Sheridan and Troup 1581* (FTG) collected 28 May 1994 (W. Zomlefer, personal communication), three years after the vouchers cited above. This northern species is also known from adjacent Alabama (Mohr 1901). It is easily overlooked and is probably undercollected in part because its unusually slender perigynia superficially appear to be immature even when fully developed.

Carex comosa Boott

U.S.A. GEORGIA. **Camden Co.:** Tarboro, along Hwy GA 252, 31°00.837'N 81°48.300'W, local along edge of slough, cespitose in large clumps, 18 May 2007, *R. Carter 17588 and W.W. Baker* (VSC, others tbd).—Infrequent in Georgia, Sweeney and Giannasi (2000) map it from only one county in the extreme northwestern portion of the state and three contiguous counties in the Upper (Gulf) Coastal Plain of southwestern Georgia. These voucher specimen data provide the first documentation of *C. comosa* from southeastern Georgia.

Carex dasycarpa Muhl. – R

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park; 30°49'20"N 81°32' 38"W; maritime forest north of boat ramp and dock and east of road; locally common on loamy rises along bluff, 2 Jul 1996, *R. Carter 12982* (VSC, others tbd); Kings Bay Submarine Base, Etowah Park, vic. Cherry Point, maritime forest E of golf course and N of Etowah Park access rd., locally common, 18 Apr 1997, *R. Carter 13990* (VSC, others tbd). **Coffee Co.:** 8.1 mi N of Hwy US 84 in Willacoochee, sandridge along N bank of Satilla River, S of Bridgeton, disturbed scrub woods, 15 Apr 1989, *R. Carter 7799* (GA, SWSL, VDB, VSC). **Decatur Co.:** vic. Faceville Landing, mesic slope with rich woods along Sandborn Creek, UTM 16 723967E 3407188N (NAD83/WGS84), USGS Faceville (GA) quadr., 2 May 1992, *R. Carter 9649* (VSC, others tbd). **Lowndes Co.:** "Troopville Woods" ca. 0.6 mi W Valdosta jct Hwy GA 94 and I-75, ca. 0.3 mi S of Hwy GA 94, low bluff along floodplain E of Withlacoochee River, UTM 17 276286E 3414815N (NAD83/WGS84), 16 Apr 1998, *R. Carter 14094* (VSC, others tbd). **Ware Co.:** 5.9 mi N of Waycross, just N of Jamestown, sandridge N of Satilla River and W of Jamestown Road, 26 Apr 1987, *R. Carter 5410 and W.K. George* (GA, IBE, MICH, MO, NY, SWSL, TAES, US, VDB, VSC). **Wheeler Co.:** Little Ocmulgee River State Park, sandridge N of river, locally common in hammock, in shade, 15 Apr 1989, *R. Carter 7800* (FLAS, GA, IBE, MICH, MO, SWSL, TAES, VDB, VSC).—These voucher specimen data provide additional documentation of *C. dasycarpa* in Georgia. Curiously, Russell and Duncan (1972) ascribe the species to the Upper Coastal Plain, whereas Sweeney and Giannasi (2000) map it in a cluster of several counties in southwestern Georgia and Long and Liberty counties along the coast. Patrick et al. (1995) map *C. dasycarpa* essentially the same as Sweeney and Giannasi (2000), with the addition of Camden County.

Carex decomposita Muhl. – S(S2?)

U.S.A. GEORGIA. **Camden Co.:** swamp forest along Satilla River at base of Magnolia Bluff, 30° 56.736'N 81°53.661'W, occasional on decorticated *Taxodium* logs, 9 Jun 2006, *R. Carter 16781 and W.W. Baker* (VSC). **Glynn Co.:** Sansavilla WMA, common on stumps in isolated swamp mainly forested by *Nyssa ogeche*, Jul 1996, *K.R. Tassin s.n.* (VSC). **Lowndes Co.:** ca. 8 mi S Valdosta city center by Loch Laurel Road and Touchton Road, Lake Louise Field Station, 30°43'36.38"N 83°15' 22.91"W, plant local, cespitose, on decaying log at edge of Lake Louise, a limesink pond, 28 Apr 2006, *R. Carter 16495* (DOV, SWSL, VSC, others tbd).—Rare and local throughout much of its range (Cochrane 2002), Sweeney and Giannasi (2000) map *C. decomposita* in only Baker County. Data reported herein document recent collections of *C. decomposita* from additional Georgia counties. Although the Lowndes County site was visited frequently by the first author over the preceding 23 years, *C. decomposita* was not observed there until 2006. Thus, we are fairly certain that the plants are only recently established at Lake Louise, perhaps in some way related to recent water-level fluctuations resulting from beaver (*Castor canadensis*) activity at the lake outlet.

Carex elliottii Schwein. & Torr.

U.S.A. GEORGIA. **Berrien Co.:** Alapaha River floodplain along Hwy GA 135, ca. 3.3 mi S Willacoochee jct Hwy US 82, swamp margin, 25 May 1992, *R. Carter 9745* (VSC, others tbd). **Camden Co.:** ca. 0.5 air mi N of Rains landing, USGS Boons Lake quadr., bluff along E bank of Satilla River, near end of 3R Fishcamp Rd, 31°00.347'N 81°54.197'W, springy seep with *Gordonia*, *Liriodendron*, *Magnolia virginiana*, *Persea palustris*, *Acer rubrum*, *Ilex coriacea*, *Woodwardia areolata*, *Sphagnum*, local, 9 Jun 2006, *R. Carter 16793 and W.W. Baker* (VSC); Oak Grove Acres development, edge of Satilla River floodplain, along E bank of narrow lake at base of slope, 31°04.702'N 81°53.337'W, occasional along spring seep, 18 May 2007, *R. Carter 17571 and W.W. Baker* (VSC, others tbd). **Evans Co.:** Ft. Stewart Military Reservation, ca. 0.12 mi north of FS 17 crossing of pond P-17 dam, elev. ca 30 m, bayswamp along creek, common, 16 June 1992, *R. Carter 9772 and P. Bauer* (GA, VSC, others tbd); Ft. Stewart Military Reservation, ca. 0.2 mi NE of jct FS 13 and dirt road along reservation boundary, then 0.45 mi SE to creek ford, bayswamp adjacent to sandridge, occasional, 16 Jun 1992, *R. Carter 9776 and P. Bauer* (VSC). **Liberty Co.:** Ft. Stewart Military Reservation, 1.7 mi SW jct Hwy GA 129 and FS 30, edge of bayswamp, locally common, 2 Jul 1992, *R. Carter 10047, J. Lusk and D. Thompson* (VSC). **Lowndes Co.:** ca. 2.4 mi E of Valdosta by Howell Road, then ESE 2.6 mi by Boring Pond Road, about 1/4 mi NE of Boring Pond Road, 8 May 1992, *Carter 9651* (VSC, others tbd). **Taylor Co.:** 3.4 mi NE of Charing, by Hwy GA 127, boggy seepage slope in clearing along Little Whitewater Creek, locally abundant, 27 May 1990, *R. Carter 8378* (VSC, others tbd).—Bryson et al. (1992) report several additional county records of this uncommon sedge from southern Georgia. The data reported herein document additional county records of this infrequently documented species in the state. The following description based on a Lowndes County site is representative of the habitat of *Carex elliottii* in Georgia: open sedge-*Sarracenia minor* bog adjacent to an evergreen shrub bog on mucky sand in a periodically disturbed powerline right-of-way, associated with *Acer rubrum* L., *Aronia arbutifolia* (L.) Pers., *Carex atlantica* L.H. Bailey ssp. *atlantica*, *Cliftonia monophylla* (Lam.) Sarg., *Clethra alnifolia* L., *Drosera capillaris* Poir., *Hypericum fasciculatum* Lam., *Ilex coriacea* (Pursh) Chapm., *I. glabra*, *Lycopodium* spp., *Lyonia lucida*, *Magnolia virginiana* L., *Morella caroliniensis* (Mill.) Small, *M. cerifera*, *Nyssa biflora* Walter, *Persea palustris*, *Pinus elliottii*, *P. serotina* Michx., *Polygala lutea* L., *Quercus nigra*, *Rhynchospora* spp., *Taxodium ascendens* Brongn., *Vaccinium corymbosum*, and *V. myrsinites*.

****Carex fissa*** Mack. var. ***aristata*** F.J. Herm. – S (S1)

U.S.A. GEORGIA. **Baker Co.:** ca. 0.3 mi ESE of confluence of Ichauwaynochaway Creek and Flint R., at break in levee of Flint River in moist riparian hammock, 5 May 1992, *L.K. Kirkman 2086 and A.K. Gholson* (VSC). **Brantley Co.:** Nahunta, along N side railroad right-of-way and Broome St near jct with E. Florida Ave, 31.20480°N 81.98006°W, locally common, 30 Apr 2008, *R. Carter 18380 and W. W. Baker* (VSC, others tbd). **Bryan Co.:** Ft. Stewart Military Reservation, 0.55 mi W of Richmond Hill city limit, then 0.7 mi S Hwy GA 144 by unmarked dirt road, mesic flatwoods, infrequent, 25 Jun 1992, *R. Carter 9950 and J. Lusk (VSC)*. **Camden Co.:** Kings Bay Submarine Base, vic. SW corner of dredge disposal area N of U.S.S. Mariano Vellajo Ave, 30°48'20"N 81°32'32"W, occasional along levee road, 9 Jul 1996, *R. Carter 13150* (VSC, others tbd); Kings Bay Submarine Base, ditch and roadside by perimeter road along boundary with Etowah Pond, SE of golf course, 30°48'58"N 81°32'55"W, occasional along roadside, 9 Jul 1996, *R. Carter 13222* (VSC); Kingsland, Vacuna Rd, ca. 0.1 mi W of railroad and Hwy US 17, 30°46.865'N 81°41.400'W, open disturbed sandy loam, 8 Apr 2006, *R. Carter 16477 and W.W. Baker* (VSC, others tbd); S of Atkinson, NW of Tarboro, jct Old Hwy 259 and Old Merrow Community Rd, by Old Hwy 259, 31°03.869'N 81°52.940'W, occasional along edge of ditch, 29 Apr 2006, *R. Carter 16520* (VSC); vic. Jim Baileys Mill, USGS Jerusalem quadr., 30°55.438'N 81° 49.259'W, clearing along Satilla River, occasional, 29 Apr 2006, *R. Carter 16527* (VSC, others tbd); Hwy US 17, N of Kingsland, just. N of jct Hwy US 17 and Daisy Ave, just S of jct Hwy US 17 and Kinlaw Rd, 30.85883°N 81.70219°W, ruderal roadside adjacent to commercial lot, locally common, 30 Apr 2008, *R. Carter 18373 and W.W. Baker* (VSC, others tbd). **Clinch Co.:** Cogdell, weedy roadside along N side Hwy GA 122, 31.16468°N 82.71743°W, locally common, 30 Apr 2008, *R. Carter 18384 and W.W. Baker* (VSC, others tbd). **Early Co.:** 3.6 mi W of Arlington, along Hwy GA 62, sandy bank of Spring Creek, locally common, 1 Apr 1990, *R. Carter 8289* (VSC, others tbd). **Grady Co.:** SE of Cairo, by Hwy GA 93, Ochlocknee River floodplain between the bridges, where mowed occasionally, 3 May 1989, *R. K. Godfrey 83166* (VSC). **Lowndes Co.:** NW of Valdosta, frontage road west of Hwy I-75, ca. 1 mi S of jct with Hwy GA 7, local in ditch, 5 May 1988, *R. Carter 6556* (VSC, others tbd); N Valdosta, Forrest St, just S jct Inner Perimeter Rd, edge of bayswamp, road bank, 29 Apr 1992, *R. Carter 9635* (VSC, others tbd). **Sumter Co.:** ca. 1.8 mi SW Leslie, beside State Hwy 118, lower bank and ditch, 22 Apr 1990, *R.A. Norris 6014 and M. Owsley* (VSC). **Ware Co.:** Waycross, ca. 150 m W of jct Pendergast St and Samuel St, ruderal lot along Pendergast St, 31.20701°N 82.34967°W, 30 Apr 2008, *R. Carter 18383 and W.W. Baker* (VSC, others tbd).—Sorrie (1998) reported this species new to Georgia based upon a specimen from Clinch County collected 4 June 1988 (*V. McNeilus 88-171*, FLAS). Reported herein, *Carter 6556* was collected about one month earlier. Given the number of records cited here and its propensity for disturbed habitats, i.e., mowed roadsides and ditches, we recommend removing this taxon from Georgia's Special Concern Plants list.

Carex floridana Schwein.

C. nigromarginata Schwein. var. *floridana* (Schwein.) Kük.

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, vic. Cherry Point, maritime forest E of golf course and N of Etowah Park access rd., locally common, 18 Apr 1997, *R. Carter 13991* (VSC, others tbd). **Lanier Co.:** Moody Air Force Base, Dudley's Hammock, with *Quercus virginiana*, *Q. alba*, *Q. michauxii*, *Magnolia grandiflora*, *Carya glabra*, *Pinus glabra* and *Ilex opaca*, south side of road, occasional, 3 Apr 1994, *R. Carter 11679* (VSC). **Lowndes Co.:** Troupville Woods, just W of Valdosta along and S of Hwy GA 94, E of Withlacoochee River, USGS Valdosta quadr., UTM 17 276285E 3414782N (WGS84/NAD83), beech-magnolia climax community, 13 April 1987, *R. Carter 5369* (VSC, others tbd).—These data comprise the first report of this species from southcentral and southeastern sectors of Georgia (cf. Sweeney & Giannasi 2000).

Carex gholsonii Naczi & Cochrane

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Diamondback, 0.81 air mi ESE jct U.S.S. Henry L. Stemson Dr and U.S.S. Daniel Webster Rd, between SWIFLANT and U.S.S. Henry L. Stimson Dr, along NW side SWIFLANT perimeter fence, between fence and drainage ditch, 30°47'20"N 81°32'51"W, plants common, cespitose, 18 Apr 1997, *R. Carter 14010* (VSC); between Woodbine and Tarboro, along Refuge Road, just W of Maryfield Plantation, 31°00.081'N 81°47.005' W, wooded floodplain along branch of Tower Swamp, plants cespitose, 30 Apr 2006, *R. Carter 16589* (ctb, DOV, VSC, others tbd).—Naczi et al. (2002) indicated *C. gholsonii* is rare in Georgia, and, among paratypes, cited vouchers from Early and Lee counties in southwestern Georgia and Jefferson County in the Upper Coastal Plain. The data reported herein provide the first documentation of *C. gholsonii* from southeastern Georgia, where it was observed in a hydric hammock and in a creek floodplain, with *Acer rubrum*, *Arisaema dracontium* (L.) Schott, *A. triphyllum* (L.) Schott, *Asclepias perennis* Walter, *Berchemia scandens* (Hill) K. Koch, *Carpinus caroliniana* Walter, *Celtis laevigata* Willd., *Cephalanthus occidentalis* L., *Cornus foemina* Mill., *Decumaria barbara* L., *Elytraria caroliniensis* (J.F. Gmel.) Pers., *Fraxinus caroliniana* Mill., *Fraxinus profunda* (Bush) Bush, *Lyonia lucida*, *Liquidambar styraciflua*, *Magnolia grandiflora*, *M. virginiana*, *Morella cerifera*, *Morus rubra* L., *Nyssa biflora*, *Quercus laurifolia* Michx., *Q. michauxii* Nutt., *Q. nigra*, *Q. virginiana*, *Rhapidophyllum hystrix* (Pursh) H.Wendl. & Drude ex Drude, *Rhynchospora miliacea* (Lam.) A. Gray, *Sabal minor* (Jacq.) Pers., *Sabal palmetto* (Walter) Lodd. ex Schult. & Schult. f., *Salix* sp., *Serenoa repens*, *Taxodium distichum* (L.) Rich., *Toxicodendron radicans* (L.) Kuntze, *Ulmus alata* Michx., *U. americana* L., *Viburnum dentatum* L., and *Pinus taeda*

Carex godfreyi Naczi – W(S3?)

U.S.A. GEORGIA. **Camden Co.:** hydric hammock S of Hwy US 17, 0.8 mi NE of Waverly, USGS Waverly quadr., UTM 17 431516E 3440695N (WGS84/NAD83), 4 Jul 1988, *R. Carter and S. Carter 6929* (VSC, others tbd); Kings Bay Submarine Base, Diamondback, 0.81 air mi ESE jct U.S.S. HenryL. Stimson Dr and U.S.S. Daniel Webster Dr, 30°47'20"N 81°32'51"W, hardwood hammock, 18 Apr 1997, *R. Carter 14008* (VSC); ca. 5.0 air mi ESE Burnt Fort; vic. Jim Baileys Mill, USGS Jerusalem quadr., 30°55.438'N 081°49.259'W; floodplain forest and adjacent clearing along Satilla River, plants occasional, cespitose, 29 Apr 2006, *R. Carter 16528* (ctb, DOV, VSC, others tbd); between Woodbine and Tarboro, along Refuge Road, just W of Maryfield Plantation, 31°00.081'N 081°47.005'W, wooded floodplain along branch of Tower Swamp, plants cespitose, 30 Apr 2006, *R. Carter 16590* (ctb, DOV, VSC, others tbd), *16591* (ctb, DOV, VSC, others tbd).—Sweeney and Giannasi (2000) map this species only in a tight cluster of three counties in the Upper (Gulf) Coastal Plain of southwestern Georgia. These voucher specimen data extend the range of this species to southeastern Georgia where *C. godfreyi* occurs in floodplain forests and hydric hardwood hammocks associated with *C. gholsonii*; other associates are listed under *C. gholsonii*.

Carex venusta Dewey – S(S1?)

U.S.A. GEORGIA. **Berrien Co.:** bay swamp and pond margin 0.5 mi E of Alapaha, just N of Hwy US 82, locally common in bay swamp, 21 May 1988, *R. Carter, S. Carter and H. Brasell 6625* (GA, MICH, SWSL, VDB, VSC); northern edge of county, bayswamp SE of jct Lax Rd and Hwy GA 158, locally common, 16 May 1992, *R. Carter 9707* (VSC, others tbd). **Brooks Co.:** ca. 4.5 mi NNE Dixie, ca. 1 mi W Beulah Hill Church by unmarked dirt road, seepage slope along NW side of bay creek, 27 May 1998, *R. Carter 14097* (VSC, others tbd). **Evans Co.:** Fort Stewart Military Reservation, ca. 0.12 mi north of FS 17 crossing of pond P-17 dam, elev. ca 30 m, bayswamp along creek, common, 16 Jun 1992, *R. Carter 9769 and P. Bauer* (GA, VSC, others tbd). **Lowndes Co.:** 9.1 mi E of Hahira, bay head along Hwy GA 122, 0.6 mi W of Hwy GA 125, 19 May 1985, *R. Carter 4090* (GA, IBE, MICH, MO, SWSL, TAES, VDB, VSC); 10 Jun 1988, *R. Carter and C. Bryson 6636a* (VSC); 15 April 1989, *R. Carter 7791* (FLAS, GA, IBE, MICH, MO, SWSL, TAES, VDB, VSC). **Randolph Co.:** Holanna Creek bottom by Hwy US 82, 3.8 mi W of Cuthbert, locally abundant in swamp, 11 April 1992, *R. Carter 9599* (VSC, others tbd). **Taylor Co.:** 6.3 mi S of Butler by Hwy GA 137, along bank of Little Whitewater Creek, 25 May 1991, *R. Carter 8669 and M.W. Morris* (VSC, others tbd).—This species was reported from the Upper Coastal Plain and Piedmont provinces by Russell and Duncan (1972). More recently, Sweeney and Giannasi (2000) map it in six Georgia counties, of which half are in the Coastal Plain. These data represent additional collections of *C. venusta* from the Coastal Plain of Georgia, with all but Lowndes being new county records (cf. Sweeney & Giannasi 2000). *Carex venusta* inhabits bayswamps, where its associates include *Itea virginica* L., *Liriodendron tulipifera* L., *Magnolia virginiana*, *Morella caroliniensis*, *M. cerifera*, *Nyssa biflora*, *Pinckneya bracteata* (Raf.) Bartr., *Toxicodendron vernix* (L.) Kuntze, and *Viburnum nudum* L. Plants in the Lowndes County population have consistently exhibited very low fertility (seed set <1%).

†****Ceratopteris pteridoides*** (Hook.) Hieron. (Parkeriaceae)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, 30°49'00"N 81°32'45"W, exposed, mechanically disturbed reddish brown loam along west bank of Etowah Pond, local, 28 Aug 1996, *R. Carter 13602* (VSC).—This genus was not cited for Georgia by Sweeney and Giannasi (2000), and these voucher specimen data provide documentation of its occurrence in Georgia. *Ceratopteris pteridoides* was associated with *Amphicarpum muhlenbergianum*, *Bulbostylis ciliatifolia* (Ell.) Fern., *B. stenophylla* (Ell.) C.B. Clarke, *Cyperus erythrorhizos* Muhl., *C. filicinus* Vahl, *C. haspan* L., *C. odoratus* L., *C. oxylepis* Nees ex Steud., *C. polystachyos* Rottb. var. *polystachyos*, *C. surimanensis* Röttb., *Eleocharis albida* Torr., *E. flavescens* (Poir.) Urb., *E. geniculata* (L.) Roem. & Schult., *E. vivipara* Link, *Euphorbia* sp., *Fimbristylis autumnalis* (L.) Roem. & Schult., *Fuirena scirpoidea* Michx., *Hedyotis* sp., *Leptochloa uninervia* (J. Presl) Hitchc. & Chase, *Lindernia anagallidea* (Michx.) Pennell, *Ludwigia suffruticosa* Walt., and *Xyris* sp.

Chamaecrista deeringiana Small & Pennell (Fabaceae) – S(S1?)

U.S.A. GEORGIA. **Mitchell Co.:** Pinewood Plantation, ca. 0.55 air mi ENE Pleasant Grove Baptist Church, ca. 3.25 air mi NW Bridgeboro, 31°25.582'N 84°01.207'W, longleaf pine-wiregrass savanna, local, 17 Jul 2007, *R. Carter 17729 and W.W. Baker* (VSC, others tbd). **Worth Co.:** Jeffords property, 0.3 mi E Hwy GA 33, 31.41400°N 83.83931°W, longleaf pine-wiregrass upland, plants rare and local, 3 Jun 2008, *R. Carter 18396 and W.W. Baker* (VSC).—In Georgia historically only four populations of this clonal perennial were known from four counties—two in the Fall Line sandhills and two in southwestern Georgia—with only two of the populations having been seen in the past 50 years (Chafin 2007). Herein, we report recently observed populations in two additional counties in southwestern Georgia. *Chamaecrista deeringiana* seems to flower earlier than the much more common and similar annual species, *C. fasiculata* (Michx.) Greene.

†****Chloris canterae*** Arechav. var. ***canterae*** (Poaceae)

U.S.A. GEORGIA. **Decatur Co.:** S Bainbridge, by Hwy GA 253, vic. county prison and industrial park, 30.90727°N 84.59900°W, locally abundant in disturbed soil, 4 Jun 2009, *R. Carter 18862 with P. Bauer and J. Carter* (VSC, others tbd).—Although the infraspecific taxa are not mapped separately, Barkworth (2003a) recognized two varieties of Paraguayan windmill-grass in North America, unequivocally cited *C. c.* var. *canterae* from Texas and Louisiana, stated that *C. c.* var. *grandiflora* has been found at wool mill sites in the southeastern U.S. without indicating which states, and also mapped the species from a small area of coastal South Carolina. Herein, we provide data for the first Georgia collection of this South American native.

Cinna arundinacea L.

U.S.A. GEORGIA. **Camden Co.:** vic. Jim Baileys Mill, USGS Jerusalem quadr., ca. 5.0 air mi ESE

Burnt Fort, 30°55.428'N 81°49.259'W, floodplain forest along Satilla River, locally common in mucky clay, 22 Sep 2006, *R. Carter and W.W. Baker 17233* (VSC, others tbd).—Although widespread and common from middle Georgia northward, except for Chatham County, this species is absent from the Coastal Plain Region of Georgia (Brandenburg et al. 1991; Sweeney & Giannasi 2000; Brandenburg 2007). These data extend the distribution of *C. arundinacea* southward to near the Georgia-Florida state boundary, indicating it might be found in similar habitat in adjacent northeastern Florida. See *Physostegia leptophylla* Small for associates.

†***Cleome viscosa*** L. (Capparaceae)

U.S.A. GEORGIA. **Dooly Co.:** 5 mi ESE of Vienna, 7 Jul 2004, *Ken Lewis s.n.* (VSC).—This introduction occurs sporadically in Florida (Wunderlin & Hansen 2008), and Jones and Coile (1988) map it in only one Georgia county (Wilcox). These voucher specimen data are for the second county record of *Cleome viscosa* in Georgia.

†****Corchorus aestuans*** L. (Tiliaceae)

U.S.A. GEORGIA. **Thomas Co.:** Boston-Monticello Rd, 0.9 mi NW jct with Mitchell Rd, 30°41.367'N 83°47.943'W, locally common along mowed roadside, 17 Sep 2006, *R. Carter 17220* (VSC).—Introduced from Asia as a source of bast fibers (Schery 1972), jute is well established in Florida (Wunderlin & Hansen 2008) but was not recorded for Georgia by Jones and Coile (1988).

Coreopsis integrifolia Poir. (Asteraceae) – T

U.S.A. GEORGIA. **Camden Co.:** 2.52 air mi S Jerusalem, W side Bailey Mill Rd, 30°56.540' N 81°50.871' W, degraded flatwoods along edge of creek floodplain, plants locally common, 22 Sep 2006, *R. Carter 17250 and W.W. Baker* (VSC); 4.07 air mi WNW Waverly jct Hwy US 17 and Hwy GA 110, 0.2 mi SW jct Inachee Rd and Hwy GA 110, 31°06.624' N 81°47.527' W, mixed hardwood pine flat and swale, plants occasional to common along edge of woods and adjacent mowed ditch along S side of Inachee Rd from 0.2 mi SW jct Inachee Rd and Hwy GA 110 to jct New Post Rd and Inachee Rd, then south along New Post Rd to approximately 0.6 mi N jct New Post Rd and Providence Church Rd, 12 Sep 2007, *R. Carter 18067 and W.W. Baker* (VSC).—This species is listed as "threatened" in Georgia, and previously only four populations had been observed in the state in the last two decades (Chafin 2007). These voucher specimen data document recently discovered populations and a new county record of *C. integrifolia* in Georgia. Associates were *Baccharis glomeruliflora* Pers., *Cephalanthus occidentalis*, *Diospyros virginiana*, *Erianthus (Saccharum)* sp., *Fraxinus* sp., *Hyptis alata* (Raf.) Shinners, *Liquidambar styraciflua*, *Morella cerifera*, *Nyssa biflora*, *Pinus taeda*, *Plantago sparsiflora* Michx., *Quercus virginiana*, and *Taxodium distichum*.

†****Crocosmia* ×*crocosmiiflora*** (Lemoine ex Anonymous) N.E. Br. (Iridaceae)

U.S.A. GEORGIA. **Lowndes Co.:** N Valdosta, ditch along Highland Heights Rd about 100 m W of jct Highland Heights Rd and Forrest St, 20 Jul 1988, *R. Carter 7102* (VSC). **Thomas Co.:** Thomasville, Pinetree Blvd, between Millpond Rd and Old Monticello Rd, ca. 150 m NE Camellia Dr, N side Pinetree Blvd, adjacent to Glen Arven Golf Course, 30.81334°N 83.95275°W, 12 Jun 2008, *R. Carter 18402 and W.W. Baker* (VSC).—This hybrid between two African species is the common ornamental montbretia (Bailey 1949). It was cited by Clewell (1985) as occasionally escaping from cultivation in the Florida panhandle, and Goldblatt (2002) indicated its naturalization in Florida, South Carolina and North Carolina. Sweeney and Giannasi (2000) mapped it in Decatur County, Georgia, and Woods and Diamond (2003) reported it new to Alabama flora. Since Jones and Coile (1988) did not include this taxon for Georgia, we presume the Lowndes County collection is the first record of naturalization of this taxon in Georgia. The naturalized population in Lowndes County persisted in a ditch for more than five years until it was destroyed by road maintenance activities (road grading).

Ctenium floridanum (Hitchc.) Hitchc. (Poaceae) – S(S1)

U.S.A. GEORGIA. **Brantley Co.:** 1.5 mi north of jct of Hwys US 84 and GA 15 in Hoboken, sandy rise E of Hwy GA 15, scrub, plants local, 2 Sep 1987, *R. Carter 6274* (UTC, VSC, others tbd). **Camden Co.:** Crooked River State Park, ca. 9 mi NNW St. Marys, 8 Sep 1969, *R. Norris 1413* (VSC); ca. 1.5 mi SE Ceylon, USGS Woodbine quadr., 30°56.898'N 81°37.914'W, sandy upland, surrounded by longleaf pine savanna, locally common, plants from previous season, 7 Apr 2006, *R. Carter 16446 and W.W. Baker* (VSC); Clarks Bluff, 30°46.349'N 81°46.515'W, narrow sandy ridge with *Pinus palustris* and *Aristida stricta*, 14 Sep 2007, *R. Carter 18105 and W.W. Baker* (VSC). **Charlton Co.:** 6 mi NE Folkston, W Ga. Rt. 252, 0.5 mi N Mays Bluff Branch, longleaf pine-wiregrass forest recently clearcut, 23 Oct 1987, *W.W. Baker s.n.* (VSC); Traders Hill, just E jct Traders Hill Rd and Hwy GA 23/121, 30°47.716'N 82°02.062'W, vacant lot in subdivision along Traders Hill Rd, open sandy soil, locally common, 19 Sep 2003, *R. Carter 15084* (VSC, others tbd); 3.0 air mi S Moniac jct, 30°28.799'N 82°11.933'W, cut-over pine-wiregrass community along W side Hwy GA 185, 21 Sep 2006, *R. Carter 17228 and W.W. Baker* (VSC).—This species is narrowly distributed in northeastern Florida and adjacent southeastern Georgia (Kral 1983; Barkworth 2003b), and Chafin (2007) reported that only five populations were known in Georgia. These previously unreported voucher specimen data include recent collections of *C. floridanum* and records for Camden, an additional Georgia county. It inhabits periodically burned longleaf pine-wiregrass savannas, and associates include *Aristida stricta*, *Castanea pumila* (L.) Mill., *Pinus palustris*, *Quercus geminata*, *Q. hemisphaerica*, *Q. incana*, *Q. laevis* Walter, *Q. margaretta* Ashe ex Small, and *Q. virginiana.* Notable is the parallel association of *C. floridanum* and *Anthaenantia villosa* (Michx.) P. Beauv. in the upland, sandridge phase of the longleaf pine-wiregrass system and that of congeners *C. aromaticum* (Walter) A. Wood and *A. rufa* (Elliott) Schult. in wet savannas and pitcherplant bogs.

†***Cyperus difformis*** L. (Cyperaceae)

U.S.A. GEORGIA. **Chatham Co.:** NW Savanna, 1.0 mi S jct Hwy US 80 and Hwy GA 307, E of Hwy GA 307, 32°04.656'N 81°11.722'W, open disturbed lot along S side Prosperity Drive, locally common in depression, most plants yet immature, 13 Jul 2006, *R. Carter 16937* (VSC). **McIntosh Co.:** S of Darien, by Hwy US 17 between Altamaha River and Butler River, James Allen Williamson Champney River Park, 31°20.148'N 81° 26.895'W, 13 Jul 2003, *R. Carter 15013* (VSC, others tbd).—The recent dispersal of this introduced weed in the United States has been well documented (Lipscomb 1980; Tyndall 1983). Subsequently, it has been reported new to Mississippi (Bryson & Carter 1992), Kentucky (Mears & Libby 1995), Georgia (Carter in Bryson et al. 1996), and Maryland (Strong & Simmons 2002). These voucher specimen data substantiate additional county records of *C. difformis* from Georgia.

†****Cyperus digitatus*** Roxb.

U.S.A. GEORGIA. **Camden Co.:** 7.6 air mi ESE Woodbine jct Hwy US 17 and Hwy GA 110, 30° 55.591'N 81°36.287'W, barrow pit along unpaved road, locally abundant, 1 Sep 2006, *R. Carter 17190 and W.W. Baker* (VSC, others tbd). **Lanier Co.:** Moody Air Force Base, Winnersville Bombing Range, vic. observation tower, bank of Cooter Creek, locally common, 15 Oct 1994, *R. Carter 12343* (VSC, others tbd).—This robust perennial is closely related to *C. erythrorhizos* but has a primarily tropical distribution, whereas *C. erythrorhizos* is a temperate zone annual. Previously, *C. digitatus* was known only from Texas and Florida in the United States (Tucker et al. 2002).

Cyperus distinctus Steud.

U.S.A. GEORGIA. **Camden Co.:** Cabin Bluff, ditch along main road ca. 200 m W of Cabin Bluff compound, 30°53'19"N 81°31'10"W, 7 Jul 1995, *R. Carter 12504* (VSC); Kings Bay Submarine Base, fill site N of N end of dock and across Kings Bay from N end of Crab Island, USGS Harrietts Bluff quadr., 30°48'47"N 81°31'46"W (WGS84/NAD83), plants local, edge of marsh, 9 Jul 1996, *R. Carter 13184* (VSC, others tbd). **Clinch Co.:** 6.7 mi S of Homerville, sandy ditch bottom in flatwoods, beside Hwy GA 187, locally common, 2 Sep 1987, *R. Carter 6303* (GA, IBE, MO, NLU, NY, SWSL, TAES, US, VDB, VSC). **Glynn Co.:** near S end of Jekyll Island, ditch just N of St. Andrews picnic area, local, 26 Aug 1988, *R. Carter 7437* (GA, MO, MICH, SWSL, VDB, VSC); Colonels Island, vicinity of Robert P.T. Young Plant, about 5 mi SW of Brunswick, mucky ditch by paved road off of and S of Hwy US 82, 21 Sep 1991, *R. Carter, P. Bauer, J. Lusk and J. Robertson 9237* (GA, IBE, MICH, MO, SMU, TAES, VDB, VSC). **Lowndes Co.:** 2.6 mi S of Lake Park and 1.6 mi N of state line, flatwoods along Hwy US 41, locally common in ditch, 29 Oct 1988, *R. Carter and M.W. Morris 7762* (FLAS, FSU, GA, GENT, GH, IBE, MO, NLU, NY, NYS, SMU, SWSL, TAES, US, USCH, VDB, VSC).

McIntosh Co.: Sapelo Island, swale near head of nature trail near south end of island, local, 27–28 Oct 2001, *R. Carter 14621* (VSC); Darien, bank along Darien River at foot of Screven Street, open sandy site at edge of brackish marsh, 21 Sep 1991, *R. Carter, P. Bauer, J. Lusk and J. Robertson 9272* (GA, IBE, VDB, VSC).—This species is known from South Carolina, Georgia, Florida, Louisiana, and the Bahamas (McGivney 1938; O'Neill 1939; Denton 1978; Godfrey & Wooten 1979; Kessler 1983). *Cyperus distinctus* has previously been reported from only three counties along the Georgia coast: Glynn, McIntosh and Liberty (Jones & Coile 1988; Sweeney & Giannasi 2000). These data report additional localities, including inland stations in Clinch and Lowndes counties. *Cyperus distinctus* bears a superficial resemblence to, and is sometimes confused with, *C. virens* Michx., but its smooth subterete culm and achene with torulose base distinguish it from that species.

Cyperus drummondii Torr. & Hook. in Torr. – W(S3?)

C. virens Michx. var. *drummondii* (Torr. & Hook. in Torr.) Kük.

U.S.A. GEORGIA. **Camden Co.:** ca. 1.2 air mi E of Rains Landing, USGS Burnt Fort quadr., 3R Fishcamp Rd, just W jct 3R Fishcamp Rd and Old Post Rd, 30°59.976'N 81°53.142'W, ditch adjacent to shallow flatwoods cypress-gum pond, local and infrequent, 9 Jun 2006, *R. Carter 16802 and W.W. Baker* (VSC, others tbd). **Miller Co.:** 16.6 mi W of Newton jct Hwy GA 91 and GA 37, 300 m E jct Kimbrel Rd and Hwy GA 91, open disturbed depression along N side Hwy GA 91, 1.5 mi W Baker-Miller county line, 31°11.043'N 84°33.829'W, 16 Aug 2007, *R. Carter 17998 and R. Kral* (VSC, others tbd). **Mitchell Co.:** ca. 1.0 mi S Camilla, ditch along E side Hwy US 19 at jct Hwy US 19 and Molasses Rd, 31°12.486'N 84°10.524'W, 18 Jun 2004, *R. Carter 15372* (VSC, others tbd). **Thomas Co.:** ca. 5.8 air mi NE Ochlocknee, ca. 0.1 air mi NE jct Palmer Rd and Pummy Rd, along drain tributary of Little Ochlocknee River, 31°01.789'N 84°00.226'W, local, 25 Jul 2007, *R. Carter 17823 and W.W. Baker* (VSC, others tbd).—These data represent additional Georgia county records of *C. drummondii*, a poorly known sedge that until recently was not recognized in floristic treatments, even infraspecifically (Carter et al. 1999). Recently, range extensions in Texas and Mexico have been reported (Rosen 2004; Rosen & Carter 2007).

†***Cyperus entrerianus*** Boeck.

U.S.A. GEORGIA. **Chatham Co.:** NW Savanna, 1.0 mi S jct Hwy US 80 and Hwy GA 307, E of Hwy GA 307, 32°04.656'N 81°11.722'W, open disturbed lot along S side Prosperity Drive, locally common, 13 Jul 2006, *R. Carter 16939* (VSC, others tbd). **Long Co.:** SW of Ludowici, 31°42.166'N 81°45.461'W, swamp forest along Jones Creek, locally common to scattered in clearings along shaded trail, 14 Jul 2007, *R. Carter 16981* (VSC, others tbd). **Tattnall Co.:** Big Hammock WMA, just N of Altamaha River, W of Hwy GA 144, 31° 52.414'N 82°06.113'W, 1.0 mi SE of J.E. Stanfield Landing, floodplain, near edge of slough, 23 Jun 2007, *R. Carter 16856* (VSC). **Tift Co.:** Tifton, jct Hwy I-75 and S Central Ave, vic. exit 60, disturbed sandy clay along exit ramp from Hwy I-75 southbound, W side Hwy I-75, 31.43062°N 83.51778°W, local, 1 Sep 2008, *R. Carter 18503* (VSC, others tbd).—This umbrella sedge was first reported in the United States in 1990, when it was described as a potential invasive weed (Carter 1990). Subsequently, its dispersal in the southeastern United States has been documented (Carter & Jones 1991; Bryson & Carter 1994; Carter & Bryson 1996). More recently, invasion of natural plant communities (e.g., bottomland hardwood forest, coastal prairie) by *C. entrerianus* in Texas was shown (Rosen et al. 2006). These data comprise three new county records (Chatham, Tattnall and Tift) for Georgia and document the occurrence of this invasive sedge in bottomland forests in Georgia. Monitoring and eradication programs should be implemented to protect natural systems from invasion by *C. entrerianus.*

Cyperus flavicomus Michx.

C. albomarginatus (Mart. & Schrad.) Steud.

U.S.A. GEORGIA. **Hall Co.:** 4.0 mi N of Buford, open mud flat along exsiccated margin of artificial pond by Hwy GA 13, with *Bidens* sp., *Cephalanthus occidentalis*, *Cyperus erythrorhizos*, *C. odoratus*, *C. polystachyos*, *C. strigosus*, *Eleocharis*, sp., *Fimbristylis* sp., *Hypericum* spp., *Ludwigia* spp., *Rotala* sp., *Sagittaria* sp., *Salix nigra*, *Scirpus* sp., and *Utricularia* sp., 16 Sep 1990, *R. Carter 8499 and M.W. Morris* (VSC, others tbd).—This species occurs sporadically in the southeastern United States where it is infrequent to rare. Previously, in Georgia it was known from only Oglethorpe County (Jones & Coile 1988; Sweeney & Giannasi 2000). These voucher specimen data document the second Georgia county record for *C. flavicomus*.

†**Cyperus fraternus* Kunth**

U.S.A. GEORGIA. **Baker Co.:** 1.9 mi N of Cooleewahee Creek bridge, N of Newton, right-of-way along W side Hwy GA 91 just S powerline crossing, 31°20.859'N 84°18.312'W, recently cleared ground and adjacent ditch, locally common, 7 Aug 2007, *R. Carter 17959 and W.W. Baker* (VSC, others tbd). **Miller Co.:** 16.6 mi W of Newton jct Hwy GA 91 and GA 37, 300 m E jct Kimbrel Rd and Hwy GA 91, open disturbed depression along N side Hwy GA 91, 1.5 mi W Baker-Miller county line, 31°11.043'N 84°33.829'W, 16 Aug 2007, *R. Carter 17997 and R. Kral* (VSC, others tbd).—This obscure sedge was treated as *C. reflexus* Vahl var. *fraternus* (Kunth) Kuntze by Denton (1978) and was given no status in the recent *Flora of North America* (Tucker et al. 2002). It has an amphitropical distribution in the New World, previously known from temperate South America, Mexico, and Texas and Louisiana in the United States (Denton 1978). Its habit, inflorescence form, scale color, and achene are very different from *C. reflexus*; thus, we treat it at the rank of species. These voucher specimen data comprise the first report of *C. fraternus* from east of the Mississippi River.

****Cyperus lecontei*** Torr. – W(S3)

U.S.A. GEORGIA. **Charlton Co.:** 4.4 mi S of St. George (2.7 mi S by Hwy GA 121-23, then S 1.7 mi by dirt road), E of Hwy GA 121-23, between Mill Branch and Saucer Branch, local in open sandy, peaty barrow pit, flatwoods, 12 May 1990, *R. Carter 8333 and M.W. Morris* (VSC). **Taylor Co.:** 3.0 mi W of Butler, drainage ditch along Hwy GA 96, 16 May 1974, *W.R. Faircloth 7567* (VSC).—This species is distributed from North Carolina, southward into southern Florida, then westward into Louisiana. It is most common near the coast in swales and ditches amid dunes, sandy shores of estuaries, banks of tidal creeks, and lake shores (Radford et al. 1968; Godfrey & Wooten 1979), but, as *Faircloth 7567* from the Fall Line Sandhills of the Upper Coastal Plain shows, *C. lecontei* also occurs sporadically inland. Sorrie (1998) reported it new to Georgia based upon his 1994 collection from Glynn County. Sweeney and Giannasi (2000) map it in only two Georgia counties, Baker and McIntosh. The voucher specimen data reported herein provide documentation for earlier collections and additional county records of *C. lecontei* in Georgia, where in Charlton County it was found in exposed, seepy sand of a barrow pit in the flatwoods and was associated with *Calopogon pallidus* Chapm., *C. tuberosus* (L.) Britt. et al., *Cleistes divaricata* (L.) Ames, *Hypericum fasciculatum*, *H. suffruticosum* Adams & Robson, *Lycopodium* spp., *Morella caroliniensis*, *M. cerifera*, *Pinguicula caerulea* Walt., *Pogonia ophioglossoides* (L.) Ker Gawl., *Polygala* spp., and *Sarracenia minor* Walt.

†**Cyperus pilosus* Vahl**

U.S.A. GEORGIA. **Bacon Co.:** Alma, jct Hwy GA 32 and Industrial Drive, 31°32.659'N 82°30.683'W, locally abundant in ditch, 10 Aug 2005, *R. Carter 16081* (VSC, others tbd).—This species, apparently an accidental introduction from Asia with rice agriculture, occurs sporadically in the lower Gulf coastal plain from southern Louisiana, southern Mississippi, to the Florida panhandle (Burkhalter 1985; Bryson & Carter 1992, 1994, 2008). It is also known from South Carolina (Tucker et al. 2002) and has recently been reported from eastern Texas (Carter et al., in press). Given the historical importance of rice agriculture in Georgia, it is surprising that it has not previously been found in the state, especially from the old rice district along the Atlantic coast. These voucher specimen data comprise the first report of *C. pilosus* from Georgia.

Cyperus tetragonus Elliott – W(S3?)

U.S.A. GEORGIA. **Camden Co.:** Cumberland Island, S end of island near Dungeness ruin, locally common in hammock at edge of salt-marsh, 5 Dec 1987, *R. Carter 6417* (GA, MO, VDB, VSC); 11.75 air mi NNE of St. Marys waterfront, ca. 1.25 mi N Cabin Bluff Lodge, 30°54'13"N 81°30'50"W, maritime live oak forest, locally common, 15 Sep 1995, *R. Carter 12727* (VSC, others tbd); maritime live oak forest NW of Shellbine, ca. 30°54'39"N 81°31'09"W, common, 15 Sep 1995, *R. Carter 12757* (VSC, others tbd). **McIntosh Co.:** Sapelo Island, ca. 250 m NE of UGAMI headquarters, maritime forest with *Quercus virginiana*, *Sabal palmetto*, *Sassafras albidum* and *Ilex opaca*, 17 Oct 1999, *R. Carter 14426* (VSC, others tbd).—This species occurs in hammocks throughout much of Florida (Long & Lakela 1971; Clewell 1985; Wunderlin &

Hansen 2003, 2008) and ranges northward along the coast into South Carolina. Sweeney and Giannasi (2000) map it only in Glynn County along the Georgia coast. These data represent additional county records of *C. tetragonus* in Georgia.

†****Dichondra micrantha*** Urb. (Convolvulaceae)

U.S.A. GEORGIA. **Camden Co.:** 1.3 mi S jct Bailey Mill Rd and John Bailey Mill Rd, near bank of Satilla River along Satilla Drive, vic. John Baileys Mill, USGS Jerusalem quadr., 30°54.517'N 81°51.761'W, local in disturbed loam, 17 Mar 2006, *R. Carter 16383 and W.W. Baker* (VSC, others tbd).—Wunderlin and Hansen (2008) map this species as occurring throughout Florida. In their revision, Tharp and Johnston (1961) document this taxon in Texas and provide a key separating *D. micrantha* and *D. carolinensis* Michx. Our data comprise the first report of *D. micrantha* from Georgia.

†****Dioscorea alata*** L. (Dioscoreaceae) – EPPC

U.S.A. GEORGIA. **Lowndes Co.:** Moody Air Force Base, 0.5 mi E of N end of main runway, along N boundary rd., 30.98590°N 83.17992°W, degraded mesic woods, 11 Jul 2008, *R. Carter 18459 and M. Nichols* (VSC).—This species is not mapped in Georgia by Sweeney and Giannasi (2000). It is listed among Category I invasive weeds (FLEPPC 2007) in Florida.

†****Dioscorea bulbifera*** L. – EPPC

U.S.A. GEORGIA. **Camden Co.:** ca. 0.4 air mi SW of Coleraine, abandoned house site along bank of St. Marys River, 30°49.626'N 81°54.437'W, high climbing liana, 20 Jul 2006, *R. Carter 17032 and W.W. Baker* (VSC, others tbd); 3.91 air mi W of Woodbine, 30°58.055'N 81°47.344'W, end of Old Jefferson Hwy at Satilla River, edge of woods, high climbing liana, local, 1 Sep 2006, *R. Carter 17183 and W.W. Baker* (VSC).—This species is not mapped in Georgia by Sweeney and Giannasi (2000). It is listed among Category I invasive weeds (FLEPPC 2007) in Florida.

†****Echium vulgare*** L. (Boraginaceae)

U.S.A. GEORGIA. **Cook Co.:** Adel, just E of I-75, 31°08.056'N 83°26.012'W, vacant lot along S side Hwy GA 37, mechanically disturbed sandy loam, 30 Apr 2004, *R. Carter 15327* (VSC, others tbd).—Native to mediterranean Europe, this introduction is naturalized in the piedmont and mountain provinces from South Carolina to Virginia as well as in the coastal plain of Virginia (Weakley 2008). These voucher specimen data comprise the first report of *E. vulgare* from Georgia.

Eleocharis albida Torr. (Cyperaceae) – S(S2S3)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, 1.09 mile S Jct. U.S.S. Kamehameha Ave and U.S.S. Henry L. Stimson Dr, edge of brackish marsh along W side U.S.S. Kamehameha Ave, 30°47'09"N 81°31'16"W, Harrietts Bluff 7.5' USGS quadr., elev. 0–5 ft, locally abundant, 8 Jul 1996, *R. Carter 13112* (VSC, others tbd); Kings Bay Submarine Base, fill site just NW from N end of dock, across Kings Bay from N end of Crab Island, 30°48'47"N 81°31'46"W, USGS Harrietts Bluff quadr., locally abundant, 9 Jul 1996, *R. Carter 13182* (VSC, others tbd); Kings Bay Submarine Base, concrete storm drain along W side U.S.S. James Monroe Avenue, 1.0 mi NW of Warrior Wharf parking area, elev. ca. 10 ft, USGS Harrietts Bluff 7.5' quadr., locally abundant, 23 Jul 1996, *R. Carter 13346* (VSC, others tbd); Kings Bay Submarine Base, NE quadrant of base, Cherry Point; 0.81 air mi NNE of golf course clubhouse, small tidal creek adjacent to salt marsh, E of eastern perimeter fence, 30°49'57"N 81°32'54"W, USGS Harrietts Bluff 7.5' quadr., locally abundant, 29 Jul 1996, *R. Carter 13407* (VSC). **Glynn Co.:** Brunswick, Lanier Boulevard, between Hwy US 341 and Ocean Avenue, edge of marsh, 21 Sep 1991, *R. Carter 9252b with P. Bauer, J. Lusk and J. Robertson* (VSC, other tbd).—These voucher specimen data indicate *E. albida* is common and locally abundant in disturbed brackish soils and along tidal creeks in coastal Camden County.

Eleocharis cellulosa Torr. – W(SNR)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, 30°49'00"N 81°32'45"W, exposed, mechanically disturbed reddish brown loam along west bank of Etowah Pond, locally common, 28 Aug 1996, *R. Carter 13598* (VSC, others tbd). **Seminole Co.:** Lake Seminole, along W bank of Lower Fish Pond Drain, 30.77013°N 84.86723°W, locally abundant in water ca. 3 dm deep along edge of lake, forming monotypic stand, 22 Jul 2008, *R. Carter 18465 with*

W.W. Baker and D. Morgan (VSC, others tbd).—Although reported from Bryan and Camden counties (Eyles 1940) and more recently from Clinch County (Rosen 2006), this species was not mapped for Georgia by Sweeney and Giannasi (2000). The collection data reported herein provide additional documentation of *E. cellulosa* in Georgia, including an additional record from Camden County which, at the time of its collection, was the first from the state in more than 50 years.

Eleocharis melanocarpa Torr. – W(S3)

U.S.A. GEORGIA. **Atkinson Co.:** sphagnous seepage slope and ditch along Hwy GA 135 and adjacent to sandridge, 1.9 mi S of Jct. with Hwy US 82 in Willacoochee, 25 May 1992, *R. Carter 9718* (VSC, others tbd). **Brooks Co.:** ca. 0.25 air mi S Piscola, N Thompson Rd, Pinion Point Plantation, 30°41.184'N 83°40.657'W, 6 Jul 2007, *R. Carter 17658 and W.W. Baker* (VSC). **Bryan Co.:** Ft. Stewart Military Reservation, 2.4 mi NW of FS 59 by FS 60, shallow, intermittently wet drainage, ca. 1400 m WSW of FS 60, elev. ca 5 m, locally common, 30 Jun 1992, *R. Carter 10002, J. Lusk and D. Thompson* (VSC); Ft. Stewart Military Reservation, 0.10–0.50 mi south of FS 43, between FS L-W and FS 88, flatwoods, elev. ca 20 m, shallow, intermittent pond in open, frequently burned pine flatwoods, locally common, 1 Jul 1992, *R. Carter 10028, J. Lusk and D. Thompson* (VSC). **Early Co.:** ca. 3.0 air mi WNW Cedar Springs, Shackleford-Williams TNC Preserve, 31°11.835'N 85°04.710'W, 19 Jul 2007, *R. Carter 17793, R. Kral and W.W. Baker* (VSC). **Irwin Co.:** S of Hwy US 319, E of Alapaha River, 31.49598°N 83.36600°W, shallow pond, with *Taxodium ascendens*, *Nyssa biflora*, *Ilex myrtifolia*, *Litsea aestivalis*, 21 Aug 2008, *R. Carter 18494 with W.W. Baker and G. Nelson* (VSC, others tbd). **Lanier Co.:** 0.9 mi E jct Hwy GA 37 and Hwy US 221, disturbed area between swamp forest and base of Hwy GA 37 berm, plants sterile, local, 23 Jul 1992, *R. Carter 10247 and J. Lusk* (VSC, others tbd). **Lowndes Co.:** just E of Valdosta, between jct Hwy GA 94 and Inner Perimeter Rd and Moulton-Branch Elementary School, ditch and backslope along E side Inner Perimeter Rd, locally common, 15 May 2000, *R. Carter 14464* (VSC, others tbd). **Talbot Co.:** 1.97 mi S Junction City jct Hwy GA 90 and Hwy GA 96, then 1.04 mi NE of railroad crossing at Brownsand by dirt road, edge of sandpit pond, 3 Sep 1994, *R. Carter 12046* (VSC). **Taylor Co.:** 2.48 mi SW Howard, 1.37 mi W jct in Howard, then 1.09 mi S by Kel Foster Rd, Parks Mill Pond, immersed in swiftly flowing outlet above spillway, 2 Sep 1994, *R. Carter 12038* (VSC, others tbd). **Turner Co.:** 2.3 mi W of Irwin-Turner county line, along north side Hwy GA 107, ca. 31°43'24"N 83°29'39"W, seasonally wet pond embedded in sand ridge, pond margin, locally common, 1 Aug 1995, *R. Carter 12595* (VSC). **Worth Co.:** 1.6 mi W Tyty, heavily cut-over slope and pond, locally common, 28 Jun 1993, *R. Carter 10865 and R. Kral* (VSC, others tbd).—The type locality of *E. melanocarpa* is "near Savannah" (Torrey 1836). Jones and Coile (1988) mapped it only in Dougherty County, and Sweeney and Giannasi (2000) in Dougherty, Montgomery and Bryan counties. In our experience, *E. melanocarpa* is infrequent, and these voucher specimen data confirm additional county records for it in Georgia, where it inhabits fine sands and loamy sands in natural, shallow, seasonal drains or seasonally wet depressions or pond margins in open, periodically burned pine flatwoods. Associates include *Acer rubrum*, *Aster reticulatus* Pursh, *Carex glaucescens* Elliott, *C. striata* Michx., *Centella asiatica* (L.) Urb., *Chaptalia tomentosa* Vent., *Drosera* sp., *Erianthus* sp., *Erigeron vernus* (L.) Torr. & A. Gray, *Gratiola pilosa* Michx., *Ilex glabra*, *I. myrtifolia* Walter, *Juncus* spp., *Lachnocaulon anceps* (Walter) Morong, *Liquidambar styraciflua*, *Lycopodium alopecuroides* L., *L. appressum* (Chapm.) F.E.Lloyd & Underw., *Morella cerifera*, *Osmunda cinnamomea* L., *Nyssa biflora*, *Pinus palustris*, *Pinus serotina*, *Polygala lutea*, *Rhexia* spp., *Rhynchospora* spp., *Sabatia campanulata* (L.) Torr., and *Woodwardia virginica* (L.) Sm.

†***Eleocharis montana*** (Kunth) Roem. & Schult.

U.S.A. GEORGIA. **Camden Co.:** 0.3 mi N Waverly jct Hwys US 17 and GA 110, 31°05.896'N 81°43.406'W, locally common, edge of bisected wetland along Hwy US 17, 14 Oct 2006, *R. Carter 17314 and W.W. Baker* (VSC, others tbd). **Glynn Co.:** Anguilla, jct Hwy GA 99 and GA 32, 31°15.325'N 81°36.217'W, open swale along right-of-way, locally common in standing water, 13 Jul 2003, *R. Carter 15022* (VSC, others tbd).—This weedy sedge is widely distributed in the New World, ranging from South America through Central America, Mexico and the West Indies into warmer portions of the United States (Smith et al.

2002; Bryson & Carter 2008). Whereas Sweeney and Giannasi (2000) map it only in Decatur and Early counties in extreme southwestern Georgia, our data extend the range of *E. montana* into the southeastern sector of the state by a distance of more than 250 km.

Eleocharis montevidensis Kunth – S(S1)

U.S.A. GEORGIA. **Brantley Co.:** 3.81 mi E of Nahunta jct Hwy US 82 and Hwy US 301, W of Lulaton, edge of cypress gum pond along N side Hwy US 82, 12 Oct 1996, *R. Carter 13927* (VSC). **Camden Co.:** Kingsland, ditch along S side Hwy GA 40 ca. 200 m E jct Hwy I-95, locally abundant, 31 Jul 1996, *R. Carter 13453* (VSC, others tbd); S of Atkinson, NW of Tarboro, jct Old Hwy 259 and Old Merrow Community Rd, by Old Hwy 259, 31°03.869'N 81°52.940'W, locally abundant in mucky ditch, 29 Apr 2006, *R. Carter 16523* (VSC, others tbd). **Glynn Co.:** Anguilla, jct Hwy GA 99 and GA 32, 31°15.325'N 81°36.217'W, open swale along right-of-way, locally common in standing water, 13 Jul 2003, *R. Carter 15023* (VSC, others tbd). **Liberty Co.:** Ft. Stewart Military Reservation, ditch along McFarland Ave, ca. 100 m S of W. 18th St, common, 16 Jul 1992, *R. Carter 10194 and P. Bauer* (GA, VSC). **Pierce Co.:** 3.4 mi NE jct Hwy GA 15/121 and Hwy US 84 in Blackshear, W side Hwy US 84, locally abundant, 19 Jun 1992, *R. Carter 9859 and P. Bauer* (VSC, others tbd), 23 Jul 1992, *R. Carter 10245 and J. Lusk* (VSC, others tbd).—This species is widely distributed in the New World, from South America, Mexico and warmer parts of the United States (Smith et al. 2002). An occasional to common weed of open wet swales and ditches in the lower coastal plain of the southeastern United States, this sedge may be locally abundant proliferating by rhizomes but sometimes only sporadically producing fruits (Bryson & Carter 2008). *Eleocharis montevidensis* was first recorded for Georgia by Eyles (1940). It is often vegetative and is easily overlooked, and its presumed rarity in Georgia is probably an artifact of undercollection.

†****Emilia fosbergii*** Nicolson (Asteraceae)

U.S.A. GEORGIA. **Lowndes Co.:** N Valdosta, Jodeco Springs Subdivision, 2943 Sutucka Circle, 22 Oct 1994, *Carter 12366* (VSC).—This species has not been reported from Georgia (Jones & Coile 1988; Barkley 2006). It is a naturalized weed in Florida (Wunderlin 1982; Clewell 1985) and has been reported from Texas (Williams 1994). These voucher specimen data comprise the first documentation of its naturalization in Georgia, where it spread from an ornamental garden plot and persisted for several years, apparently introduced with nursery stock.

Epidendrum magnoliae Muhl. (Orchidaceae) – U

E. conopseum R. Br.

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, 0.31 air mi SW jct U.S.S. Henry L. Stimson Dr and U.S.S. Woodrow Wilson Ave, hardwood hammock along N side of SWIFLANT, between SWIFLANT fence and drainage ditch, 30°47'35"N 81°32'23"W, Harrietts Bluff 7.5' USGS quadr., elev. 10–15 ft, 6 Sep 1996, *R. Carter 13659* (VSC); Magnolia Bluff, just N of Satilla River bridge, 30°56.683'N 81°53.585'W, hardwood bluff forest, epiphytic on *Magnolia grandiflora*, 9 Jun 2006, *R. Carter 16771 and W.W. Baker* (VSC). **Charlton Co.:** 1.88 mi E Folkston (courthouse) by Hwy GA 40, then 200 m N by Reynolds Rd, bayswamp along creek just N Peoples Baptist Church, 30°50'32"N 81°58'33"W, occasional epiphyte, 29 Mar 1996, *R. Carter 12928 (VSC)*.—This epiphytic orchid occurs on a variety of phorophytes, but more frequently on *Magnolia grandiflora* and *Quercus virginiana* (Bergstrom & Carter 2008). In Camden County, it was found in a hardwood hammock and a hardwood bluff forest; associates included *Arundinaria gigantea*, *Asimina parviflora* (Michx.) Dunal, *Carya glabra*, *Chasmanthium* sp., *Juniperus* sp., *Ilex opaca*, *Lyonia ferruginea*, *Liquidambar styraciflua*, *Magnolia grandiflora*, *Morella cerifera*, *Pinus elliottii*, *P. glabra* Walter, *P. taeda*, *Quercus hemisphaerica* W. Bartram ex Willd., *Q. nigra*, *Q. virginiana*, *Serenoa repens*, *Smilax pumila* Walter, *Vaccinium arboreum*, and *Vitis rotundifolia* Michx. We suspect this arboreal species is often overlooked and undercollected and is more common than herbarium records would indicate.

†****Eriobotrya japonica*** (Thunb.) Lindl. (Rosaceae)

U.S.A. GEORGIA. **Lowndes Co.:** Valdosta, vic. city bike trail along S bank One Mile Branch, between Sustella Ave and Wainwright St, UTM 17 280214E 3414480N (NAD83/WGS84), degraded slope forest, urban woodlot, occasional, 4 Mar

2007, *R. Carter 17424* (VSC).—Loquat is naturalized throughout much of Florida (Wunderlin & Hansen 2008; Judd 2003) but has not been previously recorded as naturalized in Georgia (Jones & Coile 1988). These voucher specimen data provide the first documentation of a naturalized population of loquat in Georgia.

Eriochloa michauxii (Poir.) Hitchc. var. ***michauxii*** (Poaceae) – S(S2?)

U.S.A. GEORGIA. **Charlton Co.:** ca.1.7 air mi WNW Coleraine lodge, 30°50.184'N 81°55.846'W, sawgrass depression along SE side St. Marys Cut, occasional, 20 Jul 2006, *R. Carter 17051 and W.W. Baker* (VSC, others tbd).—Sweeney and Giannasi (2000) map this species from only three Georgia counties, all coastal. These voucher specimen data confirm the occurrence of this infrequently collected species in yet another Georgia county.

Eustachys floridana Chapm. – S(S1?)

U.S.A. GEORGIA. **Berrien Co.:** S of Willacoochee, xeric sandridge, S of Alapaha River on E side Hwy GA 135, 6 Oct 2006, *W.W. Baker and F. Snow s.n.* (VSC).—Herein we report an additional voucher for this rare grass that Sweeney and Giannasi (2000) map in only Baker County. Common woody associates were *Pinus palustris*, *Quercus geminata*, *Q. incana*, *Q. laevis*, *Q. margaretta*, and *Vaccinium arboreum*, and *V. stamineum* L.

†****Eustachys retusa*** (Lag.) Kunth

U.S.A. GEORGIA. **Bryan Co.:** 1.7 mi W Pembroke jct Hwys US 280 and GA 119, 32°08.256'N 81°39.134'W, jct Hwy US 280 and Conley Rd (CR 80), along railroad adjacent to S side Hwy US 280, locally common, 12 Jul 2006, *R. Carter 16927* (VSC, others tbd).—Native to South America, this species was previously known in the United States from Texas, northwestern Florida, and central South Carolina, but not from Georgia (Jones & Coile 1988; Aulbach 2003).

Fagus grandifolia Ehrh. (Fagaceae)

U.S.A. GEORGIA. **Camden Co.:** ca. 0.5 air mi N of Rains Landing, USGS Boons Lake quadr., bluff along E bank of Satilla River, near end of 3R Fishcamp Rd, 31°00.347'N 81°54.197'W, beech-magnolia slope forest, 9 Jun 2006, *R. Carter 16799 and W.W. Baker* (VSC).—American beech has not been documented previously from southeastern Georgia (Little 1971; Godfrey 1988). The population reported herein occurs on bluffs along the Satilla River in western Camden County, where several isolated pockets with mature specimens of *F. grandifolia* were observed mostly along north-facing slopes of ravines extending eastward from the main west-facing Satilla River bluff. Trees were also observed in Camden County at Magnolia Bluff and in a remnant hardwood hammock on an expansive flat along Owens Ferry Road ca. 2.0 mi east of Jerusalem. Our efforts to locate the parasite *Epifagus virginiana* (L.) Barton at these sites have been thus far unproductive.

Forestiera segregata (Jacq.) Krug & Urb. (Oleaceae) – S(S2)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, 0.66 air mi NE of S end of U.S.S. Kamehameha Ave, shell midden off E side of small southward projecting peninsula E of head of Point Peter Creek, 30°45'49"N 81°30'26"W, Harrietts Bluff 7.5' USGS quadr., elev. 5–10 ft, local, 31 Jul 1996, *R. Carter 13446* (VSC, others tbd), 13 Sep 1996, *R. Carter 13708* (VSC, others tbd). **McIntosh Co.:** Sapelo Island, vic. Sapelo Island Post Office, USGS Doboy Sound quadr., UTM 17 473118E 3477438N (NAD83/WGS84), shell mound along Post Office Creek/Duplin River, local, 17 Oct 1999, *R. Carter 14399* (VSC, others tbd).—Herein, we report additional records of this rare shrub that ranges from the West Indies, through coastal peninsular Florida and coastal Georgia into coastal South Carolina (Chafin 2007; Wunderlin & Hansen 2008). It inhabits calcareous shell middens along saline marshes associated with coastal scrub and maritime forests.

Fuirena scirpoidea Michx. (Cyperaceae) – S(S1?)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, W bank of Etowah Pond, 30°49'00"N 81°32'45"W, Harrietts Bluff 7.5' USGS quadr., elev. 15–20 ft, mechanically disturbed pond margin, local, 28 Aug 1996, *R. Carter 13597* (VSC, others tbd).—Distributed through peninsular Florida and along the Gulf Coast into Texas, this sedge reaches the northern limit of its distribution in southeastern Georgia (Kral 1978).

†****Fumaria parviflora*** Lam. (Fumariaceae)

U.S.A. GEORGIA. **Lowndes Co.:** Valdosta, city bike trail between Sustella Ave and Wainwright St, UTM 17 280214E 3414480N (NAD83/WGS84), shaded mesic site along drain along S side One Mile Branch, 24 Apr 2007, *R. Carter 17512* (VSC). —This introduced herb with the phenology of a spring ephemeral was locally abundant and invasive in a degraded, mesic, urban woodlot. Jones and Coile (1988) do not map it for Georgia.

Galax urceolata (Poir.) Brummitt (Diapensiaceae)

U.S.A. GEORGIA. **Taylor Co.:** Atlantic white cedar swamp along Little Whitewater Creek, 6.3 mi S of Butler by Hwy GA 137; slope along creek, in remnant woods, 19 May 1991, *R. Carter 8644* (VSC).—*Galax urceolata* is restricted to the northern half of Georgia, and, according to Jones and Coile (1988), the Piedmont county of Meriwether is the southernmost Georgia county in which it is known. These voucher specimen data document a southward range extension into the Fall-line Sandhills of the Upper Coastal Plain, where a dense growth of *G. urceolata* was found in a narrow strip of remnant woods along Little Whitewater Creek associated with *Epigaea repens* L., *Chamaecyparis thyoides* (L.) Britt. et al., and *Carex collinsii*.

†****Glaucium corniculatum*** (L.) Rudolph (Papaveraceae)

U.S.A. GEORGIA. **Elbert Co.:** fescue pasture, 29 Apr 2002, *David Spaid s.n.* (VSC).—Jones and Coile (1988) do not map this species in Georgia.

Gratiola aurea Pursh (Scrophulariaceae)

U.S.A. GEORGIA. **Cook Co.:** about 6.5 mi W of Adel, N of Hwy GA 37, Reed Bingham State Park, locally abundant in slough along Little River, 18 Aug 1990, *R. Carter 8444* (GA, VDB, VSC).—This species is apparently rare in Georgia and was previously mapped only in Brooks County (Jones & Coile 1988).

†****Habranthus tubispathus*** (L'Hér.) Traub (Liliaceae)

U.S.A. GEORGIA. **Irwin Co.:** Waterloo, N side Hwy GA 125, 30°35.592'N 83°28.490'W, road shoulder and adjacent residential lawn, locally abundant, 10 Aug 2005, *R. Carter 16079* (VSC, others tbd).—The yellow-flowered copper-lily is known from South America, Texas, Louisiana, Alabama and the western panhandle of Florida (Flagg et al. 2002); it has not been previously reported from Georgia (Sweeney & Giannasi 2000).

Hartwrightia floridana A. Gray ex S. Watson (Asteraceae) – T

U.S.A. GEORGIA. **Charlton Co.:** 2.86 air mi S Moniac jct Hwy GA 185 and Hwy GA 94, W side Hwy GA 185, between Hwy and St. Marys River, ca. 150 m W of 30°28.944'N 082°11.941'W, seepage slope along W side of upland oak-pine woods, local, 12 Oct 2006, *R. Carter 17283 and W.W. Baker* (VSC); 5.91 air mi SSW St. George jct Hwy GA 23/121 and Hwy GA 94, Hwy GA 23/121, ca. mile marker #7 and cement power pole #60, 30°26.675'N 82°04.685'W, seepage slope above creek, local, 12 Oct 2006, *R. Carter 17291 and Baker* (VSC); 4.68 air mi SSW St. George jct Hwy GA 23/121 and Hwy GA 94, along Hwy GA 23/121, 30°27.542'N 82°03.906'W, gradual seepy slope at edge of cypress-gum pond, locally common, 12 Oct 2006, *R. Carter 17293 and Baker* (VSC); 11.8 air mi SSW Folkston jct Hwy US 1 and Hwy GA 23/121, ca. 0.1 mi N mile marker #23 along Hwy GA 23/121, ca. 0.2 mi N jct Joe Cone Rd and Hwy GA 23/121, between 30°40.011'N 82°03.673'W and 30°40.038'N 82° 03.680'W, seepage slope along W side Hwy GA 23/121, local, 13 Oct 2006, *R. Carter 17298 and Baker* (VSC).—*Hartwrightia floridana* was found along open seepage slopes and in shallow seasonally wet flatwoods depressions and strands. Common associates were *Acer rubrum*, *Bidens* sp., *Bigelowia nudata* (Michx.) DC., *Cliftonia monophylla*, *Coreopsis* sp., *Cyrilla racemiflora* L., *Drosera capillaris*, *Erigeron vernus*, *Eriocaulon decangulare* L., *Eupatorium* spp., *Fuirena* sp., *Gordonia lasianthus* (L.) J. Ellis, *Helianthus angustifolius* L., *Hypericum fasciculatum*, *Ilex coriacea*, *I. myrtifolia*, *Juncus* spp., *Lobelia glandulosa* Walter, *Lycopodium alopecuroides*, *L. appressum*, *L. carolinianum* L., *Lyonia lucida*, *Magnolia virginiana*, *Morella caroliniensis*, *M. cerifera*, *Nyssa biflora*, *Osmunda cinnamomea*, *Oxypolis filiformis* (Walter) Britton, *Persea palustris*, *Pinus elliottii*, *Rhexia mariana* L., *R. petiolata* Walter, *Rhynchospora* spp., *Sabatia macrophylla* Hook., *Sarracenia minor*, *Scleria reticularis* Michx., *Serenoa repens*, *Smilax laurifolia* L., *Solidago* spp., *Taxodium ascendens*, *Toxicodendron vernix*, *Woodwardia areolata* (L.) T. Moore, and *Xyris* spp. Using data provided by the Georgia Department of Natural Resources Natural Heritage Program courtesy of botanist, Tom Patrick, the first two authors attempted in 2006 to relocate historical populations of *H. floridana* in southeastern Georgia and to discover new ones. In all, 12 extant populations were found in Charlton County including eight previously undocumented ones (Carter & Baker 2006). Herein we report vouchers for some additional Georgia populations of this rare species. Our intensive search efforts for *H. floridana* in adjacent Camden County have to date been futile.

Helenium brevifolium (Nutt.) A. Wood – S1

U.S.A. GEORGIA. **Taylor Co.:** 6.1 mi S Butler by Hwy GA 137, slope along Little Whitewater Creek, open seepage bog upslope from creek, 20 Apr 1991, *R. Carter 8564 and M.W. Morris 4148* (VSC, others tbd).–Herein we report a new county record for this rare composite, which, in Georgia, is restricted to a tight cluster of counties in the west-central portion of the state (cf. Chafin 2007). Our record is from a contiguous county.

Hexastylis arifolia (Michx.) Small var. ***arifolia*** (Aristolochiaceae)

U.S.A. GEORGIA. **Charlton Co.:** Traders Hill Recreation Area, along W side of St. Marys River, hardwood slope and terrace just above confluence of two small streams, 30.78306°N 82.02895°W, plants locally common, several extensive patches observed, 21 Mar 2008, *R. Carter 18838 and W.W. Baker* (VSC, others tbd).—This species has not previously been documented from the southeastern sector of Georgia (Jones & Coile 1988; Whittemore & Gaddy 1997). First noted by Lynch and Baker (1988), the population reported herein was only recently vouchered.

†***Hibiscus trionum*** L. (Malvaceae)

U.S.A. GEORGIA. **Ware Co.:** Waycross, Rice Yard, weed in rail yard, 7 Aug 1990, *W.K. George s.n.* (VSC).—*Hibiscus trionum*, a European introduction, is widespread in eastern United States (Fernald 1950; Radford et al. 1968). Whereas Jones and Coile (1988) record it from only Clarke County, this is apparently the second vouchered county record for the state and the first for the Georgia coastal plain.

†****Hypochaeris microcephala*** (Schultz-Bipont.) Cabrera var. ***albiflora*** (Kuntze) Cabrera (Asteraceae)

U.S.A. GEORGIA. **Camden Co.:** Hwy US 17, N of Kingsland, just. N of jct Hwy US 17 and Daisy Ave, just S of jct Hwy US 17 and Kinlaw Rd, 30.85883°N 81.70219°W, ruderal roadside adjacent to commercial lot, locally abundant, roots with latex, heads white, 30 Apr 2008, *R. Carter 18369 and W.W. Baker* (VSC, others tbd).—Prior to the record reported herein, this introduced South American weed was thought to be restricted to Louisiana, Texas and Oklahoma in the United States (Bogler 2006).

Ilex amelanchier M.A. Curtis ex Chapm. (Aquifoliaceae) – S(S2)

U.S.A. GEORGIA. **Camden Co.:** vic. Douglas Fish Club, N side Douglas Fish Club Rd, SSW from Old Merrow Community Rd, S from Old Hwy 259, 31°01.612'N 81°54.072'W, floodplain along base of bluff, 29 Jun 2006, *R. Carter 16876 and W.W. Baker* (VSC, others tbd); Oak Grove Acres development, edge of Satilla River floodplain, along E bank of narrow lake at base of slope, 31°04.702'N 81°53.337'W, locally common, 18 May 2007, *R. Carter 17568 and W.W. Baker* (VSC, others tbd); Satilla River floodplain at base of bluff, along E bank of river, ca. 30.00233°N 81.90614°W, 5 m shrub, locally common, 1 Jul 2008, *R. Carter 18427 and W.W. Baker* (VSC, others tbd).—These data document an additional county record of this rare species in Georgia (cf. Jones & Coile 1988). Associates were *Acer rubrum*, *Cephalanthus occidentalis*, *Dulichium arundinaceum* (L.) Britt., *Fraxinus sp.*, *Hypericum myrtifolium* Lam., *Ilex myrtifolia* L., *Leucothoe racemosa*(L.) A. Gray, *Lobelia puberula* Michx., *Lyonia lucida*, *Morella cerifera*, *Nyssa biflora*, *N. ogeche* W. Bartr. ex Marsh., *Taxodium distichum*, and *Sabatia dodecandra* (L.) Britt. et al.

†****Indigofera spicata*** Forssk. (Fabaceae)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, mowed roadside ca. 100 m E of St. Marys Gate, 30 Aug 1996, *R. Carter 13628* (VSC); Kingsland, lot of Public Works Department, 691 N Lee St (Hwy US 17), 30° 48.581'N 81°41.546'W, 15 Oct 2007, *R. Carter 18230 and W.W. Baker* (VSC, others tbd); Kingsland, Hwy I-95 rest stop and welcome center along E side of northbound lane, 30.75313°N 81.64894°W, 17 Nov 2007, *R. Carter 18305 and W.W. Baker* (VSC, others tbd).—This African native is a weed of disturbed sites (Isley 1990). These voucher specimen data represent the first records for Georgia, as Jones and Coile (1988) do not include it.

†***Ipomoea fistulosa*** Mart. ex Choisy (Convolvulaceae)

I. carnea Jacq. subsp. *fistulosa* (Mart. ex Choisy) D.F. Austin

U.S.A. GEORGIA. **Grady Co.:** cultivated, 5.2 mi N of Reno by Hwy GA 111 and to the S of Cairo, 17 Jul 1989, *R.K Godfrey 83364* (MO, VSC). **Lowndes Co.:** Valdosta, persisting in garden at corner of N Fry Street and East Hill Avenue, 30 Nov 1991, *R. Carter 9558* (VSC).—Native to western Brazil and eastern Bolivia, this species spreads and overwinters by rhizomes, has upright aerial stems that may be 2 m high, and is an aggressive pest of wetland habitats in India where it is cultivated for its attactive flowers (Cook 1987). In the United States it has become naturalized in Texas (Correll & Johnston 1970) and Florida (Long & Lakela 1971; Wunderlin 1982; Clewell 1985). *Ipomoea fistulosa* is on Florida's list of prohibited aquatic plants (Ramey 1990). It is winter hardy in southern Georgia and persists with little or no care. Although it has not been observed to spread from plantings, it likely has the potential to do so. Because of its invasive tendencies in wetland habitats, it should be prohibited and eradicated in Georgia and elsewhere outside its native range.

Iris tridentata Pursh (Iridaceae) – S(S2?)

U.S.A. GEORGIA. **Camden Co.:** Great Satilla Preserve along W side of Old Merrow Community Rd, off Old Hwy 259, swamp forest in Satilla River floodplain, local, 31°02.636'N 81°53.845'W, 29 Jun 2006, *R. Carter 16863 and W.W. Baker* (VSC).—Sweeney and Giannasi (2000) map this species in Georgia only in Wayne and Bryan counties.

Isolepis carinata Hook. & Arn. ex Torr. (Cyperaceae)

Scirpus koilolepis (Steud.) Gleason

U.S.A. GEORGIA. **Lanier Co.:** Moody Air Force Base, E.O.D. Range, just W of Dudley's Hammock, open rutted field, rare, 9 Apr 1994, *R. Carter 11685* (VSC); zoysiagrass production field, 14 Apr 2006, *T.R. Murphy s.n.* (VSC); 1.1 mi E of Lakeland by Hwy US 129, 31°02.788'N 83°02.42.'W, floodplain E of Alapaha River, S of Hwy US 129, local in exposed rutted trail, 21 Apr 2006, *R. Carter 16494* (VSC). **Lowndes Co.:** North Valdosta, ca. 200 m east of Valdosta High School, loamy soil in shallow ditch, along Eastwind Road, 7 April 1993, *R. Carter 10644* (VSC). **Wilcox Co.:** vic. Oscewichee Spring and Ocmulgee River, 22 Apr 1989, *W.K. George s.n.* (GA, VSC); Oscewichee Springs, just NE of Bowen Mill State Fish Hatchery, SE corner of Wilcox County, ca. 2 mi NE of Hwy US 129, UTM 17 291919E 3528033N (NAD83/WGS84), USGS Queensland quadr., locally abundant in ruts along jeep trail in Ocmulgee River floodplain, 16 May 1992, *R. Carter 9677* (VSC, others tbd).—This species appears to be common in the Piedmont; however, there are only a few county records from the Coastal Plain (Sweeney & Giannasi 2000). Herein we provide additional distributional data on *I. carinata* in the Coastal Plain of Georgia.

****Isolepis pseudosetacea*** (Daveau) Gand.

Scirpus molestus M.C. Johnston

U.S.A. GEORGIA. **Jeff Davis Co.:** sandstone outcrop N of Hwy GA 107, 4.1 mi W of Snipesville, 23 Apr 1988, *R. Carter 6489* (VSC, others tbd).—This species was not reported for Georgia by Sweeney and Giannasi (2000).

Juncus coriaceus Mack. (Juncaceae)

U.S.A. GEORGIA. **Ben Hill Co.:** Red Bluff, ca. 16 mi ENE of Fitzgerald by Hwy GA 107, then 1.5 mi N along county line road, slough and bottomland at base of bluff, 13 Aug 1987, *R. Carter 6097* (VSC). **Camden Co.:** Cooper Creek swamp, ca. 2.5 air mi NW Cabin Bluff Lodge, ca. 30°55' 08"N 81°32'06"W, 7 Jul 1995, *R. Carter 12481* (VSC, others tbd); Kings Bay Submarine Base, 0.75 air mi SE of Franklin Gate, 30º 46'31"N 81º 33'58"W, wetland strand with *Nyssa biflora, Acer rubrum, Pinus elliottii, Persea palustris, Cephalanthus occidentalis, Morella cerifera, Cyrilla racemiflora, Woodwardia virginica, W. areolata, Osmunda cinnamomea* and *O. regalis*, 22 Jul 1996, *R. Carter 13318* (VSC, others tbd); 3.1 mi N Kingsland jct Hwys US 17 and GA 40, 0.3 mi E jct Hwy US 17 and Harrietts Bluff Rd, hydric hammock along creek, S side Harrietts Bluff Rd, 30°50.573'N 81°41.780'W, 19 May 2005, *R. Carter 15965* (VSC, others tbd).—Sweeney and Giannasi (2000) map this species as occurring thoughout much of Georgia; however, vouchered records were apparently lacking from the south-central and southeastern sectors of the state.

Justicia angusta (Chapm.) Small (Acanthaceae) – S(SH)

U.S.A. GEORGIA. **Charlton Co.:** 9.1 mi W of

St. George jct Hwys GA 94 and 23, pond cypress depression along N side of Hwy GA 94, plants locally abundant, rhizomatous, <1% of stems with flowers, leaves fleshy, corolla lavender with darker purple lines on lower lip, 27 May 1989, *R. Carter 7868 and M.W. Morris 3374* (VSC, others tbd).—Sorrie (1998) reported a 1954 collection (*Ahles 7798 and Bell*, NCU) from Camden County as a state record. Our collection cited above adds a second Georgia county to the known distribution of this species. The following associates were observed with *J. angusta* at the Charlton County site: *Acer rubrum*, *Aletris lutea* Small, *Centella asiatica*, *Cyrilla racemiflora*, *Eleocharis tuberculosa* (Michx.) R. & S., *Gaylussacia* sp., *Gordonia lasianthus*, *Gratiola ramosa* Walt., *Hypericum cistifolium* Lam., *H. fasciculatum*, *H. mutilum* L., *Ilex coriacea*, *I. glabra*, *I. myrtifolia*, *Juncus* spp., *Kalmia hirsuta* Walt., *Lachnocaulon anceps*, *Lyonia lucida*, *Morella cerifera*, *Nyssa biflora*, *Panicum hemitomon* Schult., *Persea palustris*, *Pluchea* sp., *Polygala lutea*, *P. ramosa* Ell., *Proserpinaca pectinata* Lam., *Rhexia alifanus* Walt., *R. lutea* Walt., *Sarracenia minor*, *Smilax laurifolia*, *S. walteri* Pursh, *Syngonanthus flavidulus* (Michx.) Ruhl., *Taxodium ascendens*, *Toxicodendron radicans*, *Vaccinium myrsinites*, and *Xyris* spp.

†***Kyllinga gracillima*** Miq. (Cyperaceae)
Cyperus brevifolioides Delahoussaye & Thieret
K. brevifolioides (Delahoussaye & Thieret) Tucker, *nom. illeg.*

U.S.A. GEORGIA. **Gilmer Co.:** marshy ditch along creek and at base of steep road cut at intersection Hwys GA 382 and GA 5/515, about 6 mi S of Ellijay city center, with *Typha latifolia* and *Cyperus strigosus*, 14 Sep 1991, *R. Carter 9145 and J. Robertson* (VSC, others tbd). **Gordon Co.:** E of Fairmont, Pleasant Grove Baptist Church grounds along S side of Hwy GA 53, branch run below cemetery, disturbed open moist clayey loam in vicinity of baptismal pool, locally common, with *Cyperus iria*, *C. strigosus*, *Eleocharis obtusa*, *K. pumila*, and *Scirpus atrovirens*, 13 Sep 1991, *R. Carter 9128 and Robertson* (VSC, others tbd). **Pickens Co.:** bottom along Talking Rock Creek by Hwy GA 5, 0.4 mi SE of intersection with Hwy GA 136 in Talking Rock, disturbed clayey loam with *Acer negundo*, *Cyperus bipartitus*, *C. croceus*, *C. flavescens*, *C. lancastriensis*, *C. squarrosus*, *C. strigosus*, *Eleocharis obtusa*, *Fimbristylis*, *Fraxinus*, *Juglans*, *Kyllinga pumila*, *Liquidambar*, *Liriodendron*, *Platanus*, *Quercus*, *Rhus glabra*, and *Salix*, 14 Sep 1991, *R. Carter 9135 and J. Robertson* (VSC, others tbd).—This species was previously reported from Walker County, Georgia (Webb et al. 1981). It is also known from Alabama, North Carolina, and Tennessee (Delahoussaye and Thieret 1967; Kral 1981; Webb et al. 1981; Bryson et al. 1997). These voucher specimen data substantiate additional populations of *K. gracillima* in Georgia.

†****Kyllinga squamulata*** Thonn. ex Vahl

U.S.A. GEORGIA. **Camden Co.:** Kingsland, Hwy I-95 rest stop and welcome center along E side of northbound lane, 30.75313°N 81.64894°W, 17 Nov 2007, *R. Carter 18306 and W.W. Baker* (VSC, others tbd). **Chatham Co.:** Savannah, Chatham County Soccer Complex, jct Eisenhower Drive and Sally Mood Drive, in turf and adjacent areas of soccer field, locally common, 23 Nov 2002, *R. Carter 14779* (VSC, others tbd). **Lowndes Co.:** Valdosta, NE sector, Valdosta High School grounds, vic. jct Inner Perimeter Rd and Forrest St, mowed strip between track and retention ponds by Inner Perimeter Rd, locally common, 1 Nov 1998, *R. Carter 14207* (VSC, others tbd); N Valdosta, just E of jct Bemiss Rd and Mt. Zion Church Rd, along Mt. Zion Church Rd, local, 17 Aug 2001, *R. Carter 14615* (VSC, others tbd); Valdosta, Valdosta State University campus, 30° 50.495'N 83°17.811'W, open infrequently mowed playing field and adjacent slope S of One Mile Branch, W of Sustella Ave, 2 Nov 2004, *R. Carter 15836* (VSC, others tbd).—*Kyllinga squamulata* is readily distinguished from its congeners in the southeastern United States by the combination of cespitose habit and lacerate-winged floral scales. It is widely distributed in tropical and subtropical regions of both Eastern and Western Hemispheres, known from the West Indies, tropical Asia, and Africa (Hooper & Napper 1972; Haines & Lye 1983; Tucker 2002). In the United States it was previously known from Florida and South Carolina where it is a weed of roadsides, lawns, athletic fields, golf courses and ruderal areas and is likely being dispersed in turf-grass sod (Bryson et al. 1997; Carter 2005; Bryson & Carter 2008). Anderson (2000) has recently documented its presence in northern Florida. This species is becoming increasingly common in Lowndes County, Georgia, where its dispersal, at least in part, appears to be related to the movement of turf-grass.

†***Lamium purpureum*** L. (Lamiaceae)

U.S.A. GEORGIA. **Lowndes Co.:** vic. Valdosta Airport, roadbank and ditch by Airport Rd, 30° 47.658'N 83°16.748'W, with *Lamium amplexicaule*, locally common, 8 Mar 2005, *R. Carter 15925* (VSC, others tbd).—Jones and Coile (1988) do not map this species from the southern half of Georgia, with Harris County being its southern limit of distribution. Wunderlin and Hansen (2008) do not include *L. purpureum* among Florida's flora. These data document the first record of this species from Georgia's coastal plain, extending its range about 250 km southward, and indicate it should be sought in northern Florida.

Leersia virginica Willd. (Poaceae)

U.S.A. GEORGIA. **Camden Co.:** 3.1 mi N Kingsland jct Hwys US 17 and GA 40, 0.3 mi E jct Hwy US 17 and Harrietts Bluff Rd, 30°50.573' N 81°41.780'W, hydric hammock along creek, S side Harrietts Bluff Rd, 4 Nov 2005, *R. Carter 16332* (VSC, others tbd).—Sweeney and Giannasi (2000) do not map this species in the southeastern quadrant of Georgia; this coastal record from Georgia's southeasternmost county represents a significant range extension.

Liatris patens G.L. Nesom & Kral (Asteraceae)

U.S.A. GEORGIA. **Camden Co.:** 6.8 mi N Tarboro jct Hwy 259 and Old Post Rd, 31°04.771'N 81°52.944'W, open sandy slope W side Hwy 259, 15 Oct 2006, *R. Carter 17339 and W.W. Baker* (VSC, others tbd). **Lanier Co.:** Grand Bay Wildlife Management Area, disturbed old field along S side east-west runway of abandoned airfield, just N Lanier-Lowndes county line, vic. campground and observation grounds, local, 7 Nov 1993, *R. Carter 11596* (VSC, others tbd).—These records provide additional documentation of this recently described species in Georgia.

Liatris tenuifolia Nutt. var. ***quadriflora*** Chapm. – S(S1)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, remnant longleaf pine forest just west of north end of golf course, 0.80 mi NNW of golf clubhouse, plants occasional, 11 Oct 1996, *R. Carter 13869* (VSC, others tbd).—These voucher specimen data provide additional documentation of this taxon from Georgia, where previously it was known from adjacent Charlton County (Nesom 2006b). Nesom (2006b) treats this name as a synonym of *L. laevigata* Nutt.

†***Linaria vulgaris*** Hill. (Scrophulariaceae)

U.S.A. GEORGIA. **Taylor Co.:** 3.4 mi NE of Charing, vicinity of Hwy GA 137 bridge over Little Whitewater Creek, locally common along edge of gravelly roadbed near bridge, *R. Carter 8370* (GA, VSC).—Jones and Coile (1988) mapped this species from only three counties, all located in northern Georgia, and these voucher specimen data comprise the first report of this species from the coastal plain of Georgia. *Linaria vulgaris*, a European introduction, has been present in North America since colonial times (Pennell 1935).

†****Lipocarpha microcephala*** (R. Br.) Kunth (Cyperaceae)

U.S.A. GEORGIA. **Brantley Co.:** 5.55 mi S Atkinson jct Hwy GA 110 and Hwy US 82, Hwy GA 110, 50 m N jct Bamboo Tr. (CR 175), 31.16376° N 81.79086°W, ditch along W side Hwy GA 110, locally common, 14 Oct 2008, *R. Carter 18666* (VSC, others tbd). **Camden Co.:** 7.83 air mi N of Kingsland jct Hwy US 17 and Hwy GA 40, vic. Seals, 30°54.709'N 81°42.736'W, ditch along W side of Hwy US 17, occasional to locally common, 1 Sep 2006, *R. Carter 17193 and W.W. Baker* (VSC, others tbd).—Tucker (2002) reported this Old World introduction from Florida and Alabama in the United States, but it has not been previously reported from Georgia. At both sites reported herein, *Lipocarpha microcephala* was found in wet soil along the edge of a ditch with a number of other ruderals: *Alternanthera philoxeroides* (Mart.) Griseb., *Bacopa* spp., *Cyperus haspan*, *C. lanceolatus* Poir., *C. polystachyos*, *C. strigosus* L., *Eleocharis quadrangulata* (Michx.) Roem. & Schult., *Fimbristylis schoenoides* (Retz.) Vahl, *Kyllinga brevifolia* Rottb., *Phyla nodiflora* (L.) Greene, *Ludwigia* spp., *Phyllanthus urinaria*, *Pontederia lanceolata* Nutt., *Sacciolepis indica* (L.) Chase, *Sesbania herbacea* (Mill.) McVaugh, and *Setaria* sp.

Litsea aestivalis (L.) Fern. (Lauraceae) – R

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, 30°50'07"N 81°33'17"W, exsiccated cypress-gum pond bisected by ditch, ca. 100 m west of north end of golf course, with *Nyssa biflora* and *Taxodium ascendens,* pond being invaded by *Ilex vomitoria*, *Morella cerifera*, *Rubus* sp., *Triadica* *sebifera*, local, 9 Jul 1996, *R. Carter 13201* (VSC, others tbd).; Kings Bay Submarine Base, 0.63 air mi NNW of S end U.S.S. Kamehameha Ave, between U.S.S. Kamehameha Ave and North River marsh, crescent-shaped pond adjacent to N side Torpedo Magazine, 30°45'57"N 81°31'09"W, Harrietts Bluff 7.5' USGS quadr., elev. 5–10 ft, locally common, 23 Jul 1996, *R. Carter 13357* (VSC, other tbd). **Turner Co.:** 2.3 mi W of Irwin-Turner county line, along north side Hwy GA 107, ca. 31° 43'24"N 83°29'39"W, 1 Aug 1995, *R. Carter 12593* (VSC).—These data provide additional records of this rare species. Inland, in Turner County, it was observed in a seasonally wet sinkhole pond embedded in a sand ridge, whereas in Camden County, along the coast, it was found in shallow, seasonal ponds and depressions. Associates at the Turner County site included *Acer rubrum*, *Aster reticulatus*, *Carex glaucescens*, *C. striata*, *Centella asiatica*, *Cephalanthus occidentalis*, *Chaptalia tomentosa*, *Clethra alnifolia*, *Drosera capillaris*, *Dulichium arundinaceum*, *Eleocharis melanocarpa*, *Erianthus* sp., *Erigeron vernus*, *Gratiola pilosa*, *G. ramosa*, *Hypericum nitidum* Lam., *Ilex glabra*, *I. myrtifolia*, *Itea virginica*, *Juncus* spp., *Lachnanthes caroliniana* (Lam.) Dandy, *Lachnocaulon anceps*, *Liquidambar styraciflua*, *Lycopodium alopecuroides*, *L. appressum*, *Lyonia lucida*, *Magnolia virginiana*, *Morella cerifera*, *Osmunda cinnamomea*, *Nyssa biflora*, *Panicum tenerum* Beyrich ex Trin., *Persea palustris*, *Pinus elliottii*, *P. serotina*, *Polygala cymosa* Walter, *P. lutea*, *Rhexia* spp., *Rhynchospora* spp., *Sabatia campanulata*, *Sagittaria graminea* Michx. var. *graminea*, *Taxodium ascendens*, *Utricularia cornuta* Michx., *Xyris jupicai* Rich., *X. smalliana* Nash, and *Woodwardia virginica*.

†***Lolium arundinaceum*** (Schreb.) Darbysh. (Poaceae)

Festuca arundinacea Schreb.

Schedonorus arundinaceus (Schreb.) Dumort.

U.S.A. GEORGIA. **Camden Co.:** S of Atkinson, NW of Tarboro, jct Old Hwy 259 and Old Merrow Community Rd, by Old Hwy 259, 31°03.869'N 81°52.940'W, plants loosely cespitose-rhizomatous, locally abundant, 29 Apr 2006, *R. Carter 16524* (VSC, others tbd).—Giannasi and Sweeney (2000) map this species in Georgia from only Long County. Thus, herein we provide a second county record and additional documentation of *L. arundinaceum* for Georgia. Although he maps it as wide-ranging in the United States and in surrounding southeastern states, Darbyshire (2007) does not include Georgia in the distribution of this species. More common in Georgia than herbarium records would indicate, this species has been observed frequently along roadsides in southern Georgia, where its infloresecences are readily observed in April and May prior to mowing.

†****Lupinus angustifolius*** L. (Fabaceae)

U.S.A. GEORGIA. **Treutlen Co.:** weed in bean field, 16 Jun 2004, *Stanley Culpepper s.n.* (VSC).—These data document the occurrence of this species in Georgia. According to Isley (1990), it is native to Mediterranean Europe, is cultivated for soil improvement and early spring forage, and is established to some extent in Florida and probably sporadically elsewhere in the southeastern United States.

Macranthera flammea (W. Bartram) Pennell (Scrophulariaceae) – T

U.S.A. GEORGIA. **Worth Co.:** Oakridge Farm, ca. 5.75 air mi ESE Anderson City, E of Sumner Rd, 31°20.964'N 83°45.844'W, shrubby edge along N side of drain, tributary of Warrior Creek, local, 27 Sep 2007, *R. Carter 18163 and W.W. Baker* (VSC); Jeffords Tract, 4.35 air mi NNW Anderson City, W of Old Hwy 33, 31.434561°N 83.868287°W, edge of drain within recently burned *Pinus palustris*-*Aristida stricta* community, plants local, 11 Sep 2008, *R. Carter 18531 and W.W. Baker* (VSC).—Alford and Anderson (2002) provide distributional data on this rare species, including the citation of a Worth County collection (*R.F. Thorne 6362*, NY) made in 1947. Our voucher data document the persistence and additional populations of *M. flammea* in Worth County. The Oakridge Farm population was first observed in 2002 by W.W. Baker. At this same site in 2007, *M. flammea* was observed flowering after a winter burn and associated with *Acer rubrum*, *Aster reticulatus*, *Clethra alnifolia*, *Cyrilla racemiflora*, *Eupatorium rotundifolium* L., *E. semiserratum* DC., *Ilex glabra*, *Magnolia virginiana*, *Nyssa biflora*, *Osmunda cinnamomea*, *Pinckneya bracteata*, *Pinus elliottii*, *Vaccinium corymbosum*, and *Woodwardia virginica*.

†***Manihot grahamii*** Hook. (Euphorbiaceae)

U.S.A. GEORGIA. **Colquitt Co.:** SW Moultrie, N of Lower Meigs Rd, off Walter Murphy Rd, Carlton Farms property, 31°08.664'N 83°48.558'

W, 12 Jul 2007, *R. Carter 17707 and W.W. Baker* (VSC). **Lowndes Co.:** Valdosta, W side of Jerry Jones Dr along S bank Two Mile Branch, vic. Joree Millpond outlet, shrub 3–4 m tall, locally abundant, 6 Sep 2008, *R. Carter 18527* (VSC, others tbd); Valdosta, S bank of One Mile Branch, between Wainwright St and Sustella Ave, ca. 100m E of Wainwright St, along city bike trail, shrub or small tree with broad spreading crown, 5–6 m tall, ca. 15 cm dbh, locally abundant, 6 Sep 2008, *R. Carter 18528* (VSC, others tbd).—Jones and Coile (1988) map this introduced shrub only in Miller County, and, in review, Dr. Loran C. Anderson (personal communication) brought to our attention a 1974 collection from Early County (*L.C. Anderson 3778*, FSU). Our observations of *M. grahamii* in woodlots and disturbed urban sites in southern Georgia indicate it is potentially invasive. It is also naturalized in Florida and Louisiana (Reese 1992; Wunderlin & Hansen 2003, 2008).

†***Melinis repens*** (Willd.) Zizka (Poaceae)
Rhynchelytrum repens (Willd.) C.E. Hubb.

U.S.A. GEORGIA. **Clinch Co.:** 2.9 mi ENE Stockton, CSX right-of-way S of Hwy US 84, 30.95292°N 82.96253°W, 16 Nov 2007, *R. Carter 18287 and W.W. Baker* (VSC, others tbd). **Echols Co.:** Mayday, along railroad right-of-way, just E Mayday Rd crossing, 30.82685°N 83.00892°W, 14 Oct 2008, *R. Carter 18656* (VSC, others tbd). **Lowndes Co.:** E of Valdosta by Howell Rd, railroad right-of-way just S of Howell Rd, vic. jct Howell Rd and Otter Creek Rd, UTM 17 294105E 3412428N (NAD27), plants locally abundant, 15 Oct 2003, *R. Carter 15165* (VSC, others tbd). **Ware Co.:** E Waycross, vic. jct Hwy US 82 and Driggers Lane, along railroad by N side of Hwy US 82, 31° 11.884'N 82°18.164'W, 21 Nov 2004, *R. Carter 15913* (VSC, others tbd).—Widely introduced in tropical and subtropical regions, this species is native to South Africa (Hitchcock & Chase 1951; Wipff 2003b). Natal grass was mapped from Lowndes and Echols counties in southern Georgia (Jones & Coile 1988; Sweeney & Giannasi 2000). Its dispersal has been observed along railroads and highways in recent years, and the preceding data document recent collections of *M. repens* in southern Georgia.

Mikania cordifolia (L.f.) Willd. (Asteraceae) – S (S1)

U.S.A. GEORGIA. **Camden Co.:** 3.1 mi N Kingsland jct Hwys US 17 and GA 40, 0.3 mi E jct Hwy US 17 and Harrietts Bluff Rd, 30°50.573' N 81°41.780'W, hydric hammock along creek, S side Harrietts Bluff Rd, 19 May 2005, *R. Carter 15964* (VSC-specimen sterile); 4 Nov 2005, *R. Carter 16329* (VSC, others tbd).—Holmes (2000) reported this species new to Georgia, based upon a Bryan County specimen. Herein, we document the second station and a new county record of *M. cordifolia* in Georgia.

†****Mitracarpus hirtus*** (L.) DC. (Rubiaceae)

U.S.A. GEORGIA. **Charlton Co.:** 5.67 air mi S Moniac jct Hwys GA 185 and GA 94, vic. creek crossing by Hwy GA 185, roadside, 30°26.497'N 82°11.898'W, 12 Oct 2006, *R. Carter 17286 and W.W. Baker* (VSC).—These voucher specimen data comprise the first report of this species from Georgia.

†***Orobanche minor*** Smith (Orobanchaceae) – FNW

U.S.A. GEORGIA. **Colquitt Co.:** SW corner of county, McCracken Farm, jct Hwy GA 202 and Luke Rd (CR 40), vic. milemarker 3, 31°05.237'N 83°57.196'W, residential yard along E side Hwy GA 202, locally common, 6 Apr 2003, *R. Carter 14821* (VSC). **Mitchell Co.:** Pelham, just E jct Cannon St and Castleberry St, 31°07.747'N 84° 09.421'W, 30 Apr 2003, *R. Carter 14920* (VSC). **Thomas Co.:** Ochlocknee, weedy roadside, about 100 yards E of SCL Railroad on Hwy GA 188, 13 May 1975, *J.A. Rollins s.n.* (VSC); same site, 22 Apr 1988, *R. Carter and S. Carter 6488* (GA, VSC); between Ochlocknee and Coolidge, 100–200 m E jct Hwy GA 188 and Hwy GA 202, right-of-way along Hwy GA 188, locally abundant, parasitic on *Hypochoeris brasiliensis*, 7 May 1993, *R. Carter 10708* (VSC); Coolidge, locally common in lawns and along streets, 21 May 1993, *R. Carter 10732, M. Overstreet and R. Eaton* (VSC).—A federally regulated noxious pest (Anonymous 2006), small broomrape is native to the Middle East and North Africa and is parasitic on tobacco, clover, and tomatoes (Miller et al. 1997). Duncan (1985) reported it from Baker County, Georgia, based upon a 1983 collection, and Jones and Coile (1988) mapped it only in Baker County. The data reported herein substantiate this species from additional Georgia counties. Also, there are reliable anecdotal reports of small broomrape from Pavo, Brooks County, near the Brooks-Thomas county line from where it has ostensibly been eradicated.

Orobanche uniflora L.

U.S.A. GEORGIA. **Colquitt Co.:** Moultrie, vicinity of Spence Field, N of Hwy GA 33, mown area around buildings adjacent to main runway, 22 Apr 1988, *R. Carter and S. Carter 6486* (GA, VDB, VSC). **Lowndes Co.:** Moody Air Force Base, mowed area along edge of woods, vicinity Mission Pond picnic shelter, 9 Apr 1994, *R. Carter 11700 and C. Wilson* (VSC); Hahira, 303 Lee Street, in lawn, 11 Apr 1994, *C. Wilson 113* (VSC); N Valdosta, ca. 150 m S jct Staten Rd and Orr Rd, along E side State Rd, locally abundant, 30.922147°N 83.291225°W, 5 Apr 2009, *R. Carter 18791* (VSC). **Thomas Co.:** weedy roadside in Ochlocknee, just E of railroad track along Hwy GA 188, local, 9 Apr 1988, *R. Carter 6475* (GA, VDB, VSC); Hwy US 84, W of Thomasville, at entrance to River Creek Wildlife Management Area, locally abundant along S side Hwy US 84, 30.87667°N 84.06081°W, 17 Apr 2009, *R. Carter 18792 and P. Bauer* (VSC). **Tift Co.:** Tifton, northern end of town along Missouri Avenue, near intersection of Hwy 41 and 20th Street, locally abundant in lawns, 12 Mar 1990, *L. Taylor 043* (VSC). **Worth Co.:** Sylvester, corner of Hwy US 82 W and Isabella Street, Jeffords Park, 11 April 1992, *L. Taylor s.n.* (VSC).—This species was not mapped for the Georgia coastal plain by Jones and Coile (1988). However, in 1988 it was discovered in Colquitt County in the coastal plain by Ms Edna Virgo, USDA, APHIS PPQ, Moultrie, GA, and was reported by Musselman (1988) without citation of a voucher specimen. Subsequently, it has been found in three additional coastal plain counties, where its primary host is *Hypochaeris chillensis* (Kunth) Britt., a widespread and common lawn weed. However, in one case Ms Lynn Taylor (personnal communication) noted and collected an apparent haustorium-root connection with centipede grass! These voucher specimen data document the occurrence of *O. uniflora* from additional counties in the Coastal Plain Region of Georgia.

†***Oxycaryum cubense*** (Poepp. & Kunth) Palla fo. ***paraguayense*** (Maury) Pedersen (Cyperaceae)

U.S.A. GEORGIA. **Seminole Co.:** Lake Seminole, 30.76063°N 84.89085°W, common and locally abundant in floating batteries along edge of lake, 22 Jul 2008, *R. Carter 18461 with W.W. Baker and D. Morgan* (VSC, others tbd).—This aquatic sedge was first reported from Georgia by Carter in Bryson et al. (1996) and was recently reported as an invasive weed along the Tennessee-Tombigbee Waterway in east-central Mississippi and adjacent west-central Alabama (Bryson et al. 2008). Herein, we report an additional and second county record of *O. cubense* from Georgia.

†****Paederia foetida*** L. (Rubiaceae)

U.S.A. GEORGIA. **Camden Co.:** E side I-95 between river and welcome station, Exit 1, mixed with Carolina jasmine, Virginia creeper, briars, grapevine, 30 Jun 1998, *A.E. Miller AEM-PD-04* (VSC). **Lowndes Co.:** Valdosta, Michael Terrace, weed in residential yard, locally common vine on foundation shrubs, 1 Aug 2002, *R. Carter 14659* (VSC, others tbd). **Thomas Co.:** Greenwood Plantation, low pine woods, burned annually, 27 Jul 1983, *R. Komarek s.n.* (TTRS); Thomasville, 105 Boston Rd, yard, 25 Jun 1998, *A.E. Miller AEM-PD-03* (VSC).—These voucher specimen data provide documentation of skunkvine in Georgia. This Asian introduction is widely distributed in Florida (Wunderlin & Hansen 2008), where it is listed as a Category I exotic invasive species (FLEPPC 2007).

Palafoxia integrifolia (Nutt.) Torr. & A. Gray (Asteraceae) – S(S2?)

U.S.A. GEORGIA. **Brooks Co.:** ca. 4.3 air mi E of Nankin, flatwoods along Rocky Ford Rd, ca. 0.2 mi E Nankin Rd, 30°39.095'N 83°24.619'W, 7 Nov 2003, *R. Carter 15270* (VSC). **Camden Co.:** vic. Kingsland, Scrubby Bluff Rd, 30°46.354'N 81° 40.120'W, sandscrub, 14 Oct 2006, *R. Carter 17316 and W.W. Baker* (VSC); 4.52 air mi SW Tarboro, 0.1 mi SE jct Old Hwy 259 and Midriver Road, 30.99055°N 81.87205°W, sandy upland, locally common, 14 Oct 2008, *R. Carter 18664* (VSC, others tbd). **Charlton Co.:** just E Folkston, N Hwy GA 40, vic. Peoples Baptist Church, 30°50.529'N 81°58.559'W, sandridge, 3 Oct 2003, *R. Carter 15115* (VSC); 2.86 air mi S Moniac jct Hwys GA 185 and GA 94, W side Hwy GA 185, between Hwy GA 185 and St. Marys River, 30°28.944'N 82°11.941'W, 12 Oct 2006, *R. Carter 17282 and W.W. Baker* (VSC); Devils Elbow TNC Preserve, 30°46.406'N 82°01.718'W, 13 Oct 2006, *R. Carter 17302 and W.W. Baker* (VSC). **Lanier Co.:** NE of

Lakeland, E of Hwy GA 135 by Linda St, disturbed sand ridge, vic. borrow pit and powerline, local, 5 Sep 2002, *R. Carter 14748* (VSC).—This species is infrequent to rare on dry sandy sites where it is associated with *Aristida stricta*, *Asclepias humistrata* Walter, *Asimina incana* (W. Bartram) Exell, *Berlandiera pumila* (Michx.) Nutt., *Carphephorus corymbosus* (Nutt.) Torr. and A. Gray, *Ctenium floridanum*, *Cyperus plukenetii* Fern., *Eryngium aromaticum*, *Pinus palustris*, *Quercus hemisphaerica*, *Q. incana*, *Q. laevis*, *Q. margaretta*, *Q. nigra*, *Q. pumila*, and *Serenoa repens*.

†***Panicum maximum*** Jacq. (Poaceae)
Urochloa maxima (Jacq.) R.D. Webster
Megathyrsus maximus (Jacq.) B.K. Simon & S.W.L. Jacobs

U.S.A. GEORGIA. **Lowndes Co.:** SW of Kinderlou, 30°46.835'N 83°22.989'W, small opening in pine plantation, common, 6 Sep 2007, *R. Carter 18007 and W.W. Baker* (VSC, others tbd). **Thomas Co.:** Boston-Monticello Rd, 0.9 mi NW jct with Mitchell Rd, 30°41.367'N 83°47.943'W, locally common in ditch adjacent to woods, 17 Sep 2006, *R. Carter 17221* (VSC, others tbd).—These data provide additional county records for this robust tropical American panic grass that Sweeney and Giannasi (2000) map in only Spalding County.

†****Panicum repens*** L.

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, dredge disposal area ca. 300 m southeast of U.S.S. Kamehameha Ave and ca. 1.25 air mi west of Warrior Wharf, 30°47'25"N 81°31'06"W, steep embankment along service road atop dike, common, 8 Jul 1996, *R. Carter 13072* (VSC, others tbd); Kings Bay Submarine Base, flatwoods along edge of cypress-gum wetland, 0.5 mi W jct U.S.S. Mariano Vellajo Ave and U.S.S. Sam Houston Rd, 30°48'13"N 81°33'12"W, locally abundant, 22 Aug 1996, *R. Carter 13586* (VSC, others tbd); just N Woodbine, N of Satilla River, W of Hwy US 17, 30°58.615'N 81°43.607'W, disturbed area below bridge, local, 20 May 2006, *R. Carter 16656 and W.W. Baker* (VSC); St. Marys, vic. public boat ramp at end of E. Meeting St, 30°43.937'N 81°32.394'W, open disturbed sand, common, 18 Aug 2006, *R. Carter 17149 and W.W. Baker* (VSC). **Chatham Co.:** S Savannah, ditch along W side Veterans Parkway, 3.4 mi N jct Hwy GA 204 and Veterans Parkway, 32°01.249'N 81°10.384'W, locally abundant in ditch and along roadbank, 14 Jul 2006, *R. Carter 16950* (VSC, others tbd). **Colquitt Co.:** Moultrie, 1.4 mi N jct Hwys US 319 and GA 33, 31°07.971'N 83°46.288'W, ditch along W side Hwy US 319, locally abundant, 18 Jun 2004, *R. Carter 15375* (VSC, others tbd). **Cook Co.:** Adel, just W jct I-75 and Hwy GA 37, 31°08.248'N 83°26.532'W, ditch slope along S side Hwy GA 37, locally abundant, 18 Jun 2004, *R. Carter 15377* (VSC, others tbd). **Glynn Co.:** Anguilla, jct Hwy GA 99 and GA 32, 31°15.325'N 81°36.217'W, open swale along right-of-way, locally common in standing water, 13 Jul 2003, *R. Carter 15024* (VSC, others tbd). **Lowndes Co.:** 1.5 mi S Cecil by Hwy US 41, 31°01.015'N 83°22.724'W, locally abundant in shallow ditches on both sides of Hwy US 41, 18 Jun 2004, *R. Carter 15378* (VSC, others tbd); Valdosta, Valdosta State University campus, 30°50.495'N 83°17.811'W, moist slope adjacent to playing field along One Mile Branch, W of Sustella Ave, 2 Nov 2004, *R. Carter 15837* (VSC, others tbd). **Worth Co.:** Poulan, N Hwy US 82, E jct Whidden Mill Rd and Hwy US 82, 31°31.646'N 83°47.739'W, ditch and road berm along Whidden Mill Rd, locally abundant, 22 Jul 2005, *R. Carter 16053* (VSC, others tbd).—These voucher specimen data document the distribution *P. repens* and its recent dispersal in Georgia. Although a common weed along roadside ditches in Florida and along the Gulf Coast westward into eastern Texas and listed as a Category I invasive weed in Florida and as a Noxious Weed in Alabama, Arizona, Hawaii, and Texas (USDA Plants Database 2008), torpedo grass was scarcely known from Georgia until recently (cf. Freckmann & Lelong 2003b). Jones and Coile (1988) did not map it at all, and Sweeney and Giannasi (2000) show it only in Crisp County. Moreover, there were no specimens of *P. repens* from Georgia at VSC until 1996; therefore, the 1996 vouchers cited above probably represent the first collections for the state.

Panicum sphagnicola Nash
D. sphagnicola (Nash) LeBlond

U.S.A. GEORGIA. Camden Co.: Kings Bay Submarine Base, 1.22 air mi WNW of St. Marys Gate, wetland along E side of cypress-gum strand, S of unmarked dirt trail, 30°46'17"N 81°33'59"W, Harrietts Bluff 7.5' USGS quadr., elev. 20–25 ft, 5 Sep 1996, *R. Carter 13654* (VSC, others tbd). **Lanier Co.:** Moody Air Force Base, Winnersville

Bombing Range, along eastern end of crescent-shaped wetland, locally common, 15 Oct 1994, *R. Carter 12345* (VSC, others tbd).—These voucher specimen data document additional records of this distinctive grass in Georgia (LeBlond 2001), which was not mapped by Sweeney and Giannasi (2000). Freckmann and Lelong (2003a) treat *P. sphagnicola* as a synonym of *Dichanthelium dichotomum* (L.) Gould subsp. *lucidum* (Ashe) Freckmann & Lelong. *Panicum sphagnicola* occurs in open grass-sedge dominated habitats along shrubby wetland margins, with *Acer rubrum*, *Carex* spp., *Eriocaulon* sp., *Hypericum cistifolium*, *Ilex glabra*, *Juncus* spp., *Lyonia lucida*, *Morella cerifera*, *Nyssa biflora*, *Panicum* sp., *Persea palustris*, *Pinus elliottii*, *Pluchea* sp., *Rhexia* sp., *Rhynchospora* spp., *Sarracenia minor*, *Serenoa repens*, *Taxodium ascendens*, *Vaccinium corymbosum*, and *Xyris* spp.

Panicum tenerum Beyrich ex Trin. – S(S1)

U.S.A. GEORGIA. **Turner Co.:** 2.3 mi W of Irwin-Turner county line, along north side Hwy GA 107, ca. 31°43'24"N 83°29'39"W, seasonally wet pond embedded in sand ridge, margin of pond, locally common, 1 Aug 1995, *R. Carter 12591* (VSC).—These voucher specimen data substantiate an additional county record for this rare grass, which, in Georgia, was previously known from only Miller County (Sweeney & Giannasi 2000). See *Litsea aestivalis* for associates.

****Panicum virgatum*** L. var. ***cubense*** Griseb.

U.S.A. GEORGIA. **Talbot Co.:** 4.0 mi S of Geneva by Hwy GA 41, Upatoi Creek bottom, N side of creek, locally common, open sandy creek bank, 13 Aug 2002, *R. Carter 14685 and R. Kral* (VSC, others tbd).—Although Hitchcock and Chase (1951) indicate its distribution as extending from Massachusetts to Florida, Freckmann and Lelong (2003) dismissed *P. virgatum* var. *cubense* as an "end point" of clinal variation, and others have not recognized this distinctive variety of *P. virgatum*. Since it has not been treated as a component of the state's flora (cf. Jones & Coile 1988; Sweeney & Giannasi 2000), herein we provide voucher collection data documenting its occurrence in Georgia.

†****Parthenium hysterophorus*** L. (Asteraceae)

U.S.A. GEORGIA. **Colquitt Co.:** ca. 1.5 air mi SSE Berlin center, S of Hwy GA 133 by Scott Cemetery Rd, vic. Mahadev Temple, UTM 17 251630E 3437611N (NAD27), USGS Berlin East quadr., locally abundant weed around farm buildings, 18 Oct 2003, *R. Carter 15169* (VSC, others tbd).—Although wide-ranging and a common weed in some parts of the United States, especially in the mid-portion of the country, *P. hysterophorus* has not been reported previously from Georgia (Jones & Coile 1988; Strother 2006b).

†****Paspalum malacophyllum*** Trin. (Poaceae)

U.S.A. GEORGIA. **Grady Co.:** Sherwood Plantation, 0.9 mi N of Rocky Hill Church, old field land with sandy-loam soil, 6 Sep 1991, *A. Gholson, Jr. 12447 with W. Baker* (TTRS); Sherwood Plantation by Meridian Rd, locally abundant in old field and adjacent cut-over pineland, both annually burned, 10 Jul 1992, *R.K. Godfrey 84321 with A. Gholson and H.L. Stoddard, Jr.* (VSC).—Sweeney and Giannasi (2000) do not include this species.

†***Pavonia hastata*** Cav. (Malvaceae)

U.S.A. GEORGIA. **Camden Co.:** 0.15 mi S Jerusalem jct Bailey Mill Rd and Owen Mill Rd, by Bailey Mill Rd, 30°58.432N 81°50.572W, disturbed edge of mesic flatwoods, locally common, 30 Jun 2006, *R. Carter 16903 and W.W. Baker* (VSC, others tbd).—This South American species is introduced in Mexico and Australia and the southeastern United States, where it was previously known only from Charlton County, Georgia, and Citrus and Levy counties in Florida (Fryxell 1988; Jones & Coile 1988; Wunderlin & Hansen 2008). Herein we provide data for the second county record of *P. hastata* in Georgia.

†****Pectis prostrata*** Cav. (Asteraceae)

U.S.A. GEORGIA. **Camden Co.:** Kingsland, Hwy I-95 rest stop and welcome center along E side northbound lane, 30.75313°N 81.64894°W, 17 Nov 2007, *R. Carter 18304 and W.W. Baker* (VSC, others tbd).—Keil (2006) reported this species from Mexico, the West Indies, Central America, and in the United States from Florida, Louisiana, Texas, and westward into Arizona and predicted its northward dispersal out of Florida. The collection data reported herein comprise the first report of *P. prostrata* from Georgia, where it was locally abundant, forming extensive mats in a mowed area along a parking lot at an interstate rest stop.

Pedicularis canadensis L. (Scrophulariaceae)

U.S.A. GEORGIA. **Camden Co.:** ca. 6.0 air mi W of Kingsland by Hwy GA 40, just W of Temple Creek Rd and E of Temple Creek, cemetery at Temple Creek Church, 30°48.571'N 81°47.324'W, locally abundant in cemetery and adjacent woods, 25 March 2006, *R. Carter 16425* (VSC, others tbd). —This species is distributed primarily in northern Georgia and in three counties in the Chattahoochee-Flint River drainage in the southwestern part of the state (Jones & Coile 1988). In Florida it is mapped in the panhandle with an outlier in Clay County (Wunderlin & Hansen 2008). The data reported herein comprise the first record of *P. canadensis* from the southeastern quadrant of Georgia.

Penthorum sedoides L. (Crassulaceae)

U.S.A. GEORGIA. **Camden Co.:** 1.86 air mi NNE Whiteoak jct Hwys US 17 and GA 252, 1.12 air mi W of Red Bluff by Oscar Rd, 31°03.124'N 81°42.651'W, swampforest along creek, locally common, 22 Sep 2006, *R. Carter 17261 and W.W. Baker* (VSC, others tbd).—According to Jones and Coile (1988), this species is not known from the southeastern quadrant of Georgia, and the nearest stations are in southwestern Georgia and Screven County along the Savannah River. Moreover, it is mapped in Florida only from the panhandle (Wunderlin & Hansen 2008). These data document an outlying population of *P. sedoides* and the first collection from southeastern Georgia.

Phragmites australis (Cav.) Trin. ex Steud. (Poaceae)

U.S.A. GEORGIA. **Camden Co.:** 0.6 mi S of Woodbine jct Hwys US 17 and GA 110, along E side Hwy GA 110, 30°57.845'N 81°44.005'W, local in marshy wetland, 22 Sep 2006, *R. Carter 17258 and W.W. Baker* (VSC, others tbd). **Seminole Co.:** Lake Seminole, 30.75515°N 84.89085°W, locally common along edge of lake, plants 4-5 m tall, with drooping inflorescences, 22 Jul 2008, *R. Carter 18460, W.W. Baker and D. Morgan* (VSC, others tbd); Lake Seminole, 30.74997°N 84.88372° W, locally abundant along edge of lake, plants 7–8 m tall, 20 Nov 2008, *R. Carter 18733, W.W. Baker and D. Morgan* (VSC, others tbd).—Although widely distributed throughout North America, the distribution of this species does not include Georgia in *The Flora of North America* (Allred 2003a), and Sweeney and Giannasi (2000) mapped it only in Glynn County. Herein, we report two additional county records for Georgia: one from along the Atlantic coast in Camden County and the other from the Gulf Coastal Plain in Seminole County. Our specimens are of two types. Those from Camden County along the Atlantic coast are less robust plants with smaller, more-or-less erect, purplish inflorescences and appear to be either the non-native, invasive *P. a.* ssp. *australis* or the native, northern *P. a.* ssp. *americanus* Saltonstall, Peterson & Soreng. Ligules (including cilia) on these specimens exceed the range given for *P. a.* ssp. *australis*, but the lower glumes (2.5 mm) are shorter than allowed for *P. a.* ssp. *americanus*. Thus, we could not reliably place them using keys in Saltonstall et al. (2004) and Barkworth et al. (2007). Our plants from Seminole County in the Gulf Coastal Plain—considerably more robust with larger, nodding, tan inflorescences—fit *P. a.* ssp. *berlandieri* (Fourn.) Saltonstall & Hauber, the native Gulf Coast taxon. Ward and Jacono (2009) provide an informative discussion and key for the two native taxa that occur in Florida, but lacking from their key is the non-native, invasive *P. a.* ssp. *australis*.

Physostegia leptophylla Small (Lamiaceae) – S (S2S3)

U.S.A. GEORGIA. **Bryan Co.:** Ft. Stewart Military Reservation, floodplain along Ogeechee River, 0.25 mi SE of Jct. FS 60 and FS 61, elev. 2–5 m, rare, 4 Aug 1992, *R. Carter 10264 and J. Lusk* (VSC); Ft. Stewart Military Reservation, vic. Kelly's Landing, bank of Ogeechee River, elev. ca 2 m, locally common, 5 Aug 1992, *R. Carter 10290 and J. Lusk* (VSC). **Camden Co.:** ca. 4.5 air mi SSE of Jerusalem, vic. Jim Baileys Mill, 30°55.442' N 81°49.263'W, floodplain woods along Satilla River, locally common, 20 May 2006, *R. Carter 16696 and W.W. Baker* (VSC).—These data provide additional documentation of this rarely collected species in Georgia, where it was observed in fine-textured soils of frequently flooded floodplain forests along tidal coastal rivers. Associates include *Acer rubrum*, *Alnus serrulata* (Aiton) Willd., *Amorpha fruticosa* L., *Betula nigra* L., *Carex intumescens* Rudge, *C. louisianica* L.H. Bailey, *Carya aquatica* (Mill.) Sweet, *Celtis laevigata*, *Cephalanthus occidentalis*, *Eryngium aquaticum* L., *Fraxinus caroliniana*, *Gleditsia aquatica* Marshall, *Hibiscus laevis* All., *Leucothoe racemosa*, *Peltandra virginica* Raf., *Planera aquatica* J.F.

Gmel., *Platanthera flava* (L.) Lindl., *Polygonum sagittatum* L., *Quercus laurifolia*, *Q. lyrata* Walter, *Sabal minor*, *Salix caroliniana* Michx., *Sebastiania fruticosa* (Bartram) Fernald, *Selaginella apoda* (L.) Spring, and *Taxodium distichum*.

Pinguicula primuliflora C.E. Wood & R.K. Godfrey (Lentibulariaceae) – T

U.S.A. GEORGIA. **Taylor Co.:** 3.2 mi N of Rupert by Hwy US 19 to just north of Whitewater Creek, then E 2.1 mi by gravel road S2093, in sphagnous mat on small island in cool clear tributary of Whitewater Creek, 23 Apr 1989, *R. Carter 7818 and T. Patrick* (VSC); 6.1 mi S of Butler by Hwy GA 137, Atlantic white cedar swamp along Little Whitewater Creek, shallow sandy highly branched spring-fed tributary of Little Whitewater Creek, 25 May 1991, *R. Carter 8675 and M.W. Morris* (VSC).— Jones and Coile (1988) mapped this in Georgia from only Early County. Herein, we report the second county record of this species from the state. Associates of *P. primuliflora* at the Taylor County sites were *Acer rubrum*, *Alnus serrulata*, *Chamaecyparis thyoides* (L.) Britt. et al., *Ilex coriacea*, *Itea virginica*, *Leucothoe racemosa* (L.) A. Gray, *Liriodendron tulipifera*, *Lyonia lucida*, *Magnolia virginiana*, *Nyssa biflora*, *Sarracenia rubra* Walter, and *Xanthorhiza simplicissima* Marshall.

Plantago sparsiflora Michx. (Plantaginaceae) – S (S2)

U.S.A. GEORGIA. **Camden Co.:** 6.5 mi SE Kingsland by M.L. King Blvd, 2.8 mi SE Camden County High School, 1.0 mi NW jct Hwy GA 40 and Colerain Rd by Colerain Rd, then 0.24 mi E jct Colerain Rd and Co. Rd 78 by Co. Rd 78, 30° 48'02"N 81°36'34"W, locally common roadshoulder and edge of swamp, 25 Oct 1996, *R. Carter 13952* (VSC, others tbd); S of Atkinson, NW of Tarboro, jct Old Hwy 259 and Old Merrow Community Rd, by Old Hwy 259, 31°03.869'N 81° 52.940'W, plants loosely cespitose-rhizomatous, locally common, roadside, 29 Apr 2006, *R. Carter 16516* (VSC, others tbd); 2.4 mi S Jerusalem jct Bailey Mill Rd and Owen Mill Rd, by Bailey Mill Rd, locally common along road and in disturbed flatwoods, 30°56.540'N 81°50.871'W, 30 Jun 2006, *R. Carter 16901 and W.W. Baker* (VSC). **Charlton Co.:** 3.7 mi ENE Folkston by Hwy GA 40, 0.6 mi ENE powerline right-of-way, roadside, locally common, 8 Apr 2001, *R. Carter 14476* (VSC, others tbd); just NW of Homeland along Old Dixie Hwy, vic. hydric barrowpit along W side of road, roadside, locally common, 30°52.298'N 82° 02.665'W, 22 Oct 2003, *R. Carter 15240* (VSC, others tbd).—Harper (1903b) commented on the rarity of *P. sparsiflora* in Georgia. Although it has a restricted range in southeastern Georgia, it is occasional to common and sometimes locally abundant there. In fact, after a point it seemed counterproductive to make additional voucher specimens documenting populations from these counties. It was almost invariably found along mowed roadsides and nowhere else; however, one population *(Carter 16901 and Baker)* did extend some distance away from a dirt road into adjacent cut-over mesic flatwoods with a pine-hardwood mixture.

****Polygala crenata*** C.W. James (Polygalaceae)

U.S.A. GEORGIA. **Charlton Co.:** Devil's Elbow Natural Area, vic. Traders Hill, 30°45.863'N 82° 01.291'W, clay-based seasonal wetland, 8 Jun 2006, *R. Carter 16758 and W.W. Baker* (VSC).— Wunderlin and Hansen (2008) map it in most of the counties of the Florida Panhandle, including those along the southwestern boundary of Georgia; however, Jones and Coile (1988) do not map this species for Georgia.

****Polygonum meisnerianum*** Cham. & Schltdl. var. ***beyrichianum*** (Cham. & Schltdl.) Meisn. (Polygonaceae) – S(S1?)

Persicaria meisneriana M. Gómez var. *beyrichiana* (Cham. & Schltdl.) C.C. Freeman

U.S.A. GEORGIA. **Brooks Co.:** 12.1 air mi SW Quitman jct Hwys US 84 and US 221, 0.55 mi SW Grooverville Cemetery, vic. Aucilla River bridge on Old Grooverville Rd, 30°42.743'N 83°44.692' W, floodplain along E bank of river, swamp forest, locally common along S side bridge, clambering vine, 17 Sep 2006, *R. Carter 17223* (VSC).— This species was first observed at this site by W.W. Baker in 1995, and the voucher specimen data cited herein document its occurrence in Georgia.

Prenanthes autumnalis Walter (Asteraceae)

U.S.A. GEORGIA. **Appling Co.:** 8.8 mi N Baxley by E side Hwy US 1, powerline right-of-way, gentle seepage slope, sandy loam, 29 Oct 2005, *R. Carter 16293 and R. Kral* (VSC). **Camden Co.:** 0.81 mi S Tarboro jct Hwy GA 252 and Refuge Rd, by

Owens Ferry Rd, 31.00178°N 81.80392°W, local, 8 Nov 2007, *R. Carter 18261* (VSC); NW Seals, 0.2 mi S jct Old Jefferson Rd and Groover Rd, Tiger Island, 30.90208°N 81.72553°W, open edge flatwoods adjacent to cypress-gum depression, infrequently mowed strip along E side Old Jefferson Rd, under powerline, with *Acer rubrum, Anthaenantia rufa, Erigeron vernus, Ilex glabra, Lobelia glandulosa, Morella cerifera, Osmunda cinnamomea, Persea palustris, Pinus elliottii, P. palustris, P. serotina, P. taeda, Polygala lutea, Pteridium aquilinum, Quercus nigra, Q. pumila,* 17 Nov 2007, *R. Carter 18312 and W.W. Baker* (VSC). —Jones and Coile (1988) show only two counties in Georgia, Toombs and Laurens. Herein, we report two additional county records of *P. autumnalis*, both in the Lower Coastal Plain.

†****Pseudognaphalium luteoalbum*** (L.) Hilliard & B.L. Burtt

U.S.A. GEORGIA. **Brooks Co.:** Hwy US 84, 0.45 mi W Dixie jct, 30.79239°N 83.67565°W, 12 Jun 2008, *R. Carter 18403* (VSC, others tbd). **Camden Co.:** Hwy GA 40, 0.3 mi W jct Hwy GA 40 and Springhill Rd, 30.81068°N 81.83528°W, locally abundant on roadshoulder along S side Hwy GA 40, 30 Apr 2008, *R. Carter 18363 and W.W. Baker* (VSC, others tbd). **Charlton Co.:** 5.6 mi S Racepond jct Hwy US 17 and Hwy GA 15/121, 0.3 mi N Spanish Creek, 30.92457°N 82.09232°W, locally abundant along roadside, 29 Apr 2008, *R. Carter 18360 and W.W. Baker* (VSC, others tbd). **Clinch Co.:** 2.5 mi E Dupont, Hwy US 84, ca. milemarker 9, 31.01153°N 82.84188°W, locally abundant along weedy roadside, 29 Apr 2008, *R. Carter 18353 and W.W. Baker* (VSC, others tbd). **Crisp Co.:** Hwy I-75, 1.67 mi S of Arabi exit, 31.81202°N 83.70812°W, disturbed ground in median, locally abundant, 20 May 2009, *R. Carter 18861 and J. Carter* (VSC, others tbd). **Lowndes Co.:** 3.1 mi W Naylor, Hwy US 84, between milemarker 20–21, 30.88958°N 83.12589°W, locally abundant along road shoulder, 29 Apr 2008, *R. Carter 18351 and W.W. Baker* (VSC, others tbd). **Thomas Co.:** Hwy US 84, 1.7 mi E Thomasville jct Hwy US 84 and Hwy US 19, 30.82815°N 83.91777°W, 12 Jun 2008, *R. Carter 18400* (VSC, others tbd). **Tift Co.:** Tifton, W side I-75 at Southwell Blvd (exit 59), 31.41676°N 83.50610°W, locally abundant along roadside, 20 May 2009, *R. Carter 18858 and J. Carter* (VSC, others tbd).—This weed is widespread in the Old World and has been reported from southern Florida, Arkansas, Louisiana and west into California, Oregon and Washington, but populations have not been previously documented from Georgia (Wunderlin & Hansen 2003, 2008; Nesom 2004, 2006a). Timing of field work relative to mowing of highway rights-of-way would seem to be critical in detecting this species. Although locally abundant along extensive stretches of highway in southern Georgia, *P. luteoalbum* would probably have gone undetected had mowing occurred just prior to our activity.

†***Pteris vittata*** L. (Pteridaceae)

U.S.A. GEORGIA. **Camden Co.:** 4.45 air mi SSE Kingsland jct Hwy US 17 and Hwy GA 40, open ruderal site below I-95 bridge near bank of St. Marys River, 30°44.706'N 81°39.186'W, 18 Aug 2006, *R. Carter 17156 and W.W. Baker* (VSC).—Herewith, we report voucher data for an additional Georgia county for this naturalized species that Sweeney and Giannasi (2000) map only in Echols and Chatham counties. Stanford and Diggs (1998) added this Asian fern to the Texas flora, and Woods and Diamond (2003) reported a range extension in southern Alabama.

Pteroglossaspis ecristata (Fern.) Rolfe (Orchidaceae) – T, S(S1)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base; ca. 0.35 mi (air) ENE of south end of U.S.S. Kamehameha Avenue, Davis Farm, meadow-like, annually mowed, open field, Harrietts Bluff 7.5' quadr., elev. 5–10 ft, 30°45' 35"N 81°30'40"W, local, 13 Sep 1996, *R. Carter 13710* (VSC). **Charlton Co.:** Devil's Elbow Natural Area, vic. Traders Hill, 30°46.406'N 82°01.718'W, degraded sandridge planted in *Pinus taeda*, with *Pinus palustris, Quercus laevis, Q. incana, Q. margaretta, Q. geminata, Serenoa repens, Rhus copallinum, Asimina incana, Palafoxia integrifolia, Eryngium aromaticum*, single fruiting specimen from previous season observed and photographed, 13 Oct 2006, *R. Carter and W.W. Baker s.n.* (VSC-photograph only, no voucher). **Worth Co.:** 1.2 mi W jct Sumner Rd and Phillip Causey Rd by Philip Causey Rd, elev. ca. 320 ft, 31°21.804'N 83°47.219'W, 27 Sep 2007, *R. Carter 18147 and W.W. Baker* (VSC).—Although Romero-Gonzalez (2002) does not include Georgia in the distribution of this species, Sweeney and Giannasi (2000) map it in four counties in eastern Georgia: Brantley, Long, McIntosh and Tatnall.

Herein, we report additional county records of this state-listed rare species.

Pycnanthemum floridanum Grant & Epling (Lamiaceae)

U.S.A. GEORGIA. **Camden Co.:** 4.9 mi S Woodbine jct Hwy US 17 and Hwy GA 110, vic. milemarker 11, USGS Woodbine quadr., UTM 17 432019E 3418917N (NAD27), W side Hwy US 17, locally abundant, 22 Jun 2007, *R. Carter 17648* (VSC, others tbd).—Coile and Garland (2003) cited *P. floridanum* among Florida's threatened and endangered plants, and, in Georgia, Jones and Coile (1988) show this essentially Floridian species only in Glynn County. Thus, herein, we report an additional Georgia county record for *P. floridanum*.

Quercus austrina Small (Fagaceae) – S(S3?)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, 0.5 mi (air) NNW of south end of U.S.S. Kamehameha Ave, scrub hammock along north side Torpedo Magazine access road, W of U.S.S. Kamehameha Ave, between U.S.S. Kamehameha Ave and Torpedo Magazine, 30°45' 55"N 81°31'05"W, Harrietts Bluff 7.5' quadr., elev. 10–15 ft, rare, 13 Sep 1996, *R. Carter 13704* (VSC, others tbd); John Baileys Mill (USGS Jerusalem, GA, quadr.), SE of Magnolia Bluff via Bailey Mill Rd to John Bailey Mill Rd, near end of John Bailey Mill Rd, mesic hammock along bank of Satilla River, 30°54.621'N 81°51.868'W, 13 Sep 2007, *R. Carter 18089 and W.W. Baker* (VSC, others tbd).—These data provide additional documentation of this rare species in Georgia. At Kings Bay, *Carter 13704* was found in a scrub hammock with *Bejaria racemosa*, *Carya glabra*, *Ilex ambigua* (Michx.) Torr., *I. opaca*, *Lyonia ferruginea*, *L. lucida*, *Morella cerifera*, *Osmanthus americanus* (L.) Benth. & Hook.f. ex A.Gray, *Persea borbonia* (L.) Spreng., *Quercus chapmanii*, *Q. geminata*, *Q. myrtifolia*, *Q. nigra*, *Q. virginiana*, and *Serenoa repens*. *Carter 18089 and Baker* was taken in a mesic hammock with *Carya glabra*, *Crataegus marshallii* Eggl., *Liquidambar styraciflua*, *Nyssa sylvatica* Marsh., *Pinus taeda*, *P. glabra*, *Quercus alba*, *Q. hemisphaerica*, *Q. virginiana*, *Sabal minor*, *S. palmetto* and *Viburnum obovatum* Walter.

Quercus chapmanii Sarg. – S(S2)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, ca. 100 m W of western finger of Etowah Pond, ca. 600 m SW Etowah Park dock and launch, 30°49'01"N 81°32' 49"W, Harrietts Bluff 7.5' USGS quadr., elev. 20–25 ft, local, 2 Jul 1996, *R. Carter 13008* (VSC); Kings Bay Submarine Base, ca. 300 m S of perimeter road along northern boundary of base, W of golf course, ca. 0.75 mi (air) N of golf course club house, 30°50'03"N 81°33'27"W, Harrietts Bluff 7.5' USGS quadr., elev. 20–25 ft, 28 Aug 1996, *R. Carter 13608* (VSC); Kings Bay Submarine Base, ca. 0.70 mi (air) NNW of southern end of U.S.S. Kamehameha Ave, scrub hammock along W side of U.S.S. Kamehameha Ave, between U.S.S. Kamehameha Ave and North River, and between DOSF and Torpedo Magazine, 30°46'01"N 81°31' 06"W, Harrietts Bluff 7.5' USGS quadr., elev. 10–15 ft, 29 Aug 1996, *R. Carter 13612* (VSC, others tbd), 25 Oct 1996, *R. Carter 13949* (VSC, others tbd). **Ware Co.:** 13.9 mi W of Waycross, then 1.7 mi N of Hwy US 82 by dirt road, sandridge S of Satilla River, 2 Sep 1987, *R. Carter 6286* (VSC, others tbd); vic. Talmo, sandridge along W side Hwy GA 158 and S of main channel of Satilla River, 31°18.007'N 82°33.574'W, 12 Nov 2006, *R. Carter 17392 and S. Carter* (VSC, others tbd).—These data document additional occurrences of this species which reaches the northern limit of its range in southeastern Georgia and is considered to be rare in the state.

Rhexia nuttallii James (Melastomataceae) – S (S1?)

U.S.A. GEORGIA. **Camden Co.:** vic. Clarks Bluff, “Piney Bluff”, 30.77457°N 81.78306°W, 21 Jul 2006, *R. Carter 17077 and W.W. Baker* (VSC); Colerain-May Bluff Rd, 4.1 mi N Hwy GA 40, 30.83633°N 81.89011°W, cut bank with seepage, edge of pine plantation, sandy soil, local and occasional, *R. Carter 18445 and W.W. Baker* (VSC).—Occurring throughout peninsular Florida and into the Florida panhandle, this species reaches its northern limit of distribution in extreme southeastern Georgia (Kral and Bostick 1969). Jones and Coile (1988) map *R. nuttallii* for Georgia only in Brantley and Echols counties. Herein, we report an additional Georgia county record for this state-listed rare species. In Camden County, it was found along the moist ecotone between an infrequently burned longleaf pine-wiregrass savanna and a titi-myrtle holly swamp associated with *Aletris* sp., *Centella asiatica*, *Drosera capillaris*, *Erigeron vernus*, *Ilex glabra*, *Lachnocaulon anceps*, *Lycopodium* *prostratum* R.M. Harper, *Mitreola sessilifolia* (J.F. Gmel.) G. Don, *Pinguicula* sp., *Polygala lutea*, *Rhexia alifanus*, *R. mariana*, *Rhynchospora* spp., and *Sarracenia minor*.

Rhexia salicifolia Kral & Bostick

U.S.A. GEORGIA. **Early Co.:** ca. 3.0 air mi WNW Cedar Springs, Schackleford-Williams TNC Preserve, 31°12.090'N 85°04.871'W, elliptical pond surrounded by longleaf pine-wiregrass community, open exsiccated pond bottom, plants locally abundant and dense, 19 Jul 2007, *R. Carter 17755, R. Kral and W.W. Baker* (VSC, others tbd).—Previously known only from the Florida Panhandle, this species was initially discovered at the location reported herein by John B. Jensen, Malcolm Hodges and Thomas Floyd on 26 June 2007 (Jensen 2007). Herein, we report voucher specimens documenting this species in Georgia.

Rhododendron alabamense Rehder (Ericaceae) – W(S2S3)

U.S.A. GEORGIA. **Grady Co.:** 4 mi N of Cairo by Hwy GA 112, then W 2.1 mi, woods along Black Creek, 9 Apr 1988, *R. Carter, S. Carter, L. Taylor and P. Medrano 6471* (FLAS, FSU, GA, IBE, MO, NLU, NY, US, VDB, VSC).—In Georgia, *R. alabamense* was thought to be restricted to a series of counties along the extreme western edge of the state (Jones & Coile 1988). This recent collection from Grady County extends the range eastward from adjacent Decatur County, and documents a sizable colony on a stream terrace by Black Creek.

Rhododendron austrinum (Small) Rehder – W (S3)

U.S.A. GEORGIA. **Baker Co.:** 0.2 mi W of Elmodel, along and N of Hwy GA 37 and along E bank of Chickasawhatchee River, local 6–8 ft shrub, 1 April 1990, *R. Carter 8288* (FLAS, GA, VDB, VSC). **Decatur Co.:** 4.5 mi N of Bainbridge, along Hwy GA 253, steep bluff along Flint River, 30 Mar 1986, *R. Carter 4692* (FLAS, GA, IBE, MO, NLU, NY, VDB, VSC). **Early Co.:** 3.8 mi W of Arlington, low ground along creek, just S of Hwy GA 62, shrubs to 12 ft, locally common, 1 Apr 1990, *R. Carter 8290* (FLAS, GA, MO, NY, VDB, VSC).—*Rhododendron austrinum* is rare to infrequent from southwestern Georgia into northwestern Florida and westward into southern Alabama and Mississippi. Herein we report additional collections from Georgia.

Rhynchosia mollissima Elliott (Fabaceae)

R. tomentosa (L.) Hook. & Arn. var. *mollissima* (Elliott) Torr. & A. Gray

U.S.A. GEORGIA. **Camden Co.:** vic. Kingsland, Scrubby Bluff Rd, sandscrub remnant, 30°46.354' N 81°40.120'W, 30 Apr 2006, *R. Carter 16570* (VSC).—Jones and Coile (1988) do not record this taxon for Georgia; however, Isley (1990) reports it as an endemic to peninsular Florida and southeastern Georgia. These voucher specimen data document *R. mollissima* in Georgia. Associates at this site degraded by conversion to pine plantation were *Pinus elliottii*, *P. taeda*, *Quercus laevis*, *Q. incana*, *Q. hemisphaerica*, *Q. geminata*, *Vaccinium stamineum*, *Juniperus* sp., *Asimina incana*, *Serenoa repens*, *Berlandiera pumila*, *Eupatorium compositifolium*, *Eryngium aromaticum* Baldw., *Orbexilum lupinellus* (Michx.) Isely, *Cyperus plukenetii*, *Cnidoscolus stimulosus* (Michx.) Engelm. & A. Gray, and *Lupinus nuttallii* S. Watson. In light of the species composition, sandy soil, and excessive drainage at this site one would expect *Pinus palustris*; however, our searches for it here were unproductive.

Rhynchospora leptocarpa (Chapm. ex Britton) Small (Cyperaceae)

U.S.A. GEORGIA. **Liberty Co.:** Ft. Stewart Military Reservation, 0.3 mi S of jct FS 6 and FS 9, bayhead E of FS 9, in shade, locally common, stems lax, 9 Jul 1992, *R. Carter 10114 and P. Bauer* (VSC). **Lowndes Co.:** Moody Air Force Base, 0.45 mi E jct of airfield by Eiseman Hwy, ecotone between bayswamp and mesic hammock, locally common in shade, plants cespitose, stems lax, 17 Jul 1993, *R. Carter 11040 and C. Wilson* (VSC, others tbd); E of Hahira, jct Hwy GA 122 and Skipper Bridge Rd, along S side Hwy GA 122, SW quadr. jct, dense woods along baycreek, locally common, cespitose, stems lax, 16 Jul 2004, *R. Carter 15392, W.W. Baker and G. Nelson* (VSC, others tbd).—Including a duplicate of the preceding *Carter 10114*, Sorrie (2000) cited vouchers of *R. leptocarpa* from only four counties in Georgia, all in the Coastal Plain. Whereas Sweeney and Giannasi (2000) do not map this species for Georgia, herein we cite vouchers, including those from Lowndes – a new county record.

Rhynchospora stenophylla Chapm. – S(S2)

U.S.A. GEORGIA. **Taylor Co.:** 4.3 mi N of Butler, open sphagnous bog in periodically disturbed powerline right-of-way in vicinity of Beaver Creek, east of Hwy GA 137, 26 May 1991, *R. Carter 8795 and M.W. Morris* (GA, VDB, VSC); S Butler, open boggy slope along Little Whitewater Creek, 32°30' 20"N 84°20'30"W, 6 May 1995, *R. Carter 12406* (VSC).—These voucher data represent additional Georgia collections of this rare plant.

Robinia viscosa Vent var. ***viscosa*** (Fabaceae) – W(SNR)

U.S.A. GEORGIA. **Marion Co.:** ca. 6 mi S of Geneva, long slope just S of Juniper Creek, edge woods along W side of Hwy GA 41, 32°31.219'N 84°34.023'W, 2–4 m shrub, locally common, 23 May 2003, *R. Carter 14949 and R. Kral* (VSC).—Although Jones and Coile (1988) did not include this taxon, Isley (1990) cited Georgia in its distribution.

†***Rottboellia cochinchinensis*** (Lour.) W.D. Clayton (Poaceae) – FNW

U.S.A. GEORGIA. **Brooks Co.:** E Quitman, Southeastern Livestock Company, along S side Hwy US 84, locally common along railroad track, 9 Aug 1994, *R. Carter 11842* (VSC, others tbd); ca. 2.9 mi WSW Quitman city center by Grooverville Hwy, CSX railroad crossing, locally abundant, 12 Aug 2002, *R. Carter 14664* (VSC, others tbd). **Camden Co.:** Old Hwy 259, 1.1 mi S Brantley-Camden county line, then 0.2 mi W, 31°04.916'N 81°53.083'W, seepy ditch with introduced railroad (?) slag, locally common, 14 Oct 2007, *R. Carter 18179 and W.W. Baker* (VSC, others tbd). **Decatur Co.:** E Bainbridge, Hwy US 84 at jct Blackjack Rd, 30.89872°N 84.51510°W, railroad right-of-way along N side Hwy US 84, 19 Sep 2008, *R. Carter 18556* (VSC, others tbd). **Houston Co.:** N of Unadilla, 0.3 mi N jct I-75 and Hwy US 41, 50 m S mile marker 122, 32.26542°N 83.75088°W, local along N bound lane I-75, one large patch observed, 1 Sep 2008, *R. Carter 18515* (VSC). **Lowndes Co.:** Valdosta, Valdosta State University campus, overgrown disturbed bank of One Mile Branch, just W of Patterson St, growing amidst concrete rubble, locally common, 25 Oct 2001, *R. Carter 14619* (VSC, others tbd). **Thomas Co.:** 5.7 mi E jct Thomasville jct Hwy US 84 and Hwy US 19/391 bypass, 250 m W Eason jct Hwy US 84 and New Hope Rd, 30.81206°N 83.85208°W, 26 Sep 2008, *R. Carter 18637* (VSC). **Tift Co.:** Hwy US 319, just W jct Goat Rd (CR 27), berm along S side Hwy US 319, 31.47799°N 83.45188°W, local, 21 Aug 2008, *R. Carter 18500 with W.W. Baker and G. Nelson* (VSC). **Worth Co.:** Sylvester, vic. jct Kelly St and Davis St, along railroad across Kelly St from Pope Park, S Hwy US 82, 31°31.650'N 83°49.712'W, locally common, 22 Jul 2005, *R. Carter 16055* (VSC, others tbd).—This native of southeastern Asia is listed as a Federal Noxious Weed in the United States (Anonymous 2006), where it has apparently dispersed along railroads (Hall and Patterson 1992). Its leaf sheaths possess stinging trichomes, hence the common name itch-grass (Hall and Patterson 1992). Although Duncan (1985) provided anecdotal information indicating it was known from 13 counties in southern Georgia, he cited only one voucher specimen (Tift County). These voucher specimen data provide further, more recent documentation of *R. cochinchinensis* in Georgia.

†****Rubus*** cf. ***armeniacus*** Focke (Rosaceae)

U.S.A. GEORGIA. **Camden Co.:** 2.47 air mi ENE of Waverly jct Hwys US 17 and GA 110, N of Hwy US 17 between Hwy and Gowrie Creek, 31°06.904N 81°41.513W, ruderal edge of mixed pine-oak woods, plants apparently persisting from cultivation, 14 Oct 2006, *R. Carter 17311 and W.W. Baker* (VSC).

****Rubus hispidus*** L. – W(SU)

U.S.A. GEORGIA. **Hall Co.:** 1 mi E of Brookton, S side of Hwy GA 52, on stream terrace with much *Sphagnum* in *Acer rubrum-Liriodendron tulipifera-Nyssa sylvatica* swamp below Glades Shoals Granite Outcrop and waterfall of Flat Creek over outcrop edge, associated with *Carex intumescens, Galax urceolata, Gentiana saponaria, Ilex verticillata, Kalmia latifolia, Lindera benzoin, Mitchella repens, Pinus strobus, Platanthera clavellata, Thelypteris noveboracensis, Toxicodendron vernix*, and *Xanthorhiza simplicissima*, occasional, 14 July 2008, *M.W. Morris s.n.* (TROY). **Lumpkin Co.:** ca. 9 mi W of Dahlonega, then N 1.5 mi on Mill Creek Road, then NW and W ca. 1 mi on Little Mountain Road and Greenway Road, respectively, opposite entrance to Fern Park real estate development, in *Acer rubrum-Alnus serrulata-Liriodendron tulipifera-Oxydendrum arboreum* swamp with braided streams and *Sphagnum*, associated with *Amianthium muscaetoxicum, Arundinaria gigantea, Galax urceolata, Hexastylis shuttleworthii, Medeola virginiana, Mitchella repens, Rhododendron* spp., *Thelypteris* *noveboracensis*, *Toxicodendron vernix*, *Uvularia sessilifolia*, *Vaccinium corymbosum*, *Viburnum nudum*, and *Xanthorhiza simplicissima*, occasional, 14 July 2008, *M.W. Morris s.n.* (TROY). **Taylor Co.:** 4.3 mi N of Butler, periodically disturbed sphagnous bog in powerline right-or-way, vicinity of Beaver Creek, locally common, 26 May 1991, *R. Carter 8786 and M.W. Morris 4330* (GA, VDB, VSC).—*Rubus hispidus* is not shown in Georgia by Jones and Coile (1988) nor is it shown as occurring in the state in the USDA Plants database (U.S.D.A. 2008), thus it is treated here as an addition to the state's flora.

Sageretia minutiflora (Michx.) C. Mohr (Rhamnaceae) – T, S(S1)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, Etowah Park, ca. 300 m north of boat ramp, between boat ramp and osprey tower, dry maritime forest along Mariana Creek estuary, 30°49'20"N 81°32'38"W, Harrietts Bluff 7.5' USGS quadr., elev. 15–20 ft, 1 Jul 1996, *R. Carter 12941* (VSC); Kings Bay Submarine Base, S end Etowah Park, old King Cemetery site on small peninsula adjacent to salt marsh, Harrietts Bluff 7.5' USGS quadr., elev. 15–20 ft, 30°48'55"N 81° 32'26"W, locally common, 14 Sep 1996, *R. Carter 13736* (VSC).—Herein we report voucher specimen data for a new county record for this rare shrub (cf. Jones & Coile 1988). It was found on shell middens in dry maritime forest associated with *Aesculus pavia* L., *Sideroxylon tenax* L., *Carya glabra*, *Cornus* spp., *Diospyros virginiana*, *Ilex opaca*, *I. vomitoria* Aiton, *Juniperus virginiana* L., *Liquidambar styraciflua*, *Lyonia ferruginea*, *Osmanthus americanus*, *Persea borbonia*, *Prunus serotina*, *Ptelea trifoliata* L., *Quercus hemisphaerica*, *Q. nigra*, *Q. virginiana*, *Sabal palmetto*, *Serenoa repens*, *Tilia americana* var. *caroliniana* (Mill.) Castigl., *Vaccinium arboreum*, *V. corymbosum*, *V. stamineum*, and *Zanthoxylum clava-herculis* L.

Sagittaria graminea Michx. subsp. ***chapmanii*** (J.G. Sm.) R.R. Haynes & Hellq. (Alismataceae) – W(S3?)

U.S.A. GEORGIA. **Camden Co.:** ca. 1.5 air mi SE of Ceylon, USGS Woodbine quadr., 30°56.898' N 81°37.914'W, intermittent shallow, isolated wetland, local, 7 Apr 2006, *R. Carter 16449 and W.W. Baker* (VSC, others tbd). **Charlton Co.:** ca. 1.35 airmi WSW Coleraine lodge, 30°49.422'N 81° 55.401'W, degraded pine flatwoods, converted to slash pine, locally common in ditch, 20 Jul 2006, *R. Carter 17033 and W.W. Baker* (VSC).—These are additional county records for this uncommon to rare aquatic.

†***Sagittaria montevidensis*** Cham. & Schltdl. subsp. ***montevidensis***

U.S.A. GEORGIA. **Bryan Co.:** Richmond Hill, degraded bayswamp along W side of Hwy US 17, near NW quadrant of jct of Hwy US 17 and Hwy GA 144, 31°57.189'N 81°18.647'W, locally abundant, 19 Jul 2006, *R. Carter 17007 and W.W. Baker* (VSC, others tbd).—Sweeney and Giannasi (2000) map this species in Georgia only in Chatham County. The voucher specimen data cited herein provide documentation for the second Georgia county record of this South American introduction. Its robust size (1.5–2 m high) and large, showy flowers make this plant spectacular in the field.

†***Salvinia molesta*** D.S. Mitch. (Salviniaceae) – FNW

U.S.A. GEORGIA. **Gwinnett Co.:** Lilburn, Denmark Dr., neighborhood pond at Evergreen Lakes, 18 Oct 1999, *A. Miller s.n.* (VSC). **Lamar Co.:** vic. Liberty Hill, Lake Weldon Rd, 1 mi S jct Lake Weldon Rd and Morgan Dairy Rd, farm pond, 3 Dec 1999, *A. Miller AEM-NW-99/02* (VSC).—Giant salvinia has been dispersed in warmer parts of the southeastern U.S. through its use in the aquarium trade and in water gardens (Jacono 1999; Haynes & Jacono 2000; Jacono et al. 2001). Herein we report additional vouchers of this aquatic noxious pest from Georgia not reported by Jacono et al. (2001). The Gwinnett County infestation was found by A.C. Mauldin II, Senior Fisheries Biologist, Georgia Department of Natural Resources, and reported to Mr. Art Miller, USDA-APHIS. It is our understanding that efforts have been taken by USDA-APHIS personnel to eradicate this aquatic noxious pest from both Georgia sites.

Schoenolirion albiflorum (Raf.) R.R. Gates (Liliaceae) – S(S1?)

S. elliottii Feay ex A. Gray, nom. illeg.

U.S.A. GEORGIA. **Bacon Co.:** 4 mi E Nichols jct along S side Hwy GA 32, pond cypress depression, local, 26 Jun 1993, *R. Carter 10822 and R. Kral* (VSC, others tbd). **Charlton Co.:** 1.9 mi W of St. George jct Hwy GA 94 and Hwy GA 121, by Hwy GA 94, 30°31.311'N 82°04.136'W, edge of shallow pond, local, 8 Jun 2006, *R. Carter 16751 and W.W. Baker* (VSC, others tbd).—Reaching the northern limit of its distribution in southeastern Georgia, this species has an essentially Floridian distribution. Sweeney and Giannasi (2000) map *S. albiflorum* in Georgia only in Brantley and Wayne counties. These voucher specimen data document the presence of this rare species in two more Georgia counties. It inhabits shallow, seasonally wet, flatwoods ponds with *Acer rubrum*, *Carex striata*, *Hypericum* spp., *Ilex myrtifolia*, *Morella cerifera*, *Nyssa biflora* and *Taxodium ascendens*.

****Schoenoplectus etuberculatus*** (Steud.) Soják (Cyperaceae) – S(S1S2)

Scirpus etuberculatus (Steud.) Kunth

U.S.A. GEORGIA. **Berrien Co.:** ca. 1.5 mi ENE Ray City, 31°04.854'N 83°10.450'W, Rays Mill Pond, near boat ramp, 24 May 2004, *R. Carter 15357* (VSC, others tbd). **Lowndes Co.:** island in Boring Pond, 5.5 mi SE of Valdosta, 1 mi N of Hwy GA 94, 19 May 1974, *J. Lefiles s.n.* (VSC); ca. 7.3 mi SE of Valdosta city center, N of Hwy GA 94, Boring Pond, 17 Aug 1990, *W.K. George s.n.* (VSC). **Talbot Co.:** 4 mi S of Geneva by Hwy GA 41, Upatoi Creek bottom, north side of creek, locally common in swift flowing creek, stems lax and swept over by water, 13 Aug 2002, *R. Carter 14684 and R. Kral* (VSC). **Taylor Co.:** 6.3 mi S of Butler by Hwy GA 137, rooted in white sandy bottom of Little Whitewater Creek, culms lax, immersed in running water ca. 0.5 m deep, 25 May 1991, *R. Carter 8667 and M.W. Morris* (VSC, others tbd). **Ware Co.:** SSE of Waycross, 3.45 mi S jct Hwys US 1 and GA 177, N of Okefenokee Swamp Park, barrowpit and adjacent flatwoods along Hwy GA 177, locally common in shallow water, 17 May 1997, *R. Carter 14022 and J. Carter* (VSC, others tbd).—Although Smith (2002) included Georgia in the range of this species, neither Jones and Coile (1988) nor Sweeney and Giannasi (2000) mapped it for the state. These voucher specimen data substantiate the presence of *S. etuberculatus* in Georgia. The variable habit of this aquatic sedge seems to be correlated with habitat. When inhabiting blackwater ponds in southern Georgia, its emergent culms – leafless except for a terminal bract that appears to be an extension of the stem – may grow a meter or more above the water's surface, imparting an oddly curious aspect. Constrastingly, in swiftly flowing blackwater streams of the fall-line sandhills, swept along by the current, the culms are lax and immersed.

Scirpus lineatus Michx.

U.S.A. GEORGIA. **Camden Co.:** hydric hammock S of Hwy US 17, 0.8 mi NE of Waverly, USGS Waverly quadr., UTM 17 431516E 3440695N (WGS84/NAD83), 4 Jul 1988, *R. Carter and S. Carter 6927* (VSC, others tbd).—Sweeney and Giannasi (2000) map this species in Georgia from only Charlton County. These voucher specimen data document *S. lineatus* in adjacent Camden, the second county for the state. Associates are the same as those listed above for *Carex godfreyi* and *Carex gholsonii*.

Sida elliottii Torr. & A. Gray (Malvaceae) – S (S2?)

U.S.A. GEORGIA. **Camden Co.:** 4.24 air mi WNW Waverly jct Hwy US 17 and Hwy GA 110, 0.75 mi SW jct Inachee Rd and Hwy GA 110, 31° 06.416'N 81°47.764'W, edge disturbed mesic hammock, occasional, sprawling herb, 12 Sep 2007, *R. Carter 18068 and W.W. Baker* (VSC, others tbd); New Post Rd, 0.6 mi N Providence Church, 31° 03.955'N 81°48.599'W, edge pine plantation converted from mesic coastal hammock, occasional, 12 Sep 2007, *R. Carter 18070 and W.W. Baker* (VSC, others tbd); SE of Magnolia Bluff, 0.5 mi S jct Bailey Mill Rd and John Bailey Mill Rd, mesic flatwoods converted to pine plantation by John Bailey Mill Rd, 30°55.232'N 81°51.515'W, 13 Sep 2007, *R. Carter 18093 and W.W. Baker* (VSC).—Jones and Coile (1988) map *S. elliottii* from three widely scattered counties in Georgia, none from the southeastern sector of the state.

****Solanum carolinense*** L. var. ***floridanum*** Chapm. (Solanaceae)

U.S.A. GEORGIA. **Camden Co.:** ca. 1.1 mi W of Forestview, Kingsland NE quadr., maritime bluff forest, W side of Hermitage Swamp, 30°55.804'N 81°36.686'W, occasional along loamy jeep trail, 19 May 2006, *R. Carter 16642 and W.W. Baker* (VSC). **Colquitt Co.:** ca. 5.75 mi SE Crosland, disturbed roadside and edge of field, 26 Jun 1988, *R. Carter 6809 and W.K. George* (VSC, others tbd).—These voucher specimen data document the occurrence of this taxon in Georgia (cf. Jones & Coile 1988).

†****Solanum chenopodioides*** Lam.

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, open sandy area SE of SE end of U.S.S. James Monroe Ave, vicinity of Warrior Wharf, sandy area within loop road, 30°47'02"N 81°29'55"W, 23 Jul 1996, *R. Carter 13337* (VSC, others tbd).—These voucher specimen data comprise the first report of this species for Georgia.

Solidago rugosa Mill. var. ***celtidifolia*** (Small) Fern. (Asteraceae)

U.S.A. GEORGIA. **Camden Co.:** vic. Owens Ferry, 1.6 mi E Jerusalem jct Owens Ferry Rd and Bailey Mill Rd, by Owens Ferry Rd, 30.97150°N 81.81600°W, locally common, 8 Nov 2007, *R. Carter 18267* (VSC, others tbd).—Jones and Coile (1988) do not map *S. rugosa* from the southeastern sector of Georgia, and Wunderlin and Hansen (2008) do not show it in northern peninsular Florida. These voucher specimen data represent a substantial range extension eastward into extreme southeastern Georgia, where *S. rugosa celtidifolia* was found in moist, fine sand along a shallow road ditch by a disturbed remnant hardwood hammock. Nomenclature for this taxon follows Semple and Cook (2006).

Spiranthes longilabris Lindl. (Orchidaceae) – S (S1)

U.S.A. GEORGIA. **Cook Co.:** 2.5 mi W of Adel, boggy ditch, local, 14 Nov 1987, *R. Carter 6411* (VSC).—This species was not mapped by Sweeney and Giannasi (2000). At the Cook County site it was associated with *Pinus serotina*, *Sarracenia flava* L., *S. minor*, and *Taxodium ascendens.*

†****Sporobolus indicus*** (L.) R. Br. var. ***pyramidalis*** (P. Beauv.) Veldkamp (Poaceae)

U.S.A. GEORGIA. **Camden Co.:** W of Kingsland by Hwy GA 40, 50 m W jct Hwy GA 40 and Colerain Rd, 30°48.649'N 81°44.934'W, locally abundant, 29 May 2006, *R. Carter 16743* (VSC, others tbd). **Lowndes Co.:** 4.7 mi W of Valdosta jct Interstate 75 and Hwy US 84 by Hwy US 84, 30°47.953'N 83°23.414'W, locally abundant along highway embankment, 19 Jun 2005, *R. Carter 16000* (VSC, others tbd).—This taxon, which Peterson et al. (2003) treated as *S. jacquemontii* Kunth, appears to be dispersing rapidly along highways in southern Georgia and most probably invaded the state from neighboring Florida. As neither Peterson et al. (2003) nor Sweeney and Giannasi (2000) listed or mapped this taxon for Georgia, these voucher specimen data comprise the first reports of it from the state.

Stewartia malacodendron L. (Theaceae) – R, S (S2)

U.S.A. GEORGIA. **Cook Co.:** Reed Bingham State Park, about 6.5 mi W of Adel, mesic bluff along E bank of Little River, shrub to 3 m high with broad spreading crown, 25 Apr 1990, *Carter 8291* (FSU, GA, VDB, VSC). **Irwin Co.:** S of Hwy US 319, E of Alapaha River, 31.50418°N 83.38054°W, mesic slope along Alapaha River floodplain, plants locally abundant, 21 Aug 2008, *R. Carter 18499 with W.W. Baker and G. Nelson* (VSC, others tbd).—Jones and Coile (1988), in the southwestern quadrant of Georgia, map *S. malacodendron* from only one county (Calhoun County). The voucher specimen data reported herein add an additional county to the distribution of this rare species. At the Cook County site, intensive searching of the area indicated *S. malacodendron* was quite local. Only five plants were found, and these were in close proximity to one another. Moreover, the aerial stems of most of the shrubs of *S. malacodendron* showed evidence of substantial die-back and were suckering from their bases. At the Cook County site *S. malacodendron* was found with the following woody associates: *Asimina parviflora*, *Castanea pumila*, *Carya glabra*, *C. tomentosa* (Michx.) Nutt., *Celtis* sp., *Cercis canadensis* L., *Cornus florida* L., *Halesia diptera* J. Ellis, *Hamamelis virginiana* L., *Ilex opaca*, *Liquidambar styraciflua*, *Lyonia ferruginea*, *Magnolia grandiflora*, *Osmanthus americanus*, *Prunus serotina*, *Styrax grandifolius*, *Symplocos tinctoria*, *Quercus alba* L., *Q. laurifolia*, *Sideroxylon lanuginosum* Michx., *Vaccinium* sp. and *Viburnum rufidulum* Raf. Although Patrick et al. (1995) map *Stewartia malacodendron* for Irwin County, site data on the supporting voucher specimen (*T.R. Colvin and D.W. Speake s.n.*, 17 Jul 1977, VSC-24783) are imprecise: "Edge along sand hill and swamp beside Alapaha River." Thus, we provide precise locality data for a recent collection from Irwin County.

Stokesia laevis (Hill) Greene (Asteraceae) – S(S1)

U.S.A. GEORGIA. **Charlton Co.:** just W of St. George along Hwy GA 94, low flatwoods, local, 3 Jul 2003, *R. Carter 14999* (VSC). **Colquitt Co.:** ca. 1.25 air mi NNW of Norman Park, 31°17.162'N 83°41.416'W, Page Woods Tract, E side powerline, seepage slope along drain, locally common, 11 Jul 2007, *R. Carter 17697 and W.W. Baker* (VSC); ca. 75 m N of Moye Rd, 31.31719°N 83.72173°W, 9 Jul 2008, *R. Carter 18448 and W.W. Baker* (VSC). **Worth Co.:** ca. 4.3 air mi NW of Norman Park, seepage slope along NE bank of bay creek tributary of Warrior Creek, 31°19.282'N 83°43.425'W, pitcher plant bog, locally common, 11 Jul 2007, *R. Carter 17675 and W.W. Baker* (VSC).—These voucher specimen citations provide additional records of this rare composite.

Stylisma aquatica (Walter) Raf. (Convolvulaceae) – W(S3?)

U.S.A. GEORGIA. **Brooks Co.:** ca. 5 mi NNE Dixie, 1.65 mi N jct Hodges Rd and Dry Lake Rd, then 0.95 mi W jct Hodges Rd and Powerline Rd, by Powerline Rd, 30.85998°N 83.68316°W, seasonal pond at upper western edge of seepage slope, with *Taxodium ascendens*, *Nyssa biflora*, *Ilex myrtifolia*, *Acer rubrum* and *Liquidambar styraciflua*, 15 Jun 1998, *R. Carter 14105* (VSC, others tbd). **Irwin Co.:** S of Hwy US 319, E of Alapaha River, 31.50977°N 83.35280°W, Grady pond, with *Pinus taeda*, *Diospyros virginiana*, *Quercus virginiana*, *Q. laurifolia*, *Acer rubrum*, *Morella cerifera*, 21 Aug 2008, *R. Carter 18491 with W.W. Baker and G. Nelson* (VSC, others tbd). **Lowndes Co.:** Grand Bay WMA, Blanton Estate, 0.37 air mi N Knights Academy Rd, wetland along E side access rd., 30°55'32"N 83°11'32"W, 20 Jun 1995, *R. Carter 12416* (VSC). **Miller Co.:** 6.7 air mi NW of Colquitt town center; Mayhaw Wildlife Management Area, ca. 1.5 mi N of Griggs-Lucile Rd by Womble Rd, then NE of Womble Rd by unmarked trail; 31.22266°N 84.83015°W; margin of small sinkhole with *Taxodium ascendens*, *Crataegus aestivalis*, *Quercus laurifolia*; plants forming locally dominant ground cover along exsiccated pond margin; 19 Sep 2008, *R. Carter 18572* (VSC).—Wunderlin and Hansen (2008) map this species from only the panhandle of northwestern Florida, and Jones and Coile (1988) show it only from Miller County in southwestern Georgia. The additional county records of this rare to uncommon species reported herein provide documentation of its occurrence in south-central Georgia.

Thalia dealbata Fraser ex Roscoe (Marantaceae) – S(S1)

U.S.A. GEORGIA. **Camden Co.:** ca. 3.5 mi S Woodbine jct Hwy US 17 and Hwy GA 25, E of Hwy US 17, cleared wetland under powerline, adjacent to hydric hammock, 30°54.226'N 81°42.332' W, 27 Oct 2006, *R. Carter 17359 and W.W. Baker* (VSC); 5.1 mi S Woodbine jct Hwy US 17 and Hwy GA 110, ditch along W side Hwy US 17, 30.89450°N 81.70897°W, edge of cypress-gum swamp, 14 Oct 2008, *R. Carter 18662* (VSC, others tbd). **Glynn Co.:** Sterling, NE of jct Hwy US 341 and Hwy GA 99, mucky ditch at edge of swamp forest along Hwy GA 99, 26 Aug 1988, *R. Carter 7414* (FSU, GA, IBE, MO, NLU, VDB, VSC); 23 May 1997, *R. Carter 14031 and D. Alexander* (VSC). —Herein we report additional records of this rare monocot for Georgia. The Glynn County site was initially observed and brought to the attention of the first author by Dr. Wayne R. Faircloth.

****Thalia geniculata*** L.

U.S.A. GEORGIA. **Camden Co.:** ca. 7.0 mi E Folkston, 30°50.173'N 81°53.000'W, jct Hwys GA 40 and GA 110, N side Hwy GA 40, hydric flatwoods, local, 3 Oct 2003, *R. Carter 15112* (VSC, others tbd); 11.6 air mi W of Kingsland jct Hwy GA 40 and Hwy US 17, 0.5 mi E jct Hwy GA 40 and Hwy GA 110, 30°49.986'N 81°52.935'W, cleared right-of-way along Hwy GA 40 in Mill Creek floodplain, local in swale, 1 Sep 2006, *R. Carter 17175 and W.W. Baker* (VSC).—This species was previously thought to be restricted to Florida and the West Indies (Godfrey & Wooten 1979), and neither Jones and Coile (1988) nor Sweeney and Giannasi (2000) map it for Georgia. Thus, the voucher specimen data reported herein document the occurrence of *T. geniculata* in Georgia.

Tillandsia bartramii Elliott (Bromeliaceae) – S (S2)

U.S.A. GEORGIA**. Camden Co.:** Cabin Bluff Preserve, 30.889°N 81.517°W, USGS Kingsland NE quadr., ca. 11.75 air mi NNE St. Marys waterfront, ca. 2.1 miles NW Cabin Bluff Lodge, ca. 1.2 mi WNW of Shellbine by Shellbine Road, Cooper Creek swamp and hammock, epiphytic on live oak, rare, 6 Oct 1995, *R. Carter 12890* (VSC); Kings Bay Submarine Base, 0.15 air mi NW golf clubhouse, along W edge enclosure for radio tower, N U.S.S. Proteus Rd, 30°49'27"N 81°33' 15"W, 20 Jul 1996, *R. Carter 13241* (VSC); Kings Bay Submarine Base, hammock, 0.75 mi W of jct U.S.S. Henry L. Stimson Dr. and U.S.S. James

Monroe Ave, along N side U.S.S. Henry L. Stimson Dr., hammock adjacent to salt marsh at upper reaches of North River, 30°48'09"N 81°32'05"W, 23 Aug 1996, *R. Carter 13588* (VSC, others tbd); Magnolia Bluff, 30°56.683'N 81°53.585'W, hardwood bluff forest, epiphytic on *Carya glabra*, 9 Jun 2006, *R. Carter 16768 and W.W. Baker* (VSC); Magnolia Bluff, just N of bridge over Satilla River, 30° 56.736'N 81°53.661'W, swamp forest along base of bluff, epiphytic on *Taxodium distichum*, 9 Jun 2006, *R. Carter 16780 and W.W. Baker* (VSC); Clarks Bluff, Clarks Bluff Cemetery at along N bank St. Marys River, USGS Kings Ferry quadr., UTM 17 426777E 3405226N (WGS84/NAD83), hammock with *Pinus palustris*, *P. taeda*, *Quercus hemisphaerica*, *Q. nigra*, *Q. virginiana*, epiphytic on *Prunus serotina*, 10 Jun 2006, *R. Carter 16810 with W.W. Baker* (VSC). **Charlton Co.:** 1.88 mi E Folkston (courthouse) by Hwy GA 40, then 200 m N by Reynolds Rd, bayswamp along creek just N Peoples Baptist Church, 30°50'32"N 81°58'33"W, locally common epiphyte, 29 Mar 1996, *R. Carter 12929* (VSC); Traders Hill Recreation Area, hardwood slope with sandy creek bottom along St. Marys River, 30°46.988'N 82°01.490'W, epiphytic on *Quercus hemisphaerica*, 8 Jun 2006, *R. Carter 16766 and W.W. Baker* (VSC, others tbd).—Herein we report additional records of this epiphytic bromeliad near the northern limit of its distribution (Luther & Brown 2000), where it was observed on a variety of phorophytes, including *Carya glabra*, *Prunus serotina*, *Quercus hemisphaerica*, *Q. virgininiana*, *and Taxodium distichum.*

Tillandsia recurvata (L.) L. – S(S1)

U.S.A. GEORGIA. **Camden Co.:** Kings Bay Submarine Base, hammock along NW bank of pond P-1, between U.S.S. Kamehameha Avenue and North River marsh, 0.28 air mi NE of North River Causeway, Harrietts Bluff 7.5' quadr., elev. ca. 15 ft, 30°45'45"N 81°31'14"W, disturbed hammock remnant along edge of pond, locally abundant, epiphyte on mature live oak trees, 29 Aug 1996, *R. Carter 13611* (VSC, others tbd); Kings Bay Submarine Base; 0.31 air mi SW Jct. U.S.S. Henry L. Stimson Drive and U.S.S. Woodrow Wilson Avenue; hardwood hammock along N side of SWIFLANT, between SWIFLANT fence and drainage ditch, Harrietts Bluff 7.5' quadr., elev. 15 –20 ft, 30°47'35"N 81°32'23"W, hardwood hammock, epiphytic on mature live oak, 6 Sep 1996, *R. Carter 13660* (VSC). **Lowndes Co.:** Valdosta, Valdosta State University main campus, local on transplanted *Quercis geminata* behind West Hall, epiphyte, 15 Oct 2000, *R. Carter 14472* (VSC).—The Valdosta, Lowndes County, population (*Carter 14472*) was introduced with nursery-grown specimens of *Q. geminata* shipped from Florida. These epiphytes appear to be thriving on their introduced phorophytes that were established on the Valdosta State University (VSU) campus about 1989. A similarly introduced population grows on ornamental *Lagerstromia indica* L. (crape-myrtle) specimens in downtown Douglas, Coffee County, Georgia, where it has been established for about five years (Frankie Snow, personal communication). The first author has made annual observations for about five years of a single *T. recurvata* plant attached to an aerial utility wire in vicinity of the Clay Road railroad overpass in Valdosta, located about 2.6 air mi SE of the population reported above (*Carter 14472*). Presumably, this plant was established naturally, perhaps from windborne seed produced by "nursery plants" on the Valdosta State University campus.

†****Tradescantia fluminensis*** Vell. (Commelinaceae)

U.S.A. GEORGIA. **Camden Co.:** St. Marys, Dilworth St and railroad crossing, along S side railroad, E of Dilworth St, 30°44.191'N 81°33.370'W, *R. Carter 15935* (VSC, others tbd), *R. Carter 15968* (VSC, others tbd); ca. 5.0 air mi ESE Burnt Fort, vic. Jim Baileys Mill, USGS Jerusalem quadr., 30° 55.428'N 81°49.259'W, floodplain forest along Satilla River, locally abundant in shaded second growth woods, 22 Sep 2006, *R. Carter and W.W. Baker 17241* (VSC, others tbd). **Lowndes Co.:** Valdosta, vic. city bike trail along S bank One Mile Branch, between Sustella Ave and Wainwright St, UTM 17 280214E 3414480N (NAD83/WGS84), terrace along creek, degraded urban woodlot, locally abundant, 4 Mar 2007, *R. Carter 17422* (VSC). —Georgia was not included within the range of this species by Faden (2000), nor was it mapped by Sweeney and Giannasi (2000). Native to South America, Faden (2000) reported this species as introduced and naturalized in the United States in Florida, southern Alabama, Louisiana and California. The voucher specimen data reported herein comprise the first records of *T. flumenensis* in Georgia, where it has been observed to be a locally abundant weed. *Tradescantia flumenensis* is cited as an invasive pest in Florida (Langeland & Burks 1998).

Triphora trianthophora (Sw.) Rydb. (Orchidaceae) – S(S2?)

U.S.A. GEORGIA. **Camden Co.:** bluff along E bank of Satilla River, N of 3R Landing, 31°00.688' N 81°54.020'W, mesic slope with *Fagus grandifolia*, *Ilex opaca*, *Nyssa sylvatica*, *Quercus alba*, *Q. michauxii*, *Pinus glabra*, *Carya tomentosa*, *Vaccinium arboreum*, *V. elliottii*, *Asimina parviflora and Hamamelis virginiana*, 23 Sep 2006, *R. Carter 17276 and W.W. Baker* (VSC). **Charlton Co.:** Okefenokee National Wildlife Refuge, Floyd's Island, NW end of island on borders of Indian mound, under oaks, 18 Oct 1975, *W. Cribbs s.n.* (VSC). **Lanier Co.:** Moody Air Force Base, Dudley's Hammock, local and rare under shade of massive live oaks, south side of hammock road, 6 Aug 1994, *C. Wilson 339, J. Lusk and R. Carter* (VSC).—Despite the fact that this species has long been known from northern Florida (Luer 1972) and the coastal plain of South Carolina (Porcher 1977), Jones and Coile (1988) and Sweeney and Giannasi (2000) only map it in a cluster of counties in the extreme northeastern corner of Georgia. Thus we provide documentation of *T. trianthophora* from the Georgia Coastal Plain. The Dudley's Hammock population in Lanier County was observed on two separate dates, one week apart. On 6 Aug 1994, 37 stems of *T. trianthophora* were counted in an area ca. 1×3 m^2; ca. one-third of these had flowers. On 13 Aug 1994, 21 stems were visible in the same area; ca. one-quarter of these had flowers. The Dudley's Hammock site with *T. trianthophora* was dominated by *Quercus virginiana*, and additionally the following species were noted: *Carya glabra*, *Gaylussacia frondosa* (L.) Torr. & Gray ex Torr., *Ilex opaca*, *Lyonia ferruginea*, *Magnolia grandiflora*, *Mitchella repens*, *Nyssa sylvatica*, *Osmanthus americanus*, *Pinus glabra* Walter, *Pteridium aquilinum*, *Quercus michauxii*, *Q. nigra*, *Serenoa repens*, *Vaccinium arboreum*, *V. corymbosum*, and *V. elliottii* Chapm. The vegetation of Dudley's Hammock is characterized further in Bergstrom and Carter (2008).

†****Verbascum virgatum*** Stokes (Scrophulariaceae)

U.S.A. GEORGIA. **Camden Co.:** S of Atkinson, NW of Tarboro, 0.2 mi N jct Old Hwy 259 and Old Merrow Community Rd, 31°04.105'N 81° 53.008'W, road embankment along Old Hwy 259, locally common, 29 Apr 2006, *R. Carter 16496* (VSC, others tbd). **Charlton Co.:** 4.1 mi S Racepond jct Hwy US 17 and Hwy GA 15/121, 30.94216°N 82.10637°W, median of Hwy US 17, locally common, 29 Apr 2008, *R. Carter 18358 and W.W. Baker* (VSC, others tbd.). **Lowndes Co.:** S Valdosta, 50 m S jct Hwy US 41 and Inner Perimeter Rd, shoulder along W side Hwy US 41, 30.79435°N 83.241516°W, plants local, 4 Apr 2009, *R. Carter 18790 and S. Carter* (VSC).—This species, an introduction from Europe, was known from Ontario, the northeastern United States, South Carolina, southeastern Texas and Florida (Pennell 1935; Godfrey & Kral 1958; Gleason & Cronquist 1991; Wunderlin & Hansen 2008). Voucher specimen data reported herein comprise the first report of *V. virgatum* from Georgia.

****Verbesina heterophylla*** (Chapm.) A. Gray (Asteraceae)

U.S.A. GEORGIA. **Charlton Co.:** 3.2 mi S Moniac, W side Hwy GA 185, 30°28.891'N 82°11.945' W, upland flat with *Pinus elliottii*, *Aristida stricta*, *Quercus incana*, *Q. minima*, *Serenoa repens*, and *Pteridium aquilinum*, plants local, 9 Aug 2007, *R. Carter 17961 and W.W. Baker* (VSC, others tbd).—Previously thought to be endemic to northeastern Florida (Cronquist 1980; Chafin 2000; Strother 2006c), *V. heterophylla* is reported herein new to Georgia. The site was an upland sandy flat with native ground cover including *Aristida stricta* and *Ctenium floridanum*, likely formerly dominated by *Pinus palustris* but now converted to slash pine (*P. elliottii*).

†****Vicia ludoviciana*** Nutt. ex Torr. & A. Gray subsp. ***leavenworthii*** (Nutt. ex Torr. & A. Gray) Lassetter & C.R. Gunn (Fabaceae)

U.S.A. GEORGIA. **Camden Co.:** Woodbine, 50 m S jct E Oak St and W 4th St, 30°58.015'N 81° 43.500'W, edge woodlot by E Oak St, low ground along ditch bank, locally common, 30 Mar 2007, *R. Carter 17472* (VSC, others tbd).—These voucher specimen data comprise the first report of this species from Georgia (cf. Lasseter 1984; Isely 1990).

****Vicia minutiflora*** D. Dietr.

U.S.A. GEORGIA. **Camden Co.:** St. Marys, Oak Grove Cemetery, UTM 17 446939E 3398863N (NAD27), locally abundant in open sandy soil, 22

Feb 2007, *R. Carter 17410 and W.W. Baker* (VSC, others tbd).—Jones and Coile (1988) do not map this species for Georgia, and according to Wunderlin and Hansen (2008), in Florida, it is restricted to four counties along the Apalachicola River in the panhandle. Thus, these voucher specimen data provide documentation of *V. minutiflora* from Georgia.

Vigna luteola (Jacq.) Benth. (Fabaceae) – S(S2?)
U.S.A. GEORGIA. **Camden Co.:** John Baileys Mill (USGS Jerusalem, GA, quadr.), SE of Magnolia Bluff via Bailey Mill Rd to John Bailey Mill Rd, near end of John Bailey Mill Rd along bank of Satilla River, 30°54.621'N 81°51.868'W, 13 Sep 2007, *R. Carter 18090 and W.W. Baker* (VSC, others tbd).—Jones and Coile (1988) map the species in Camden and Chatham counties. Herein, we report recent voucher specimen data of this species, infrequently collected in Georgia.

†***Zephyranthes simpsonii*** Chapm.
(Amaryllidaceae) – S(S1)
U.S.A. GEORGIA. **Camden Co.:** 1.6 mi N Waverly jct Hwy US 17 and GA 110, 100 N Butler Rd, 31°06.052'N 81°42.239'W, open right-of-way, edge flatwoods, 5 May 2006, *W.W. Baker s.n.* (VSC); 19 May 2006, *R. Carter 16651 and W.W. Baker* (VSC). **McIntosh Co.:** 4.1 mi N Darien jct Hwy US 14 and Hwy GA 99, 0.2 mi N Ridgeville, ditch along E side Hwy GA 99, 6 Apr 2003, *R. Carter 14898* (VSC, others tbd).—This species was not mapped by Sweeney and Giannasi (2000).

Zigadenus leimanthoides (A. Gray) A. Gray
(Liliaceae) – S(S1)
U.S.A. GEORGIA. **Taylor Co.:** vicinity of Little Whitewater Creek, 6.1 mi S of Butler by Hwy GA 137, open sphagnous seepage slope at edge of Atlantic white cedar swamp, 15 Sep 1990, *R. Carter and M.W. Morris 8469* (VSC, fruiting specimen); 4.3 mi N of Butler, periodically disturbed sphagnous powerline right-of-way in vicinity of Beaver Creek, locally common, 26 May 1991, *R. Carter and M.W. Morris 8785* (GA, MMNS, VSC, WTU).—Jones and Coile (1988) mapped this species in Georgia only in Turner County. The records reported herein provide documentation for this rare plant in a second Georgia county. Associates in Taylor County were *Calopogon tuberosus*, *Carex glaucescens*, *Cleistes divaricata*, *Eriocaulon decangulare*, *Fuirena squarrosa* Michx., *Hypericum crux-andreae* (L.) Crantz, *Juncus trigonocarpus* Steud., *Lycopodium appressum*, *L. alopecuroides*, *Mitreola sessilifolia*, *Oxypolis rigidior* (L.) Raf., *Platanthera blephariglottis* (Willd.) Lindl., *Pogonia ophioglossoides*, *Polygala nana* (Michx.) DC., *P. cruciata* L., *Rhexia petiolata*, *Rhynchospora* spp., *Sabatia* spp., *Sarracenia rubra* Walter, *Syngonanthus flavidulus*, *Utricularia subulata* L., and *Xyris* spp.

LITERATURE CITED

Alford, J. and L.C. Anderson. 2002. The taxonomy and morphology of *Macranthera flammea* (Orobanchaceae). Sida 20:189–204.

Allred, K.W. 2003a. *Phragmites*. In: M.E. Barkworth, K.M. Capels, S. Long, and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. P. 10.

Allred, K.W. 2003b. *Bothriochloa*. In: M.E. Barkworth, K.M. Capels, S. Long, and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 639–647.

Anderson, L.C. 2000. Noteworthy plants from north Florida. VII. Sida 19:211–216.

Anonymous. 2006. Federal noxious weed list (June 30, 2006). USDA-APHIS. http://www.aphis.usda.gov/plant_health/plant_pest_info/weeds/downloads/weedlist2006.pdf [last accessed 9 March 2008].

Anonymous. 2007. Georgia rare species and natural community information – Protected plants, special concern plants, watched plants. Date of information - 7/2/2007. Georgia Department of Natural Resources, Natural Heritage Program. Social Circle, Georgia. http://georgiawildlife.dnr.state.ga.us. [last accessed 14 March 2008].

Aulbach, C. 2003. *Eustachys*. In: M.E. Barkworth, K.M. Capels, S. Long, and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 218–224.

Bailey, L.H. 1949. Manual of cultivated plants. Macmillan Publishing Company, New York. 1116 pp.

Barkley, T.M. 2006. *Emilia*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 21. Oxford University Press, New York. Pp. 605–607.

Barkworth, M.E. 2003a. *Chloris*. In: M.E. Barkworth, K.M. Capels, S. Long, and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 204–218.

Barkworth, M.E. 2003b. *Ctenium*. In: M.E. Barkworth, K.M. Capels, S. Long, and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 232, 234 and 236.

Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep, eds. 2007. vol. 25: Additions, corrections and comments. In: M.E. Barkworth, K.M. Capels, S. Long, and M.B. Piep, eds. Flora of North America, vol. 24. Oxford University Press, New York. Pp. 790–793.

Bergstrom, B.J. and R. Carter. 2008. Host tree selection by an epiphytic orchid, *Epidendrum magnoliae* Muhl., in an inland hardwood hammock in Georgia. Southeastern Naturalist 7:571–580.

Bogler, D.J. 2006. *Hypochaeris*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 19. Oxford University Press, New York. Pp. 297–299.

Bostick, P. E. 1971. Vascular plants of Panola Mountain, Georgia. Castanea 36:194–209.

Bostick, P. E. 1977. Dissemination of some Florida plants by way of commercial peat shipments. Castanea 42:106–108.

Brandenburg, D.M. 2007. *Cinna.* In: M.E. Barkworth, K.M. Capels, S. Long, L.K. Anderton and M.B. Piep, eds. Flora of North America, vol. 24. Oxford University Press, New York. Pp. 773–775.

Brandenburg, D.M., W.H. Blackwell, and J.W. Thieret. 1991. Revision of the genus *Cinna* (Poaceae). Sida 14:581–596.

Bridges, E.L. and S.L. Orzell. 1989. *Evolvulus sericeus* (Convolvulaceae) in Georgia, with floristic and ecological notes. Sida 13:509–512.

Broyles, S.B., and R. Wyatt. 1988. *Asclepias syriaca* in Georgia. Bull. Torr. Bot. Club 115:297–298.

Bruce, J.G., S.B. Jones, Jr., and N.C. Coile. 1980. The pteridophytes of Georgia. Castanea 45:185–193.

Brummitt, R.K. and C.E. Powell. 1992. Authors of plant names. Royal Botanical Garden, Kew.

Bryson, C.T. and R. Carter. 1992. Notes on *Cyperus* and *Kyllinga* (Cyperaceae) in Mississippi with records of six species new to the state. Sida 15:119–124.

Bryson, C.T. and R. Carter. 1994. Notes on *Carex*, *Cyperus*, and *Kyllinga* (Cyperaceae) in Mississippi with records of eight species previously unreported to the state. Sida 16:171–182.

Bryson, C.T. and R. Carter. 2008. The significance of Cyperaceae as weeds. In: R.F.C. Naczi and B.A. Ford, eds. Sedges: Uses, diversity, and systematics of the cyperaceae. Monogr. Syst. Bot. Missouri Bot. Gard. 108., St. Louis. Pp. 15–101.

Bryson, C.T., R. Carter, L.B. McCarty, and F.H. Yelverton. 1997. *Kyllinga*, a genus of neglected weeds in the continental United States. Weed Technol. 11:838–842.

Bryson, C.T., J.R. MacDonald, R. Carter, and S.D. Jones. 1996. Noteworthy *Carex*, *Cyperus*, *Eleocharis*, *Kyllinga*, and *Oxycaryum* (Cyperaceae) from Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, Tennessee, and Texas. Sida 17:501–518.

Bryson, C.T., V.L. Maddox and R. Carter. 2008. Spread of Cuban club-rush [*Oxycaryum cubense*

(Poeppig & Kunth) Palla] in the southeastern United States. Invasive Plant Science and Management. 1:326–329.

Bryson, C.T. and R.F.C Naczi. 2002. *Carex* sect. *Laxiflorae*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J.L. Strother, eds. Flora of North America, vol. 23. Oxford University Press, New York. Pp. 431–440.

Bryson, C.T., R.F.C. Naczi, and S. McDaniel. 1992. Notes on noteworthy records of *Carex* (Cyperaceae) from the southeastern United States. Sida 15:125–135.

Burkhalter, J.R. 1985. *Aletris farinosa*, *Cyperus difformis*, and *Cyperus pilosus* new for Florida. Sida 11:247–248.

Carter, R. 1990. *Cyperus entrerianus* (Cyperaceae), an overlooked species in temperate North America. Sida 14:69–77.

Carter, R. 2005. An introduction to the sedges of Georgia. Tipularia 20:15–44.

Carter, R., C.W. Allen, P. Lewis and D. Lewis. 2009. *Cyperus pilosus* new to the flora of Texas. J. Bot. Res. Inst. Texas. In press.

Carter, R. and W.W. Baker. 2006. Report on *Harwrightia floridana* survey: 12–14 October 2006. Unpublished report to Georgia Department of Natural Resources, Natural Heritage Program. Submitted 20 October 2006. 4 pp.

Carter, R. and C.T. Bryson. 1996. *Cyperus entrerianus*: A little known aggressive sedge in the southeastern United States. Weed Technol. 10:232–235.

Carter, R. and C.T. Bryson. 2000. *Cyperus sanguinolentus* (Cyperaceae) new to the southeastern United States, and its relationship to the supposed endemic *Cyperus louisianensis*. Sida 19:325–343.

Carter, R., D.K. Alexander, C.T. Bryson, and A. Lazari. 1999. The taxonomy of *Cyperus virens* and *Cyperus drummondii* (Cyperaceae) in the southeastern United States. Sida 18:1049–1063.

Carter R. and S.D. Jones. 1991. Additional records of *Cyperus entrerianus* (Cyperaceae) in the United States. Sida 14:615–616.

Carter, R. and W.R. Faircloth. 1986. *Osmunda cinnamomea* forma *frondosa* in the coastal plain of Georgia and Florida. Amer. Fern J. 76:189.

Chafin, L.G. 2000. Field guide to the rare plants of Florida. Florida Natural Areas Inventory, Tallahassee.

Chafin, L.G. 2007. Field guide to the rare plants of Georgia. State Botanical Garden of Georgia, Athens.

Chapman, A.W. 1860. Flora of the southern United States. Ivison, Phinney, New York. 621 pp.

Chapman, A.W. 1889. Flora of the southern United States. 2nd ed. Ivison, Blakeman, Taylor & Co. , New York. 698 pp.

Chapman, A.W. 1897. Flora of the southern United States. 3rd ed. American Book Company, New York. 655 pp.

Clemants, S.E. 2003. *Alternanthera*. In: K. Gandhi, R.W. Kiger, N.R. Morin, J.G. Packer, B.D. Parfitt, L.M. Shultz, R.W. Spellenberg, J.L. Zarucchi, J.L. Stother, and J.W. Thieret, eds. Flora of North America, vol. 4. Oxford University Press, New York. Pp. 447–450.

Clewell, A.F. 1985. Guide to the vascular plants of the Florida panhandle. Florida State University Press, Tallahassee. 605 pp.

Cochrane, T.S. 2002. *Carex* sect. *Heleoglochin*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J. L. Strother, eds. Flora of North America, vol. 23. Oxford University Press, New York. Pp. 278–281.

Coile, N.C. 1981. Flora of Elbert County, Georgia. Castanea 46:173–194.

Coile, N.C. 1988. Scientific notes: new to Georgia: *Neviusia alabamensis*, *Cotinus obovatus*, and *Stylophorum diphyllum*. Castanea 53:309–310.

Coile, N.C. and S.B. Jones, Jr. 1985. Georgia plant list: A list of the Georgia plants in the University of Georgia Herbarium. Department of Botany, University of Georgia. Athens. 69 pp.

Coile, N.C. and S.B. Jones, Jr. 1988. Checklist of the vascular flora of St. Catherines Island, Georgia. Am. Mus. Novit. 20:1–14.

Coile, N.C. and M.A. Garland. 2003. Notes on Florida's endangered and threatened plants. Botany Contribution No. 38, 4th ed. (PDF version). Florida Department of Agriculture & Consumer Services, Division of Plant Industry, Gainesville.

Constance, L. 1993. Apiaceae [Umbelliferae]. In: J.C. Hickman, ed. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley. Pp. 136–166.

Cook, C.D. 1987. *Ipomoea fistulosa*: A new problem for India? Aquaphyte 7:12.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation. Renner. 1881 pp.

Cronquist, A. 1980. Asteraceae. Vascular flora of the southeastern United States, vol. 1. University of North Carolina Press, Chapel Hill. 261 pp.

Darbyshire, S.J. 2007. *Schedonorus.* In: M.E. Barkworth, K.M. Capels, S. Long, L.K. Anderton and M.B. Piep, eds. Flora of North America, vol. 24. Oxford University Press, New York. Pp. 445–448.

Delahoussaye, A.G. and J.W. Thieret. 1967. *Cyperus* subgenus *Kyllinga* (Cyperaceae) in the continental United States. Sida 3:128–136.

Dennis, W.M. 1980. *Sarracenia oreophila* (Kearny) Wherry in the Blue Ridge Province of northeastern Georgia. Castanea 45:101–103.

Denton, M.F. 1978. A taxonomic treatment of the *Luzulae* group of *Cyperus*. Contr. Univ. Michigan Herb. 11:197–271.

Drew, M.B., L.K. Kirkman, and A.K. Gholson, Jr. 1998. The vascular flora of Ichauway, Baker County, Georgia: a remnant longleaf pine/wiregrass ecosystem. Castanea 63:1–24.

Duncan, W.H. 1971. *Angelica triquinata* (Umbelliferae) southward and *Lotus helleri* (Leguminosae) westward into Georgia. Castanea 36:163–164.

Duncan, W.H. 1975. Woody vines of the southeastern United States. University of Georgia Press, Athens. 75 pp.

Duncan, W.H. 1982. The vascular vegetation of Sapelo Island, Georgia. Department of Botany, University of Georgia, and Georgia Department of Natural Resources, Athens. 75 pp.

Duncan, W.H. 1985. Ten additions to the vascular flora of Georgia. Castanea 50:52–55.

Duncan, W.H. and M.B. Duncan. 1978. *Elliottia* in the Piedmont of Georgia. Castanea 43:182–184.

Duncan, W.H., and D. Funderburk. 1972. *Lycopodium appressum* adventive in the Blue Ridge of Georgia. Amer. Fern J. 62:30.

Duncan, W.H. and J.T. Kartesz. 1981. Vascular flora of Georgia: an annotated checklist. University of Georgia Press, Athens.

Echols, S.L. and W.B. Zomlefer. In press. Vascular plant flora of the remnant Blackland Prairies in Oaky Woods Wildlife Management Area, Houston County, Georgia. Castanea.

Elliott, S. 1816–1821. Sketch of the botany of South Carolina and Georgia, vol. 1. J.R. Schenck, Charleston. 606 pp., 6 pl.

Elliott, S. 1821–1824. Sketch of the botany of South Carolina and Georgia, vol. 2. J.R. Schenck, Charleston. 743 pp., 6 pl.

Eyles, D.E. 1940. Three species of *Eleocharis* new to Georgia. Castanea 5:98–99.

Faden, R.B. 2000. *Tradescantia*. In: Flora of North America Editorial Committee, eds. Flora of North America, vol. 22. Oxford University Press, New York. Pp. 173–187.

Faircloth, W.R. 1970. An occurrence of *Elliottia* in central south Georgia. Castanea 35:58–61.

Faircloth, W.R. 1971. The vascular flora of central south Georgia. Master's thesis, University of Georgia, Athens. 217 pp.

Faircloth, W.R. 1975. Ferns and other primitive vascular plants of central south Georgia. Castanea 40:217–228.

Faircloth, W.R. 1981. *Diplazium japonicum* and *Selaginella uncinata* newly discovered in Georgia. Amer. Fern J. 71:48–50.

Fernald, M.L. 1950. Gray's manual of botany. 8th ed. American Book Co. New York. 1632 pp.

Flagg, R.O., G.L. Smith and W.S. Flory. 2002. *Habranthus*. In: G.W. Argus, K. Gandhi, P. Goldblatt, W.J. Hess, R.W. Kiger, J.L. Strother, F.H. Utech and J.L. Zarucchi, eds. Flora of North America, vol. 26. Oxford University Press, New York. Pp. 281–282.

FLEPPC. 2007. List of Florida's invasive plant species. Florida Exotic Pest Plant Council. Internet: http://www.fleppc.org/07list.htm or Wildland Weeds 10(4), Fall 2007.

Freckmann, R.W. and M.G. Lelong. 2003a. *Dichanthelium*. In: M.E. Barkworth, K.M. Capels, S. Long and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 406–450.

Freckmann, R.W. and M.G. Lelong. 2003b. *Panicum*. In: M.E. Barkworth, K.M. Capels, S. Long and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 450–488.

Fryxell, P.A. 1988. Malvaceae of Mexico. Syst. Bot. Monogr. 25:1–522.

Gleason, H. A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada, 2nd ed. The New York Botanical Garden, Bronx, New York. 910 pp.

Godfrey, R.K. 1988. Trees, shrubs, and woody vines of northern Florida and adjacent Georgia and Alabama. University of Georgia Press, Athens. 734pp.

Godfrey, R.K. and R. Kral. 1958. Observations on the Florida flora. Brittonia 10:166–177.

Godfrey, R.K. and J.W. Wooten. 1979. Aquatic and wetland plants of southeastern United States: Monocotyledons. University of Georgia Press, Athens. 712 pp.

Godfrey, R.K. and J.W. Wooten. 1981. Aquatic and wetland plants of southeastern United States: Dicotyledons. University of Georgia Press, Athens. 933 pp.

Godfrey, R.K. 1988. Trees, shrubs, and woody vines of northern Florida and adjacent Georgia and Alabama. University of Georgia Press, Athens. 734 pp.

Goldblatt, P. 2002. *Crocosmia*. In: G.W. Argus, K. Gandhi, P. Goldblatt, W.J. Hess, R.W. Kiger, J.L. Strother, F.H. Utech and J.L. Zarucchi, eds. Flora of North America, vol. 26. Oxford University Press, New York. Pp. 402–403.

Haines, R.W. and K. A. Lye. 1983. The sedges and rushes of East Africa. East African Natural History Society, Nairobi. 404 pp.

Hall, D.W. and D.T. Patterson. 1992. Itchgrass: Stop the trains. Weed Technol. 6:239–241.

Harper, R.M. 1900a. Notes of the flora of middle Georgia. Bull. Torrey Bot. Club 27:320–341.

Harper, R.M. 1900b. Notes on the flora of south Georgia. Bull. Torrey Bot. Club 27:413–436.

Harper, R.M. 1901. On a collection of plants made in Georgia in the summer of 1900. Bull. Torrey Bot. Club 28:454–484, pl. 29.

Harper, R.M. 1903a. Botanical explorations in Georgia during the summer of 1901—I. Itinerary. Bull. Torrey Bot. Club 30:282–295.

Harper, R.M. 1903b. Botanical explorations in Georgia during the summer of 1901—II. Noteworthy species. Bull. Torrey Bot. Club 30:319–342.

Harper, R.M. 1904. Explorations in the coastal plain of Georgia during the season of 1902. Bull. Torrey Bot. Club 31:9–27.

Harper, R.M. 1905a. Phytogeographical explorations in the coastal plain of Georgia in 1903. Bull. Torrey Bot. Club 32:141–171.

Harper, R.M. 1905b. Phytogeographical explorations in the coastal plain of Georgia in 1904. Bull. Torrey Bot. Club 32:451–467.

Harper, R.M. 1906a. A phytogeographical sketch of the Altamaha grit region of the coastal plain of Georgia. Ann. New York Acad. Sci.17:1–414, 28 pl., map.

Harper, R.M. 1906b. Some new or otherwise noteworthy plants from the coastal plain of Georgia. Bull. Torrey Bot. Club 33:229–245.

Harper, R.M. 1909. Some coastal plain plants in the piedmont region of Georgia. Bull. Torrey Bot. Club 36:583–593.

Harper, R.M. 1910. Notes on the distribution of some plants observed in traveling through the coastal plain from Georgia to New York in July, 1909. Bull. Torrey Bot. Club 37:591–603.

Haynes, R.R. and C.C. Jacono. 2000. Scientific Note: Status of *Salvinia* (Salviniaceae) in Alabama. Castanea 65:225–227.

Hays, III, J.F. 2002. *Agalinis* Raf. (Scrophulariaceae) of the East Gulf Coastal Plain. Master's thesis, University of Louisiana, Monroe. 101 pp.

Hill, S.R. and C.N. Horn. 1997. Additions to the flora of South Carolina. Castanea 62:194–208.

Hitchcock, A.S. and A. Chase. 1951 [title page 1950]. Manual of the grasses of the United States, 2nd ed., rev. by A. Chase. USDA Misc. Publ. 200, Washington, D.C. 1051 pp.

Holmes, W.C. 2000. Noteworthy collections: Georgia: *Mikania cordifolia* (L. f.) Willd. (Compositae). Castanea 65:299.

Holmgren, P.K. and N.H. Holmgren. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/

Hooper, S. S. and D.M. Napper. 1972. Cyperaceae. In: F.N. Hepper, Flora of West Tropical Africa. Crown Agents for Oversea Governments and Administrations, London. Pp. 278–349.

Houle, G. 1987. Vascular plants of Arabia Mountain, Georgia. Bull. Torrey Bot. Club 114:412–418.

Howel, C.L. 1991. Floristics of two state parks in the piedmont of Georgia: Indian Springs and High Falls. Castanea 56:38–50.

Hunt D.M. 1986. Distribution of *Quercus arkansana* in Georgia. Castanea 51:183–187.

Hunt, T. and K. Langeland. 2008. Exotic plant species of Cumberland Island, Georgia. Nat. Areas J. 28:299–306.

Isley, D. 1990. Leguminosae (Fabaceae). Vascular flora of the southeastern United States, vol. 3(2). University of North Carolina Press, Chapel Hill. 258 pp.

Jacono, C.C. 1999. *Salvinia molesta* (Salviniaceae), new to Texas and Louisiana. Sida 18:927–928.

Jacono, C.C., T.R. Davern, and T.D. Center. 2001. The adventive status of *Salvinia minima* and *S. molesta* in the southern United States and the related distribution of the weevil *Cyrtobagous salviniae*. Castanea 66:214–226.

Jenkins, R.A. and P.D. McMillan. 2005. Noteworthy collections: South Carolina, Georgia. Castanea 70:76–77.

Jensen, J.B. 2007. Georgia's newest plant: Panhandle meadowbeauty (*Rhexia salicifolia*). BotSoc News 81(5):1,3.

Jones, S.B., Jr., 1974. The flora and phytogeography of the Pine Mountain region of Georgia. Castanea 39:113–149.

Jones, S.B., Jr. and N.C. Coile. 1988. The distribution of the vascular flora of Georgia. Department of Botany, University of Georgia, Athens.

Judd, W.S. 2003. New and Noteworthy Collections from Florida. Castanea 68:81–83.

Keil, D.J. 2006. *Pectis*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych and J.L. Zarucchi, eds. Flora of North America, vol. 21. Oxford University Press, New York. Pp. 222–230.

Kessler, J.W. 1983. Range extensions for Cyperaceae in Louisiana and Texas. Sida 10:92.

Kral, R. 1960. A revision of *Asimina* and *Deeringothamnus* (Annonaceae). Brittonia 12:233–278.

Kral, R. 1978. A synopsis of *Fuirena* (Cyperaceae) for the Americas north of South America. Sida 7:309–354.

Kral, R. 1981. Further additions to some notes on the flora of the southern states, particularly Alabama and middle Tennessee. Rhodora 83:301–315.

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the south. Two volumes. USDA Forest Service, Technical Publication R8-TP 2, Atlanta. 1305 pp.

Kral, R. 1997. Annonaceae. In: N.R. Morin, ed. Flora of North America, vol. 3. Oxford University Press, New York. pp. 11–20.

Kral, R. and P.E. Bostick. 1969. The genus *Rhexia* (Melastomataceae). Sida 3:387–440.

Lane, R.L. 1976. The vascular flora of the west-central upper coastal plain of Georgia. Master's thesis, University of Georgia, Athens. 132 pp.

Langeland, K.A. and K.C. Burks, eds. 1998. Identification and biology of non-native plants in Florida's natural areas. University of Florida, Gainesville. 165 pp.

Lasseter, J.S. 1984. Taxonomy of the *Vicia ludoviciana* complex (Leguminosae). Rhodora 86:475–505.

LeBlond, R. J. 2001. Taxonomy of the *Dichotoma* group of *Dichanthelium* (Poaceae). Sida 19:821–837.

Leslie, K.A. and M.P. Burbanck. 1979. Vegetation of granitic outcroppings at Kennesaw Mountain, Cobb County, Georgia. Castanea 44:80–87.

Lipps, E.L. and H.R. De Selm. 1969. The vascular flora of the Marshall Forest, Rome, Georgia. Castanea 34:414–432.

Lipscomb, B.L. 1980. *Cyperus difformis* L. (Cyperaceae) in North America. Sida 8:320–327.

Little, E.L., Jr. 1971. Atlas of United States trees, volume 1, conifers and important hardwoods. USDA Misc. Publ. 1146, Washington, DC. 9 p., 200 maps.

Long, R.W. and O. Lakela. 1971. A flora of tropical Florida. University of Miami Press, Coral Gables. 962 pp.

Luer, C. 1972. The native orchids of Florida. The New York Botanical Garden. New York. 293 pp.

Luther, H.E. and G.K. Brown. 2000. *Tillandsia*. In: Flora of North America Editorial Committee. Flora of North America, vol. 22. Oxford University Press, New York. Pp. 288–296.

Lynch, J.M. and W.W. Baker. 1988. Natural areas inventory of the St. Mary's River, Georgia-Florida. Unpublished report to The Nature Conservancy.

Matthews, J.F., W.R. Faircloth, and J.R. Allison. 1991. *Portulaca biloba* Urban (Portulacaceae), a species new to the United States. Syst. Bot. 16:736–740.

McGivney, M.V. 1938. A revision of the subgenus *Eucyperus* found in the United States. Cathol. Univ. Am. Biol. Ser. 26:1–74.

McMillan, P.D., R.K. Peet, R.D. Porcher, and B.A. Sorrie. 2002. Noteworthy botanical collections from the fire-maintained pineland and wetland communities of the Coastal Plain of the Carolinas and Georgia. Castanea 67:61–83.

McVaugh, R., and J.H. Pyron. 1951. Ferns of Georgia. University of Georgia Press, Athens. 195 pp.

Mears, R.L. and G.W. Libby. 1995. New records of *Cyperus* (Cyperaceae) from Kentucky. Castanea 60:79–82.

Miller, A.E., Douce G.K., Murphy, T.R., Watson, B.T., and T.J. English. 1997. Small Broomrape, *Orobanche minor* Smith (Factsheet). University of Georgia Cooperative Extension Service in cooperation with USDA-APHIS-PPQ. GACAPS 0497-1 April 1997.

Missouri Botanical Garden. 2008. w³TROPICOS VAST database (rev. 1.5), http://mobot.mobot.org/W3T/Search/vast.html [last accessed 15 March 2008]. St. Louis, Missouri.

Mohr, C. 1901. Plant life of Alabama. Contr. U.S. Natl. Herb. 6, Washington, D.C. 921 pp.

Muir, M.A. 1979. Distribution and identification of the Onagraceae in Georgia. Castanea 44:114–125.

Musselman, L.J. 1988. Weedy populations of *Orobanche uniflora* in Georgia. Haustorium No. 20 (June), pages not numbered.

Naczi, R.F.C., C.T. Bryson, and T.S. Cochrane. 2002. Seven new species and one new combination in *Carex* (Cyperaceae) from North America. Novon 12:508–532.

Nesom, G.L. 2004. Notes on the distribution of *Pseudognaphalium luteoalbum* (Asteraceae: Gnaphalieae). Sida 21:463–464.

Nesom, G.L. 2006a. *Pseudognaphalium*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 19. Oxford University Press, New York. Pp. 415–425.

Nesom, G.L. 2006b. *Liatris*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 21. Oxford University Press, New York. Pp. 512–535.

Norsworthy, J. 1966. Fern records for Echols County and the state of Georgia. Amer. Fern J. 56:55–57.

O'Neill, H.T. 1939. The status and distribution of *Cyperus distinctus* Steud. Rhodora 41:131–133.

Patrick, T.S., J.R. Allison, and G.A. Krakow. 1995. Protected plants of Georgia. Georgia Department of Natural Resources, Social Circle. 246 pp.

Pennell, F.W. 1935. The Scrophulariaceae of eastern temperate North America. Proc. Acad. Nat. Sci. Philadelphia 1:1–650.

Peterson, P.M., S.L. Hatch, and A.S. Weakley. 2003. *Sporobolus*. In: M.E. Barkworth, K.M. Capels, S. Long and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 115–139.

Porcher, R.D. 1977. The rediscovery of *Triphora trianthophora*, three birds orchid, in the coastal plain of S.C. Castanea 42:108–11.

Porcher, R.D. 1978. *Boerhaavia diffusa* L. (*B. coccinea* Mill.) (Nyctaginaceae) in the Carolinas. Castanea 43:172–74.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill. 1183 pp.

Ramey, V.,ed. 1990. Florida prohibited aquatic plants. D.N.R. Bureau of Aquatic Plant Management, Tallahassee. Pages not numbered.

Reese, W.D. 1992. Acadiana flora: Native and naturalized woody plants of south-central Louisiana. Center for Louisiana Studies, University of Southwestern Louisiana, Lafayette. 126 pp.

Rogers, K.E. and F.D. Bowers. 1973. Notes on Tennessee plants III. Castanea 38:335–339.

Romero-González, G.A. 2002. *Pteroglossaspis*. In: G.W. Argus, K. Gandhi, P. Goldblatt, W.J. Hess, R.W. Kiger, J.L. Strother, F.H. Utech and J.L. Zarucchi, eds. Flora of North America, vol. 26. Oxford University Press, New York. Pp. 641–642.

Rosen, D.J. 2004. Noteworthy collections of *Cyperus drummondii* (Cyperaceae) from Texas. Sida 21:495–497.

Rosen, D.J. 2006. A systematic study of select species complexes of *Eleocharis* subgenus *Limnochloa* (Cyperaceae). Ph.D. dissertation, Texas A. & M. University, College Station. 228 pp.

Rosen, D.J. and R. Carter. 2007. Additional noteworthy collections of *Cyperus drummondii* (Cyperaceae) from Texas and first report from Mexico. J. Bot. Res. Inst. Texas. 1:779–780.

Rosen, D.J., R. Carter, and C.T. Bryson. 2006. The spread of *Cyperus entrerianus* (Cyperaceae) in the southeastern United States and its invasive potential in bottomland hardwood forests. Southeastern Naturalist 5:333–344.

Russell, G.E.G. and W.H. Duncan. 1972. An annotated checklist of *Carex* (Cyperaceae) in Georgia. Castanea 37:200–214.

Ruter, J.M., G. Krewer, and W.R. Faircloth. 1995. A new location for *Elliottia racemosa* Muhl. ex Ell. (Ericaceae) in southwest Georgia. Castanea 60:370–371.

Saltonstall, K., P.M. Peterson, and R.J. Soreng. 2004. Recognition of *Phragmites australis* subsp. *americanus* (Poaceae: Arundinoideae) in North America: Evidence from morphological and genetic analysis. Sida 21:683–692.

Schery, R.W. 1972. Plants for man, 2nd ed. Prentice-Hall, Inc. Englewood Cliffs. 657 pp.

Semple, J.C. and R.E. Cook. 2006. *Solidago*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 20. Oxford University Press, New York. Pp. 107–166.

Singhurst, J.R., W.J. Ledbetter, and W.C. Holmes. 1997. *Ardisia crenata* (Myrsinaceae): New to Texas. Southwestern Naturalist 42:503–504.

Small, J.K. 1903. Flora of the southeastern United States. Published by the author, New York. 1370 pp.

Small, J.K. 1913. Flora of the southeastern United States, 2nd ed. Published by the author, New York. 1394 pp.

Small, J.K. 1933. Manual of the southeastern flora. University of North Carolina Press, Chapel Hill. 1554 pp.

Smith, S.G. 2002. *Schoenoplectus*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J.L. Strother, eds. Flora of North America, vol. 23. Oxford University Press, New York. Pp. 44–60.

Smith, S.G., J. J. Bruhl, M. S. Gonzalez-Elizondo, and F. J. Menapace. 2002. *Eleocharis*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J.L. Strother, eds. Flora of North America, vol. 23. Oxford University Press, New York. Pp. 60–120.

Snyder, L.H, Jr. and J.G. Bruce. 1986. Field guide to the ferns and other pteridophytes of Georgia. University of Georgia Press, Athens. 270 pp.

Sorrie, B.A. 1998. Noteworthy Collections: Georgia. Castanea 63:496–500.

Sorrie, B.A. 2000. *Rhynchospora leptocarpa* (Cyperaceae), an overlooked species of the southeastern United States. Sida 19:139–147.

Standley, L.A. 2002. *Carex* sect. *Multiflorae*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J.L. Strother, eds. Flora of North America, vol. 23. Oxford University Press, New York. Pp. 281–285.

Stanford, J.W. and G.M. Diggs, Jr. 1998. *Pteris vittata* (Pteridaceae), a new fern for Texas. Sida 18:359–360.

Stiles, B.J. and C.L. Howel. 1994. Noteworthy collection: *Stellaria graminea* L. Castanea 59:367.

Stiles, B.J. and C.L. Howel. 1996. Preliminary results of a floristic survey of Rabun County, Georgia. Castanea 61:62–85.

Stiles, B.J. and C.L. Howel. 1998. Floristic survey of Rabun County, Georgia, Part II. Castanea 63:154–160.

Straley, G.B. and F.H. Utech. 2002. *Asparagus*. In: G.W. Argus, K. Gandhi, P. Goldblatt, W.J. Hess, R.W. Kiger, J.L. Strother, F.H. Utech and J.L. Zarucchi, eds. Flora of North America, vol. 26. Oxford University Press, New York. Pp. 213–214.

Strong, M.T. and R.H. Simmon. 2002. Noteworthy Collections. Castanea 67:331–332.

Strother, J.L. 2006a. *Ambrosia*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 21. Oxford University Press, New York. Pp. 10–18.

Strother, J.L. 2006b. *Parthenium*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 21. Oxford University Press, New York. Pp. 20–22.

Strother, J.L. 2006c. *Verbesina*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 21. Oxford University Press, New York. Pp. 106–111.

Strother, J.L. 2006d. *Acmella*. In: T.M. Barkley, L. Brouillet, H. Jeude, J.L. Strother, K. Gandhi, R.W. Kiger, K. Yatskievych, and J.L. Zarucchi, eds. Flora of North America, vol. 21. Oxford University Press, New York. Pp. 132–133.

Sweeney, P.W. and D.E. Giannasi. 2000. The Vascular plant distribution atlas of Georgia: Pteridophytes, Gymnosperms, Monocots. (www.plantbio.uga.edu/herbarium/GeorgiaAtlas/; posted June 2007)

Tharp, B.C. and M.C. Johnston. 1961. Recharacterization of *Dichondra* (Convolvulaceae) and a revision of the North American species. Brittonia 13:346–360.

Thorne, R.F. 1949a. Inland plants on the Gulf Coastal Plain of Georgia. Castanea 14:88–97.

Thorne, R.F. 1949b. The flora of southwestern Georgia. Ph.D. dissertation, Cornell University, Ithaca. 660 pp.

Thorne, R.F. 1951. Vascular plants previously unreported from Georgia. Castanea 16:29–48.

Torrey, J. 1836. Monograph of North American Cyperaceae. Ann. Lyceum Nat. Hist. New York 3:249–288.

Townsend, J.F., R. Carter, R.D. Porcher, and P.D. McMillan. 2000. Noteworthy collections: Georgia and South Carolina – *Sesbania drummondii*. Castanea 65:231–232.

Tucker, G.C. 2002. *Lipocarpha*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J.L. Strother, eds. Flora of North America, vol. 23. Oxford University Press, New York. Pp. 195–197.

Tucker, G. C., B. G. Marcks, and J. R. Carter. 2002. *Cyperus*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J.L. Strother, eds. Flora of North America, vol. 23. Oxford University Press, New York. Pp. 141–191.

Tyndall, R.W. 1983. Distribution of *Cyperus difformis* L. (Cyperaceae) in the southeastern United States. Castanea 48:277–280.

U.S.D.A. 2008. Plants Database. United States Department of Agriculture, National Resources Conservation Service. Online database, last accessed 14 January 2008, http://plants.usda.gov/

Venard, H. 1969. Bibliography of Georgia botany. Castanea 34:267–306.

Ward, D.B. and C.C. Jacono. 2009. *Phragmites australis* (common reed), a looming threat to Florida wetlands. Wildland Weeds. 12(2): 7–9.

Weakley, A.S. 2008. Flora of the Carolinas, Virginia, Georgia, northern Florida, and surrounding areas. Working Draft: 7 April 2008. University of North Carolina Herbarium (NCU), North Carolina Botanical Garden, University of North Carolina, Chapel Hill. 924 pp.

Webb, D.H., W.M. Dennis, and T.S. Patrick. 1981. Distribution and naturalization of *Cyperus brevifolioides* (Cyperaceae) in eastern United States. Sida 9:188–190.

Whittemore, A.T. and L.L. Gaddy. 1997. *Hexastylis*. In: N.R. Morin, ed. Flora of North America, vol. 3. Oxford University Press, New York. Pp. 54–58.

Whetstone, R.D., C.L. Lawler, L.H. Hopkins, A.L. Martin, and C.C. Dickson. 1987. Scientific notes: Kral's water-plantain, *Sagittaria secundifolia* Kral (Alismataceae), new to Georgia. Castanea 52:313–314.

Williams, J.K. 1994. *Emilia fosbergii* (Asteraceae: Senecioneae), a new introduction to Texas. Sida 16:378–379.

Wipff, J.K. 2003a. *Amphicarpum*. In: M.E. Barkworth, K.M. Capels, S. Long and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 385–388.

Wipff, J.K. 2003b. *Melinis.* In: M.E. Barkworth, K.M. Capels, S. Long and M.B. Piep, eds. Flora of North America, vol. 25. Oxford University Press, New York. Pp. 490–492.

Woods, M. and A.R. Diamond, Jr. 2003. Noteworthy Collections: Alabama. Castanea 68:91–92.

Wunderlin, R.P. and B.F. Hansen. 2003. Guide to the vascular plants of Florida, 2nd ed. University Press of Florida. Gainesville. 787 pp.

Wunderlin, R.P. and B.F. Hansen. 2008. Atlas of Florida vascular plants (http://www.plantatlas.usf.edu/). [S. M. Landry and K. N. Campbell (application development), Florida Center for Community Design and Research.] Institute for Systematic Botany, University of South Florida, Tampa.

Zomlefer, W.B., D.E. Giannasi, K. Bettinger, L. Echols, and L.M. Kruse. 2008. Vascular plant survey of Cumberland Island National Seashore, Camden County, Georgia. Castanea 73:251–382.

CYPERUS PILOSUS (CYPERACEAE) NEW TO THE FLORA OF TEXAS

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ABSTRACT

Cyperus pilosus is reported new to Texas and a dichotomous key is presented to distinguish it from congeners in that state.

RESUMEN

Cyperus pilosus se cita nuevo para Texas y se presenta una clave dicotómica para diferenciarlo de sus congéneres en el estado.

Cyperus pilosus Vahl is widely distributed in tropical or subtropical areas of the Old World (Kükenthal 1935–1936). It is a common weed of rice in Asia (McGivney 1938; Bryson & Carter 2008) and is known from Hawaii based upon a single historical collection made in 1916 (Wagner et al. 1999). *Cyperus pilosus* was first reported in the continental United States from Louisiana, where it was apparently introduced from Asia as a contaminant of rice seed (O'Neill 1938). Subsequently, it has been reported from Florida (Burkhalter 1985), Mississippi (Bryson & Carter 1992), South Carolina (Tucker et al. 2002), and Georgia (Carter et al. 2009). *Cyperus pilosus* inhabits hydric soils of wet ditches, rice fields, edges of ponds, and wetlands. It has not previously been reported from Texas (Jones et al. 1997; Tucker et al. 2002; Diggs et al. 2006), and the nearest mapped locality is in nearby Calcasieu Parish, Louisiana (Thomas & Allen 1993).

The specific epithet *pilosus* is descriptive of the hispidulous rachis. The species is illustrated in Figure 1. If inserted in the key to *Cyperus* immediately after the first lead of couplet 8 on page 1133 in Diggs et al. (2006), the following couplet will enable the identification of *C. pilosus* in eastern Texas.

8. Plant with elongated slender rhizomes; culm sharply triquetrous, easily compressed ____________________ **C. pilosus**
8. Plant cespitose, without elongated rhizomes; culm subterete to obtusely trigonous, not easily compressed ____________________ **continue with couplet 9**

Voucher specimens: **TEXAS. Newton Co.:** Caney Creek Park, S of Hwy. US 190 in Newton, 30° 50' 842"N 93° 45' 802"W, 30 Oct 2008, *Allen and Lewis 21096* (VSC), *Allen and Lewis 21098* (BRIT, FTPK, VSC).

REFERENCES

Bryson, C.T. and R. Carter. 1992. Notes on *Cyperus* and *Kyllinga* (Cyperaceae) in Mississippi with records of six species new to the state. Sida 15:119–124.

Bryson, C.T. and R. Carter. 2008. The significance of Cyperaceae as weeds. In: R.F.C. Naczi and B.A. Ford, eds. Sedges: uses, diversity, and systematics of the Cyperaceae. Monogr. Syst. Bot. Missouri Bot. Gard. 108:15–101.

Burkhalter, J.R. 1985. *Aletris farinosa, Cyperus difformis*, and *Cyperus pilosus* new for Florida. Sida 11:247–248.

Carter, R., W.W. Baker, and M.W. Morris. 2009 Contributions to the flora of Georgia, U.S.A. Vulpia. In press.

Diggs, G.M., B.L. Lipscomb, and R.J. O'Kennon. 2006. Illustrated flora of east Texas. Sida, Bot. Misc. 26:1–1594.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas. Univ. of Texas Press, Austin.

Kükenthal, G. 1935–1936. Cyperaceae-Scirpoideae-Cypereae. In A. Engler, ed., Pflanzenreich IV. 20 (Heft) 101:1–671.

J. Bot. Res. Inst. Texas 3(1): 457 – 459. 2009

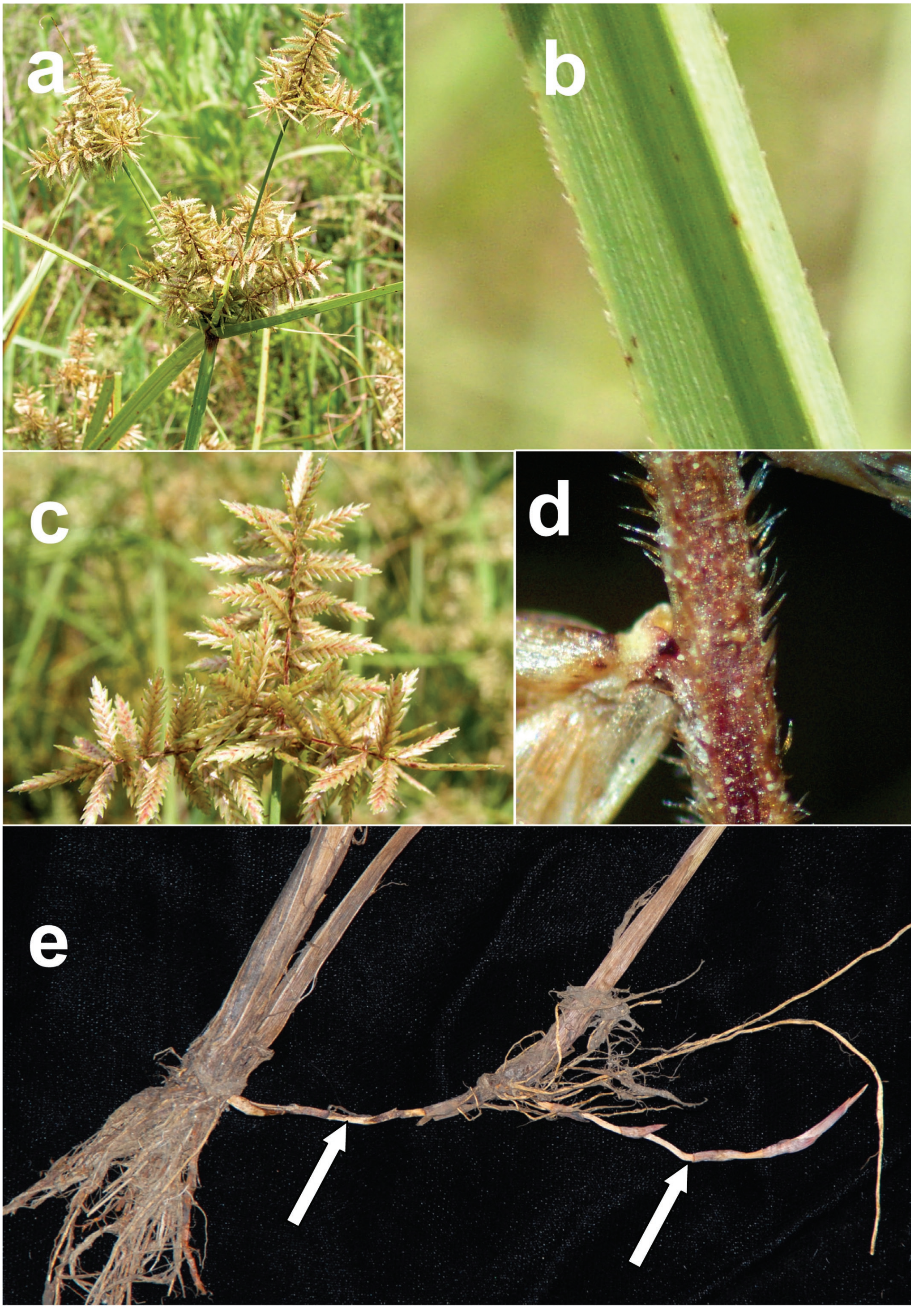

Fig. 1. ***Cyperus pilosus*. 1a.** Inflorescence habit. **1b.** Detail of triquetrous culm showing antrorse prickle hairs on wing-edges. **1c.** Inflorescence ray with spikelets. **1d.** Hispidulous rachis. **1e.** Rhizomes (arrows) and connected bases of culms. Photographs from *R. Carter 16081,* Bacon County, Georgia.

McGivney, M.V. 1938. A revision of the subgenus *Eucyperus* found in the United States. Cathol. Univ. Amer. Biol. Ser. 26:1–74.

O'Neill, H.T. 1938. *Cyperus pilosus* Vahl in the United States. Rhodora 40:74.

Thomas, R.D. and C.M. Allen. 1993. Atlas of the vascular flora of Louisiana, vol.1: Ferns & fern allies, conifers & monocotyledons. Louisiana Department of Wildlife & Fisheries, Baton Rouge.

Tucker, G.C., B.G. Marcks, and J.R. Carter. 2002. *Cyperus*. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, and J.L. Strother, Flora of North America, vol. 23. Oxford Univ. Press. New York. Pp. 141–191.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the flowering plants of Hawai`i (rev. ed.). 2 vols. Bishop Mus. Spec. Pub. 97. Univ. Hawaii and Bishop Museum Press. Honolulu.

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The potential dispersal of Benghal dayflower seeds by mourning doves was studied in southern Georgia, U.S.A. The gut contents (both crop and gizzard) of mourning doves harvested in the autumn months were investigated to determine if mourning doves fed on Benghal dayflower and whether seeds can survive conditions in the bird gut. Research indicated that mourning doves fed selectively on Benghal dayflower with some harvested birds containing hundreds of Benghal dayflower seeds and capsules in their guts. Further, some seeds recovered remained highly viable. Germination rates in seeds taken from bird crops were similar to controls over the first 4 wk of germination and enhanced over control treatments during the latter 16 wk of a 20-wk germination study. Ultimately, seeds extracted from dove crops had 92% germination as compared to 80% for control seeds. Seeds extracted from dove gizzards had 45% germination, about half that of controls. Benghal dayflower seeds have a structurally reinforced seed coat that probably aids in survival of mechanical damage through bird intestinal tracts. Benghal dayflower seeds exposed to 1.0 M HCl treatment for 2 h had little loss in viability, successfully germinating after such treatment. When evaluating mechanisms for the eradication of Benghal dayflower from agricultural crops, consideration needs to be given to the large number of mourning doves and other bird species that visit cropland and potentially aid in its dispersal.

Nomenclature: Benghal dayflower, *Commelina benghalensis* L. COMBE; mourning dove, *Zenaida macroura* L.
Key words: Exotic weed, Federal Noxious Weed List, frugivory, granivory, invasive species, invasive weed, seed dispersal, tropical spiderwort.

Benghal dayflower, also known as tropical spiderwort, is an introduced noxious weed that infests many agricultural crops throughout the world (Holm et al. 1977). The weed is a tenacious competitor with crop plants, becoming entrenched in agricultural fields because of its tolerance to many commonly used herbicides, particularly glyphosate (Owen and Zelaya 2005; Webster et al. 2005); its ability to propagate vegetatively from broken stem pieces (Budd et al. 1979); and its variable growth habit with negative, positive, and diagravitropic branches that produce both aerial and underground flowers, fruits, and seeds (Maheshwari and Singh 1934). Additionally, Benghal dayflower can harbor plant pathogens (Davis et al. 2006; Desaeger and Rao 2000) and has been associated with outbreaks of epidemic proportion in agricultural crops (Gibbs 2002; Kucharek et al. 1998).

Although Benghal dayflower was identified in the United States from collections as early as 1928 and was established in Florida by the 1930s (Faden 1993), only with the relatively recent introduction of genetically modified, glyphosate-resistant crop plants has this weed become problematic in agronomic crops (Culpepper et al. 2004). The evidence and opinion of agricultural experts support the fact that Benghal dayflower in the southeastern United States is becoming one of the most troublesome weeds in crops because of glyphosate-induced shifts in weed species composition (Culpepper 2006). Prior to 2001, this weed was virtually unknown as an agricultural pest in agronomic crops of the southeastern United States. To explain the rapidity of expansion of Benghal dayflower throughout the southeastern United States and to evaluate control measures, it is necessary to understand the biology of its seed dispersal as well as the invasion ecology attributed to the species' glyphosate tolerance.

Very little is known about how Benghal dayflower has explosively dispersed through many counties in Georgia, except for reports of infestations in plant nurseries distributing container ornamentals (Durham 2006). Frugivory and granivory, particularly by birds, provides a vector by which fruits and seeds can be transported to new environments. Seed passage through bird guts can enhance or inhibit germination depending on the particular type of seed and bird (Robertson et al. 2006). Mourning doves are among the top ten most abundant migratory game birds in the United States, ranging from Canada throughout the United States. These doves are found in a variety of habitats from open woodland to forest edges, grasslands, and fields, and in agricultural and suburban areas (Mirarchi and Baskett 1994). Mourning doves are common in residential areas as well as agricultural and wild habitats and appear little affected by human activity. Indeed, during hunting season, doves are known to use residential areas as refugia (Losito and Mirarchi 1991). Mourning doves are frequent visitors to row crop fields, and data show that they have relatively equal preferences for cultivated and wild fields (Best et al. 1997).

Little is known about specific feeding preferences in mourning doves except that wild mourning doves forage selectively, but with variable preferences (Hayslette and Mirarchi 2001). The present study was undertaken to determine if wild mourning doves harvested in Georgia in locations abundant with Benghal dayflower consume seeds of this weed and if Benghal dayflower seed can survive conditions in the bird gut.

Materials and Methods

Wild mourning doves were harvested during one of three legal dove seasons in the autumn of each year from 2003 to

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2006. Doves harvested from 2003 to 2005 were taken from Grady County, GA, and those from 2006 were taken either from Cook or Berrien counties, GA. In all cases, doves were hunted in locations known to have infestations of Benghal dayflower in area crops.

Gut contents from doves were removed shortly after harvest. In most cases, dove handling was not controlled until the birds reached the laboratory. In 2006, efforts were made to ensure that freshly harvested doves were placed on ice in the field for transport to the laboratory. Dove gut contents were removed in the laboratory, and the contents of crop and gizzard were combined to determine if birds ingested Benghal dayflower seeds and capsules. After extraction, the contents were rinsed with deionized water, then spread on paper towels and allowed to air dry at room temperature. Dry contents from each dove were placed into labeled specimen envelopes and stored at room temperature before observation and testing. In 2006, freshly harvested doves from Berrien County were further processed to separate gut contents into crop and gizzard contents unless those organs were damaged. Seeds of Benghal dayflower are quite distinctive (Scher 2005) and were easily identified and separated from dove gut contents. To confirm that seeds from dove contents were identified correctly, seeds extracted from the gizzard of a dove harvested in Berrien County were germinated and grown in pots to maturity, at which time voucher specimens were prepared and submitted to the Valdosta State University Herbarium (voucher specimen: U.S.A. Georgia. Berrien County: Plant grown in laboratory from seed extracted from gizzard of a mourning dove identified as *Berrien.03* harvested in Berrien County, December 6, 2006; seed planted May 1, 2007; voucher harvested August 4, 2007, *Carter 17903* [VSC]).

Seed Viability. Seed viability was tested with 1% 2,3,5-triphenyl tetrazolium chloride[1] (TZ) using the methods of Peters (2000). Prior to testing, Benghal dayflower seeds were imbibed at 32.5 C between filter paper[2] soaked with deionized water in plastic petri dishes for approximately 48 h in a plant growth chamber[3] in the dark. Imbibed seeds were bisected with a clean razor blade and placed section-side down in drops of 1% TZ in phosphate buffer (pH 7.0). Seeds were then incubated in TZ in the dark for 12 h at 32.5 C before observation. All control seeds used in TZ experiments were collected from aerial flowers from greenhouse-grown or field-collected Benghal dayflower plants in 2003. Boiled and unboiled mature seeds of Benghal dayflower were used as negative and positive controls, respectively. Staining was recorded by photographing stained, sectioned embryos.

Seed Sterilization, Scarification, and Germination. For germination tests, seeds were sown directly in sterile petri dishes onto autoclaved filter paper soaked in sterile deionized water. In all germination tests reported, 100 seeds were used and distributed into five replicates of 20 seeds each. Where noted, wild seeds were sterilized with commercial bleach solutions before testing. For this, seeds were first imbibed for 24 to 48 h in deionized water or running tap water before being placed in 10% bleach containing 0.1% polyoxyethylene sorbitan monolaurate solution[4] as a wetting agent for 30 min. Seeds were given a 15-min rinse in sterile deionized water, changing the sterile water at least one time, before processing further.

The germination of seeds extracted from several doves was tested, with more extensive tests conducted on seeds extracted from doves harvested in 2006 from Berrien County. Doves from this collection had seed extracted from separate crop and gizzard organs, and Benghal dayflower seeds were recovered in relatively large quantity. Two doves were first tested from the 2006 harvest, Berrien.02 and Berrien.03, by sowing 100 seeds from each bird's crop and gizzard onto sterile filter paper soaked with sterile deionized water. Despite high germination rates in these tests, results were variable between organ replicates, possibly because of extensive microbial growth that may have interfered with germination. Therefore, a subsequent germination test of seeds extracted from crop or gizzard from two remaining doves (Berrien.01 and Berrien.06) with substantial numbers of seeds in both crop and gizzard were tested. For this, however, 20 seeds per replicate were dispersed in a 2% solution of an antimicrobial preservative medium developed for plant tissue culture (PPM[5]) for 12 h. Seeds were dried briefly on sterile filter paper then arranged in petri dishes over filter paper soaked in sterile deionized water containing 0.2% PPM to retard microbial growth during the germination tests. Similar replicates of control seeds were also treated with PPM as above for a positive control, and an identical test without PPM treatment of wild seeds was used as a negative control. All control seeds in this test were from aerial flowers collected from greenhouse grown plants in 2006.

The need for seed scarification to break dormancy was tested in Benghal dayflower aerial seeds collected in 2006. Replicate tests (five by 20 seeds) were used for each treatment, and the entire test was repeated three times, staggering the commencement of the test in 2-wk intervals. Wild seeds tested were imbibed for 24 h in sterile deionized water then processed to surface-sterilize the seeds with bleach as described previously. Bleach-sterilized control seeds not treated in acid were sown on wetted filter paper with no further treatment. Two sets of control seeds were prepared: one set was left uncovered in the light identical to the treatments for the acid scarified seeds, and the other set was covered in two layers of foil[6] to incubate simultaneously in the dark. The dark-treated controls remained covered in the dark for 12 wk of the 20-wk germination test, when the foil was removed and the seeds were exposed to light conditions for the remaining period. Acid scarification treatments included 0.1 M HCl (equivalent to strong avian stomach acid; Welty and Baptista, 1988) for 1, 2, or 4 h; 1.0 M HCl for 1 or 2 h; or 12 M HCl for 1 h. All acid treatments included a 15-min rinse in sterile water (two changes) after acid treatment and prior to seed sowing. Each treatment was sown in sterile petri dishes with autoclave-sterilized filter paper soaked in sterile deionized water. Petri plates were sealed[7] and incubated at 32.5 C in plant growth chambers[3] on a 12 h/12 h light/dark cycle. All germination tests were monitored for 20 wk after sowing and sterile deionized water added as needed to ensure that petri plate moisture remained high. A seed was considered germinated once a radicle emerged and was clearly visible, approximately 2 mm in length. Germination data were recorded at 1, 2, 4, 8, 12, 16, and 20 wk after treatment (WAT).

Statistical Analysis. Seed germination data were analyzed at 4, 12, and 20 WAT using PROC Mixed in SAS,[8] with variances partitioned into random effects of trial and

Table 1. Summary of mourning doves harvested by year from 2003 to 2006 and the total number of doves recovered with Benghal dayflower seeds. All doves harvested in 2003 to 2005 were taken in Grady County, GA. Doves harvested in 2006 were from Cook or Berrien counties, GA as noted.

Year	Doves harvested	Doves with Benghal dayflower seeds	Total Benghal dayflower seeds recovered	Doves ingesting Benghal dayflower seeds	Benghal dayflower seeds recovered
	No.	No.	No.	%	No. of seed/bird
2003	6	*[a]	32	n.d.[b]	5.3
2004	11	3	116	27	10.5
2005	14	9	90	64	6.4
2006 (Cook)	32	6	209	19	6.5
2006[c] (Berrien)	7	7	2029	100	289.9

[a] Dove gut contents from all doves collected in 2003 were combined.
[b] Abbreviation: n.d., not determined.
[c] See also Table 2.

replication. Germination data were square-root transformed prior to analysis of variance. Transformed treatment means were separated using Fisher's Protected $LSD_{0.05}$ but are presented in original form for clarity.

Microscopy. All stereomicroscope photographs were taken with a stereo–dissecting microscope outfitted with a digital camera.[9] Some samples were prepared for scanning electron microscopy[10] (SEM) as follows. Air-dried seeds or gut contents were not processed further but were mounted on SEM stubs using double-stick carbon tape. Images were obtained from samples coated with gold–palladium.[11]

Results and Discussion

Do Mourning Doves Eat Benghal Dayflower Seeds and Capsules? Mourning doves ingested Benghal dayflower seeds from all locations where they were harvested and in all years studied. Benghal dayflower seeds were ingested by 19 to 100% of doves collected from different locations (Table 1). In some doves, gut contents were nearly exclusively Benghal dayflower fruits and seeds, although seeds of other plant species were usually present. When Benghal dayflower was present in any dove, it was most often present in abundance regardless of other food types noted, indicating either that doves had been foraging and feeding selectively on Benghal dayflower or that there was an abundance of Benghal dayflower available relative to other food sources. Mourning doves feed mostly on seeds, with most reports identifying these birds as granivorous (Hayslette and Mirarchi 2001). Mourning doves have a stable year-round population in Georgia, with additional numbers of migratory doves populating the area during the cooler months. Nesting pairs of doves breed primarily from February through October and produce new clutchs repeatedly during the season, generally after a previous clutch has fledged (Mirarchi and Baskett 1994). Likewise, Benghal dayflower grows with a continuous emergence pattern during the summer months; it flowers and sets seeds continuously, potentially producing multiple generations a year (Webster et al. 2005). Estimates of resource allocation in Benghal dayflower show that the plant allocates 15% of its total resources to reproduction (Kaul et al. 2002). An Australian field study demonstrated that a single Benghal dayflower plant can potentially produce as many as 7,940 seeds (Walker and Evenson 1985). The fact that mourning doves eat Benghal dayflower seeds selectively in abundance indicates that they find Benghal dayflower a highly palatable food source that they actively feed on when it is available. The preference of mourning doves for Benghal dayflower seeds and their potential to disperse this weed present a potentially catastrophic situation for agroecosystems, considering the persistence of both dove and Benghal dayflower during the growing season, the prolific seed volume produced by populations of Benghal dayflower, and the potential spread of Benghal dayflower through this avian vector.

Many of the Benghal dayflower seeds taken from the doves with combined gizzard and crop contents appeared intact with varying degrees of surface scarring. When crop and gizzard contents were observed separately from doves taken in 2006, the crop of all but one bird contained more Benghal dayflower seed than the gizzard (Table 2). This observation is expected because doves feed quickly in the field, filling their crop with food and later digesting the crop contents from the safety of roosting sites (Mirarchi and Baskett 1994). The crop contents of birds positive for Benghal dayflower contained numerous dehisced or partially dehisced capsules of Benghal dayflower with up to hundreds of seeds present (Figure 1a; Table 2). Seeds present in the crop were morphologically similar to control seeds with little evidence of damage to the seed coat when viewed by light microscopy (Figure 1a inset). Once seeds and fruits entered the gizzard, however, capsules were not easily distinguished, being ground in the gizzard to smaller pieces with fibrous material intertwining the seeds and other gut contents (Figure 1b). Still, several intact seeds, including Benghal dayflower and other species, were present in the gizzard contents (Figure 1b). In general, relatively intact seeds of Benghal dayflower, often in large numbers, were obtained from the gizzard, although frequently some seed pieces were found, indicating that at least some seeds had been fragmented in the gizzard. Despite reports of the seeds of

Table 2. Number of Benghal dayflower seeds recovered separately from crop and gizzard in doves harvested in 2006 from Berrien County.

Bird Number	Organ	Seeds Recovered
Berrien.01	Crop	562
	Gizzard	123
Berrien.02	Crop	149
	Gizzard	122
Berrien.03	Crop	310
	Gizzard	104
Berrien.04 [a]		115
Berrien.05	Crop	3
	Gizzard	42
Berrien.06	Crop	271
	Gizzard	123
Berrien.07	Crop	not recovered
	Gizzard	105

[a] Crop and gizzard combined.

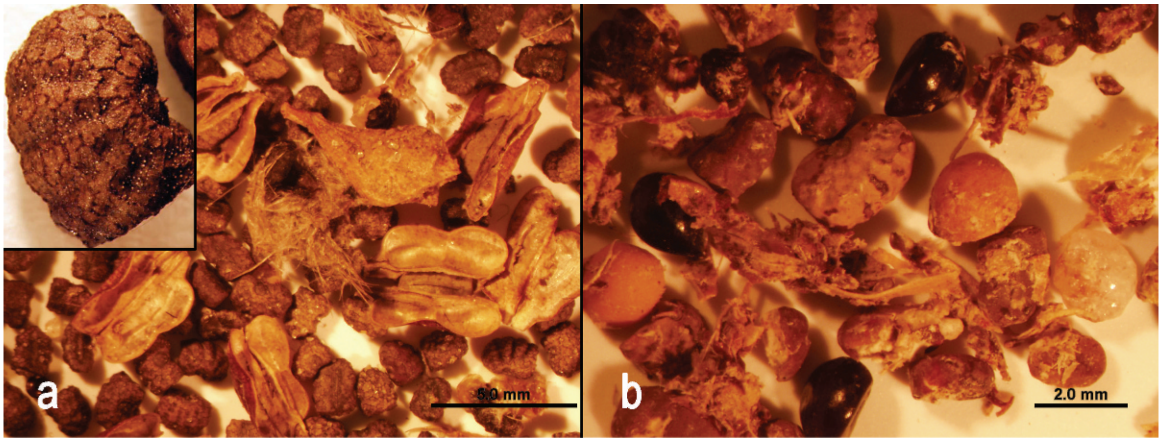

Figure 1. Crop and gizzard contents extracted from a mourning dove in 2006 identified as Berrien.01. (a) Crop contents with numerous intact dehisced capsules and seeds of Benghal dayflower are present. Inset: higher magnification of a seed taken from the crop that appears unscathed (bar = 5 mm). (b) Gizzard contents show no intact capsules or other fruits present but many intact seeds from Benghal dayflower (center) and other species (bar = 2 mm).

Commelina species having a hard seed coat that require abrasive scarification for germination (Budd et al. 1979), knowing whether these seeds can withstand the caustic and mechanical stresses of the dove intestinal tract intact is paramount to understanding whether doves or other avian species facilitate the spread of Benghal dayflower.

Seed Viability. For the initial seed viability test, data indicated a small percentage of seeds from doves taken in 2004 tested strongly positive with TZ, indicating that at least some ingested seeds were viable with staining similar to controls (Figures 2a–c). Although only 5 to 7% of the seeds taken from gut contents demonstrated strongly positive staining similar to the controls (Table 3), there were many seeds that had weak staining of the embryo but were assessed as a negative reaction. To determine further if seeds from dove gut contents could regenerate Benghal dayflower, additional germination tests were performed on seeds from different doves.

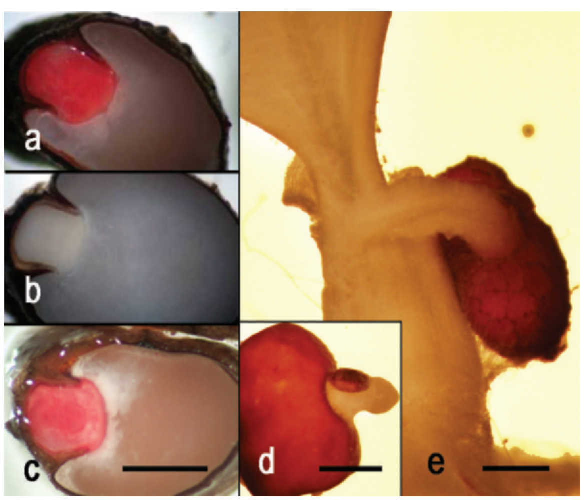

Figure 2. Seed viability and germination of Benghal dayflower. (a–c) Strong positive results of viability testing with tetrazolium (TZ). (a) Control seed that was imbibed unboiled and stained in 1% TZ demonstrates a red-stained embryo. (b) Control seed that was imbibed then boiled to kill cells of the embryo, then stained in 1% TZ demonstrates no staining of the embryo. (c) Seed extracted from gut contents, stained with 1% TZ showing a strongly positive red-stained embryo from bird 2004.01. (d–e) Germinating seeds of Benghal dayflower. (d) The embryotega is lifted as the embryo emerges while the seed coat remains intact. (e) Germinated seedling of Benghal dayflower. The still intact seed/seed coat is connected to the vertically oriented seedling by the taenia or cotyledonary stalk (bars = 0.5 mm).

Functional Morphology of *Commelina* Seeds and Seed Germination. Seeds of *Commelina* species germinate by rupturing through the micropyle region and lifting the embryotega, a callus-like covering over the micropyle that functions essentially as an operculum (Figure 2d). Even after imbibition, the seed coat never ruptures, an attribute apparently related to its strength, but the germinating seedling emerges by pushing the embryotega aside (Figure 2d). Most of the embryo is extruded and develops outside the seed coat connected by a taenia, or cotyledonary stalk, to the scutellum inside the seed (Figure 2e). Benghal dayflower seeds have a distinctive shape with a clearly visible embryotega and linear hilum (Figure 3a). The seed surface has a relief pattern with large and smaller reticulations (Figure 3b). There is a thin papery outer layer of the seed coat that covers the entire seed including the embryotega, which likely developed from the epidermis postanthesis. In unimbibed seeds, this layer is intact with no visible cracks or breaks when viewed by SEM (Figures 3b and 3c). After imbibition, small cracks can first be seen over the embryotega and linear hilum regions (Figures 3d and 3e, respectively).

In crop extracts many capsules were found still containing Benghal dayflower seeds (Figure 4a). Seeds extracted from bird crops were not identical to control seeds as perceived by light microscopy but had extensive cracks in the surface layer of the seed coat, particularly around the embryotega when viewed by SEM (Figure 4b; compare with Figure 3a). Even seeds still attached to dehisced capsules demonstrated surface

Table 3. Results of TZ[a] testing of seeds taken from the gut contents of two doves harvested in 2004.

Treatment/bird	No. of seed tested	Seed with a strong positive TZ reaction	Positive TZ reaction
	No. of seed		%
Control (boiled)	11	0	0
Control (not boiled)	22	17	77.3
2004.01	15	1	6.7
2004.03	38	2	5.3

[a] Abbreviation: TZ, tetrazolium.

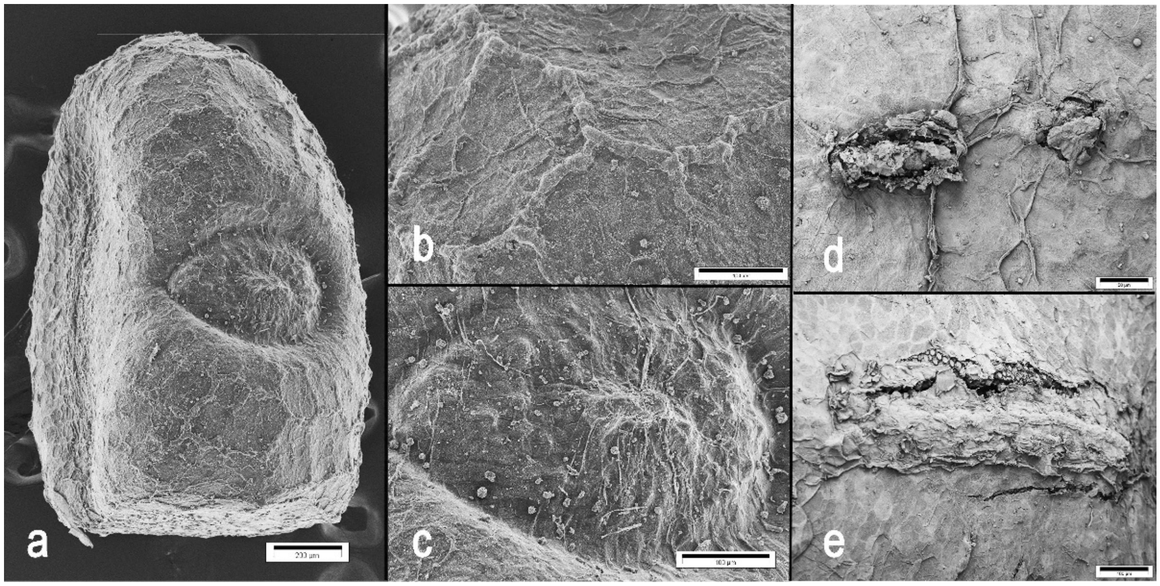

Figure 3. Surface morphology of wild, control seeds that had been imbibed or not. (a) Intact unimbibed aerial control seed collected from Benghal dayflower plants in the field. Distinctive features include the elliptical embryotega at the center and the linear hilum apparent on the flattened surface at left in the image (bar = 200 µm). (b) A distinctive feature of Benghal dayflower seeds is the raised surface over the seed coat in a reticulate pattern. Both large and smaller reticulations are clearly evident (bar = 100 µm). (c) Higher magnification image of the unimbibed control seed embryotega in Figure 3a. The embryotega is covered, with no cracks or breaks, by a layer of the seed coat that is continuous over the entire seed (bar = 100 µm). (d) In an imbibed control seed, cracks are shown in the outer surface layer of the seed coat over the embryotega (bar = 50 µm). (e) The linear hilum region of a control seed that had been imbibed also demonstrates extensive cracking of the surface layer of the seed coat (bar = 100 µm).

abrasion in the crop (Figure 4c). In many seeds extracted from the crop, the surface layer of the seed coat had already been abraded away, or chemically removed, revealing a subtending layer of cells with interconnected thick walls in a honeycomb pattern (Figure 4d). This layer of cells and the subtending wall appear to form a resilient barrier of the seed coat, which is discussed further with regard to the morphology of seeds extracted from the gizzard.

Some seeds present in the gizzard had been stripped of surface layers of the seed coat, revealing the embryotega completely (Figure 5a). Other seeds extracted from the gizzard were encrusted with debris (Figures 5b and 5c) but with their papillate embryotega revealed (Figure 5c). Large sections of the outer layer of the seed coat were removed in the gizzard revealing the honeycombed network of cells seen in seeds from the bird crop (Figure 5d). The surface reticulations

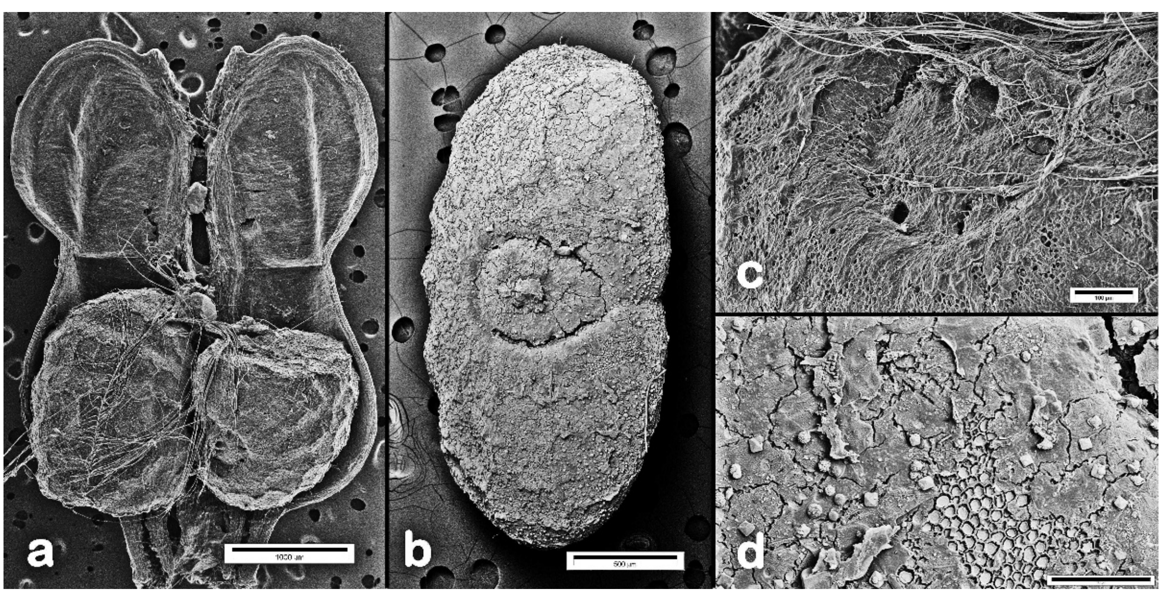

Figure 4. Morphology of seeds extracted from dove crops. (a) Image of an intact dehisced capsule with two seeds in place extracted from a dove crop (bar = 1 mm). (b) Backscatter electron image of a whole seed extracted from dove crop. The outer surface layer of the seed coat is extensively cracked, particularly around the edge of the embryotega (bar = 0.5 mm). (c) High-magnification image of one of the seeds present in Figure 4a, from dove crop. Surface of the seed (shown near the embryotega) is already cracked and abraded revealing underlying cells in a seed that has not yet been mechanically dislodged from the fruit (bar = 100 µm). (d) Higher magnification backscatter-electron scanning electron micrograph of the seed surface from a bird crop showing parts of the outer layer of the seed coat already fully removed revealing a tightly packed layer of cells whose walls form a honeycomb pattern (bar = 100 µm).

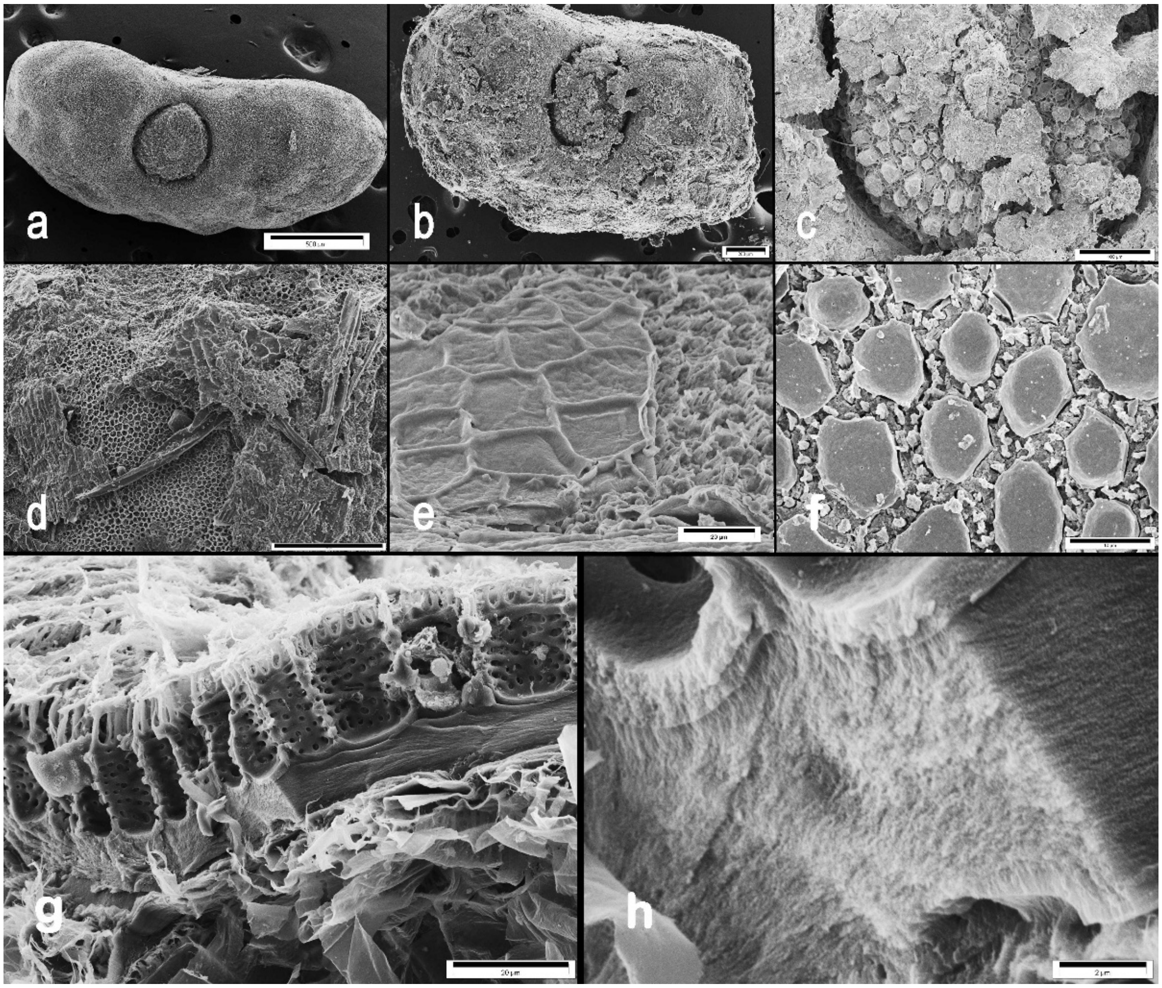

Figure 5. Morphology of Benghal dayflower seeds extracted from dove gizzard. (a) Whole seed with the surface covering fully removed and exposing the embryotega covering the micropyle (bar = 0.5 mm). (b) Common appearance of seeds in the gizzard demonstrates debris covering the surface with most of the seed coat covering abraded, revealing underlying layers of the seed coat (bar = 200 µm). (c) Higher magnification scanning electron micrograph (SEM) of embryotega with papillate cells (bar = 100 µm). (d) SEM image of the seed surface with debris or seed coat layers partially occluding the continuous layer of cells forming the underlying surface of the seed coat (bar = 200 µm). (e) SEM image of a portion of the seed surface with a remnant of the outer layer of the seed coat with minor reticulations. Minor reticulations are larger than the underlying cells (bar = 20 µm). (f) SEM image of the layer of cells underlying the seed coat removed in the gizzard. Lateral walls have projecting spires that give them a punctate appearance when seen in surface view. Lateral walls are closely appressed between cells and provide no identifiable intercellular spaces between cells. Cells are covered with a lid-like structure (bar = 10 µm). (g–h) Lateral view of a seed coat cell layer (similar to surface view of the same layer in Figure 5f) in a seed fractured with a razor blade prior to processing for SEM. (g) Surface cells have no intercellular spaces and trabeculate lateral walls, open at the surface. All surface cells are appressed to a continuous tangential wall layer forming part of the seed coat (bar = 20 µm). (h) High magnification image of the tangential wall at the base of the seed coat (seen in Figure 5g; bar = 2 µm).

noted in intact seeds (Figure 3b) are often not apparent in seeds extracted from the gizzard or are present only as dislodged fragments of seed coat surface material among other debris in the gizzard (Figures 5d and 5e). These fragments appear to be exclusively a part of the outer layer that is removed during digestion.

The underlying cell layer of the seed coat has complex lateral cell walls that form a honeycomb pattern and have little or no intercellular spaces (Figure 5f). In one seed that was forcibly fractured with a razor blade during preparation, the outer honeycomb-patterned cell layer of the seed coat was revealed in cross-section (Figure 5g). In the fractured seed coat layer, the cell lumen is exposed, revealing thick, almost trabeculate walls with a subtending continuous tangentially oriented wall layer (Figure 5g). This subtending wall layer is microfibrillar in structure and forms a barrier beneath the honeycomb-patterned cells upon which each cell in the layer is continuous (Figure 5h). The Benghal dayflower seed coat appears adapted for strength and rigidity. Although the honeycombed network of cells in this layer appears to provide structural reinforcement, this layer of cells is sometimes scraped away in the gizzard (Figures 6a and 6b) revealing only the subtending continuous tangential wall layer (Figure 6b). The honeycomb pattern of the abraded cells is still apparent on the surface that is revealed (Figure 6b). Few seeds were found that were cracked or in pieces relative to the number of intact seeds.

The Benghal dayflower seed coat appears at least two-layered with a rigid thick inner layer and a thin outer covering. From the morphological data acquired in this study and the germination data presented subsequently, it appears that maintaining the integrity of the outer covering of the seed coat is necessary to preserve seed dormancy. The inner layer of the seed coat appears to be structural in nature and may protect the seed from harsh mechanical perturbation in the bird gizzard. The question remains whether seeds that pass

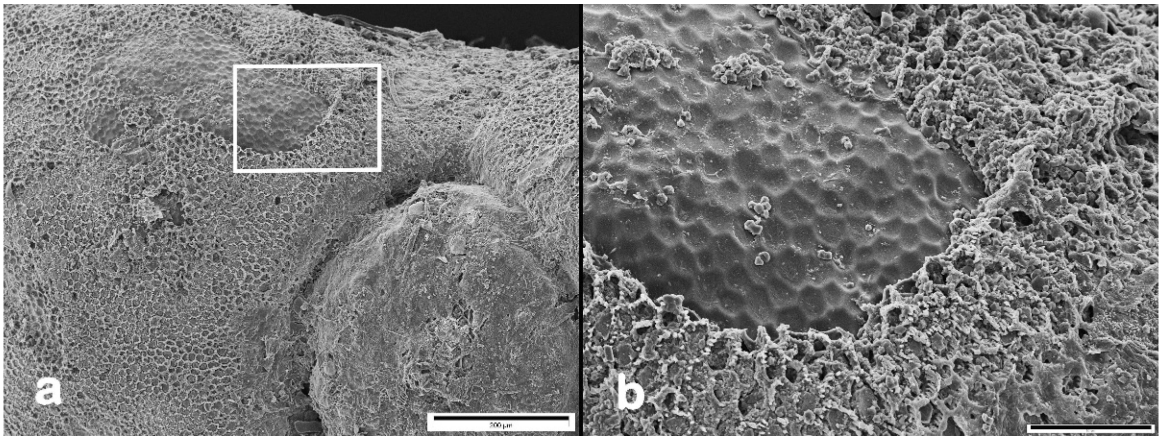

Figure 6. Scanning electron micrograph of the surface of a seed extracted from dove gizzard. (a) Parts of the trabeculate cell layer have been abraded and removed exposing the continuous tangential cell layer (bar = 200 µm). (b) Detail of the portion of Figure 6a outlined by the white box. Seed coat is not cracked even with the surface layer of cells abraded away. Tangential wall that remains shows clearly the honeycombed pattern of the cell walls that were removed (bar = 50 µm).

through dove digestive tracts remain intact and viable, germinating after passing, a test not accomplished in this study.

Germination Studies. Seeds from several doves, harvested between 2003 through 2005, germinated in our tests (data not shown). Because the gut contents of these birds contained combined crop and gizzard contents, the enhancement or inhibitory effects of each organ on the germination rate was in question. We therefore took seeds separated from these organs from doves harvested in Berrien County in 2006 that had large numbers of seeds extracted from both organs (Table 2). In initial tests, seeds were not subjected to surface sterilization to reduce the chance of artificial enhancement or reduction in seed germination, but these petri plates developed extensive fungal growth that may have inhibited seed germination. Each petri plate in this first test had different microbial flora populations, probably resulting from different foraging habits of individual doves, and replicate treatments were inconsistent with each other. The antimicrobial solution PPM used in subsequent tests eliminated most microbial growth and only minor fungal growth appeared on test plates (data not shown). The results obtained from the second controlled test are presented in Table 4. We subjected the PPM control tests to statistical comparison with the bleach-sterilized control seeds in the acid treatments. Data analysis indicated there were no differences between these controls except at 20 WAT when the bleach-treated seeds had greater germination (92%) than the PPM control (80%). Control tests of seeds left untreated in PPM had extensive fungal and bacterial contaminants. Comparison between the PPM-treated control seeds and untreated control seeds was highly significant at all times (Table 4), indicating that microbial competition or pathogenesis can greatly reduce seed germination in Benghal dayflower seeds.

Table 4. Summary results of seed germination in seeds extracted from bird crop and gizzard in birds Berrien.01 and Berrien.06 harvested in 2006, and between PPM[a]-treated control vs. no PPM treatment.

	4 wk	12 wk	20 wk
		% seed germination	
Organ of seed recovery			
Crop	49	87	93
Gizzard	37	45	45
F-value	3.11	76.93	79.88
P-value	0.099	< 0.0001	< 0.0001
Control treatment			
PPM	50	79	80
No PPM	24	37	51
F-value	15.23	89.62	47.74
P-value	0.0169	0.0007	0.0023

[a] Abbreviation: PPM, plant preservative medium.

Seeds taken from the crops of birds Berrien.01 and Berrien.06 germinated at rates similar to controls up to 4 WAT, but ultimately their germination rate exceeded that of the control test with PPM at 12 and 20 WAT (Table 4). At 20 WAT, seeds extracted from bird crops had 93% germination, greater than the 80% germination in the control. This enhancement in germination rate may be due to the cracking and seed coat scarification we observed with SEM in seeds from dove crops (e.g., Figures 4b–d). Seeds recovered from the gizzards of the birds had 45% germination, less than half the germination of seeds from the control and seeds from crops (Table 4). Benghal dayflower seeds are released under strong dormancy, presumably because of their hard seed coat (Budd et al. 1979). Physical or chemical seed scarification is required to increase Benghal dayflower germination (Budd et al. 1979; Kim et al. 1990). Birds tend to ingest grit and small stones that collect in the gizzard that help to fragment ingested food. Passage of seeds or other foods to the gizzard from the crop move through a proventriculus or glandular stomach that secretes acid and digestive enzymes that range in pH from 0.7 to 2.5, before grinding in the gizzard and passing to the intestine (Welty and Baptista, 1988). Our data indicate that exposure to bird crop conditions enhanced germination. In contrast, seed from the gizzard germinated at significantly reduced rates likely because of their exposure to the harsher conditions present there. It is unlikely that acid treatment alone reduces the germination of Benghal dayflower seeds extracted from the gizzard when the effects of acid treatment are considered (below). It is more likely that the mechanical grinding in the gizzard ultimately disrupts the integrity of seeds. We observed variation in the amount and size of grit and small stones in the dove gizzard. This variation may present an opportunity for some seeds to

Table 5. Summary results of percentage of seed germination at 4, 12, or 20 wk after planting, in different acid treatments on wild seed. Analysis of variance was performed using PROC Mixed in SAS, with variances partitioned into random effects of trial and replication. Transformed treatment means were separated using Fisher's Protected $LSD_{0.05}$.

Treatment	4 wk		12 wk		20 wk	
	% seed germination[a]					
Light control	54	a	79	ab	92	a
Dark control	12	d	30	c	87	b
0.1 M HCl for 1 h	41	bc	84	a	93	a
0.1 M HCl for 2 h	37	c	75	ab	93	a
0.1 M HCl for 4 h	49	ab	79	ab	92	a
1 M HCl for 1 h	40	c	70	b	84	b
1 M HCl for 2 h	41	bc	70	b	82	b
12 M HCl for 1 h	0	e	0	d	0	c

[a] Means with different letters within a column are significantly different.

pass relatively unscathed through birds with decreased grit in their gizzard.

Many birds are known to regurgitate some of the seeds or food that they eat; they particularly regurgitate larger seeds whereas smaller seeds are processed and defecated (Murray et al. 1994). The crop of mourning doves is a glandular organ that produces crop milk for feeding young. Both male and female doves regurgitate crop milk and seed for their young during brooding that is often continuous from February through October and sometimes occurs year-round (Mirarchi and Baskett 1994). It is possible that regurgitated seeds from the dove crop would have an enhanced germination rate and that some seeds of Benghal dayflower eaten by mourning doves might be dispersed from field to field or field to nest by regurgitation, retaining the potential to germinate and establish new Benghal dayflower populations.

Although we could not evaluate the viability of seeds that fully pass through dove guts with our methods, the high rate of germination recorded from seeds extracted from the gizzard and crop indicates that some Benghal dayflower seeds may be surviving complete passage and would be passed to new territory as the dove travels. Increased time under mechanical and acidic stress may reduce germination, and this hypothesis should be tested in the future. It should be noted that our results were obtained from wild birds and that seed retention time was not controlled. Although this results in considerable variation, significant germination was obtained from seeds extracted from all bird crops and gizzards tested. This might indicate a high probability that Benghal dayflower seeds remain viable in the dove gut and could potentially germinate when passed, spreading this weed. Retention time is a key factor affecting viability of seeds dispersed endozoically by birds (Traveset et al. 2001a) with shorter retention generally resulting in greater viability. The results of one previous study based upon unempirical visual estimates suggested that mourning doves had a seed retention time of approximately 4 h (Blockstein et al. 1987). Other bird species, particularly those eating fleshy fruits, have documented retention times from only 12 to 75 min (Barnea et al. 1991; Bartuszevige and Gorchov 2006; Murray et al. 1994), sometimes being regurgitated and other times defecated. Also, larger seeds tend to be regurgitated in some birds or pass through the gut more quickly than smaller seeds, increasing their chance of survival and subsequent germination (Murray et al. 1994; Traveset et al. 2001a). This is somewhat significant because Benghal dayflower produces dimorphic seeds of variable size from aerial and underground flowers. Differences have been reported for large and small seeds from aerial and underground flowers, particularly with respect to germination success (Kim et al. 1990; Matsuo et al. 2004). Further research using captive birds to determine the retention time of Benghal dayflower capsules and seeds in doves and the viability of defecated and regurgitated seeds should be done to understand fully whether the dove and Benghal dayflower have developed a mutualistic relationship promoting seed dispersal.

Acid Scarification Effect on Germination. For acid scarification studies, we used hydrochloric acid to most closely imitate the stomach environment. For the control and acid-treated seeds, total germination increased over an extended period, indicating a slow release from seed dormancy and substantial variation between individual seeds. Treating sterile control seeds with acid (up to 1.0 M HCl) resulted in little difference in the rate of germination compared to the control (Table 5). Using 0.1 M HCl, simulating the pH conditions in an avian stomach, for variable times of up to 4 h (estimated time of food retention in doves) revealed no reduction in seed germination relative to the light control at 12 and 20 WAT (Table 5). When treating in acid conditions 10-fold stronger (1.0 M HCl) than typically encountered in avian digestive tracts for 1 or 2 h, there still was little difference from the controls. Only with exposure to 12M HCl for 1 h (100-fold greater acidity than avian digestive tract) is germination totally inhibited. Seeds from this latter treatment were extremely soft at the end of the germination test and none demonstrated positive TZ results (data not shown). Additionally, light promoted germination increasing germination levels considerably when compared to dark-germinated controls (Table 5), similar to results of other studies (Matsuo et al. 2004). In comparing light- and dark-treated control seeds, the difference in germination rates is highly significant at 4 and 12 WAT with greatly decreased germination in the dark. Dark-grown control seeds reached only a 30% germination rate as compared to 79% germination in controls in the light at the end of 12 WAT. Dark-treated seeds were returned to the light at the end of 12 WAT. Germination in these formerly dark-treated seeds increased to 87% at 20 WAT, slightly lower than the light-treated controls (92% germination; Table 5).

Just as seeds in the dove gizzard need to withstand severe mechanical stress in order to survive, they also must be able to withstand substantial acidic environments for any possibility of remaining viable after excretion. Previous studies have scarified Benghal dayflower seeds by mechanical means (Budd et al. 1979) and by temperature or chemical means including concentrated sulfuric acid (no more than 2 min), dry heat or hot water, or bleach treatments (Kim et al. 1990). All scarification treatments produce some or significant increase in germination of the seeds.

The potential for mourning doves to disperse weed seeds has been studied previously with respect to the dispersal of leafy spurge (*Euphorbia esula* L.)(Blockstein et al. 1987). This study concluded that leafy spurge seed did not survive conditions through the mourning dove gut, being crushed in the gizzard. Therefore dispersal of leafy spurge was not an issue with respect to mourning dove ingestion. Although we did not use doves in captivity, our study indicates that Benghal dayflower seeds are structurally reinforced against the mechanical stresses of the dove gizzard and, at the least, survive in highly acidic environments. In other studies with different plants and birds, individual birds have been found to have no effect, an enhancement effect, or an inhibitory effect on seed germination depending on the bird and the species of plant seed the bird is ingesting (Barnea et al. 1991; Bartuszevige and Gorchov 2006; Samuels and Levey 2005; Traveset et al. 2001b). Likewise, evidence points to increasing seed viability and germination for seeds that are retained in the bird gut for shorter times rather than longer periods (Barnea et al. 1991). The ability of exotic plants to incorporate native animal species in mutualistic interactions, such as seed dispersal, is often a key factor facilitating invasion (Richardson et al. 2000).

Control of Benghal dayflower is a complex problem. No attempt was undertaken in this study to survey other avian visitors to agricultural fields in southern Georgia, but it is quite likely that other bird species are ingesting Benghal dayflower. In another study of six Midwestern states, up to 48 different bird species were surveyed in row crop fields (Best et al. 1997). Thus, where infestations of Benghal dayflower have been established, it is likely that a variety of bird vectors are dispersing Benghal dayflower seed. Our study shows that mourning doves eat Benghal dayflower seeds and that seeds from this plant have a high potential for survival in the mourning dove gut. Clearly, if we are concerned about the prevalence and control of Benghal dayflower in agricultural crops, we need to determine if other birds forage freely on Benghal dayflower. From a behavioral standpoint, any bird foraging on Benghal dayflower seed may deposit viable seed in a natural area or another agricultural field. The potential for reservoir populations of Benghal dayflower in natural areas is a definite concern with respect to the eradication of Benghal dayflower. From any perspective, aggressive control of Benghal dayflower is necessary in all known newly infested agricultural and natural environments to minimize the potential for exponential spread and impact of this weed.

Sources of Materials

[1] 2,3,5-Triphenyl tetrazolium chloride, Sigma-Aldrich, St. Louis, MO 63103.

[2] Whatman No. 1 filter paper was used in all experiments noting use of filter paper. Fisher Scientific, Pittsburgh, PA 15275.

[3] Plant growth chambers used were either a Percival E30b or RE-9 plant growth chamber, Percival Scientific, Inc., Perry, IA 50220.

[4] Polyoxyethylene (20) sorbitan monolaurate solution 70% in H_2O (Tween 20), Sigma-Aldrich, St. Louis, MO 63103.

[5] Plant preservative medium, Plant Cell Technology, Inc., Washington, DC 20036.

[6] Reynolds 655 standard foil (approx. 0.02 mm thick) was used for dark-treated plates. Fisher Scientific, Pittsburgh, PA 15275.

[7] Parafilm® M laboratory sealing film was used as a barrier to inhibit water vapor loss and promote gas exchange in seed germination experiments. Fisher Scientific, Pittsburgh, PA 15275.

[8] The data analysis for this paper was generated using SAS software version 9.1 copyright, SAS Institute Inc., Cary, NC.

[9] Stereo dissection microscope used was either an Olympus SZ-6045 stereo-dissecting microscope with phototube and Kodak DC-290 digital zoom camera, Eastman Kodak Scientific Imaging Systems, 4 Science Park West, New Haven, CT 06511, or an Olympus SZX-12 stereo-dissecting microscope outfitted with an Olympus DP-71 digital camera, Olympus America, Center Valley, PA 18034.

[10] JEOL 6480LV scanning electron microscope, JEOL USA, Inc., 11 Dearborn Rd., Peabody, MA 01960.

[11] Specimens were coated for SEM using a Denton Desk IV sputter coater, Denton Vacuum USA, 1259 North Church St., Moorestown, NJ 08057.

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Literature Cited

Barnea, A., Y. Yom-Tov, and J. Friedman. 1991. Does ingestion by birds affect seed germination? Funct. Ecol. 5:394–402.

Bartuszevige, A. M. and D. L. Gorchov. 2006. Avian seed dispersal of an invasive shrub. Biol. Invasions 8:1013–1922.

Best, L. B., H. Campa III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, Jr., and S. R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: a regional approach. Wildl. Soc. Bull. 25:864–877.

Blockstein, D. E., B. D. Maxwell, and P. K. Fay. 1987. Dispersal of leafy spurge seeds (*Euphorbia esula*) by mourning doves (*Zenaida macroura*). Weed Sci. 35:160–162.

Budd, G. D., P.E.L. Thomas, and J.C.S. Allison. 1979. Vegetative regeneration, depth of germination and seed dormancy in *Commelina benghalensis* L. Rhod. J. Agr. Res. 17:151–153.

Culpepper, A. S. 2006. Glyphosate-induced weed shifts. Weed Technol. 20:277–281.

Culpepper, A. S., J. T. Flanders, A. C. York, and T. M. Webster. 2004. Tropical spiderwort (*Commelina benghalensis*) control in glyphosate-resistant cotton. Weed Technol. 18:432–436.

Davis, R. F., T. M. Webster, and T. B. Brenneman. 2006. Host status of tropical spiderwort (*Commelina benghalensis*) for nematodes. Weed Sci. 54:1137–1141.

Desaeger, J. and M. Rao. 2000. Parasitic nematode populations in natural fallows and improved cover crops and their effect on subsequent crops in Kenya. Field Crop Res. 65:41–56.

Durham, S. 2006. Controlling tropical spiderwort in the Southeast. Agr. Res. 54:7.

Faden, R. B. 1993. The misconstrued and rare species of *Commelina* (Commelinaceae) in the United States. Ann. Missouri Bot. Gard. 80:208–218.

Gibbs, H.A.A. 2002. A monocot plant identified as an alternate host of the causal agent of bacterial spot of tomato and pepper. HortScience 37:969–972.

Hayslette, S. E. and R. E. Mirarchi. 2001. Patterns of food preferences in mourning doves. J. Wildl. Manag. 65:816–827.

Holm, L. G., D. L. Plucknett, J. V. Pancho, and J. P. Herberger. 1977. The World's Worst Weeds: Distribution and Biology. Honolulu: University Press of Hawaii.

Kaul, V., N. Sharma, and A. K. Koul. 2002. Reproductive effort and sex allocation strategy in *Commelina benghalensis* L., a common monsoon weed. Bot. J. Linnean Soc. 140:403–413.

Kim, S. Y., S. K. De Datta, and B. L. Mercado. 1990. The effect of chemical and heat treatments on germination of *Commelina benghalensis* L. aerial seeds. Weed Res. 30:109–116.

Kucharek, T. A., D. E. Purcifull, and R. G. Christie. 1998. The association of severe epidemics of cucumber mosaic in commercial fields of pepper and tobacco in North Florida with inoculum in *Commelina benghalensis* and *C. communis.* Plant Dis. 82:1172.

Losito, M. P. and R. E. Mirarchi. 1991. Summertime habitat use and movements of hatching-year mourning doves in northern Alabama. J. Wildl. Manage. 55:137–146.

Maheshwari, P. and B. Singh. 1934. A preliminary note on the morphology of the aerial and underground flowers of *Commelina benghalensis*, Linn. Curr. Sci. India 3:158–160.

Matsuo, M., H. Michinaga, H. Terao, and E. Tsuzuki. 2004. Aerial seed germination and morphological characteristics of juvenile seedlings in *Commelina benghalensis* L. Weed Biol. Manag. 4:148–153.

Mirarchi, R. E. and T. S. Baskett. 1994. Mourning dove (*Zenaida macroura*). Pages 1–32 *in* A. Poole, and F. Gill, eds. The Birds of North America, No. 117. Philadelphia: The Academy of Natural Sciences. Washington, DC: The American Ornithologists' Union.

Murray, K. G., S. Russell, C. M. Picone, K. Winnett-Murray, W. Sherwood, and M. L. Kuhlmann. 1994. Fruit laxatives and seed passage rates in frugivores: consequences for plant reproductive success. Ecology 75:989–994.

Owen, M.D.K. and I. A. Zelaya. 2005. Herbicide-resistant crops and weed resistance to herbicides. Pest Manag. Sci. 61:301–311.

Peters, J., ed. 2000. Tetrazolium Testing Handbook. Contribution No. 29 to the Handbook on Seed Testing. Lincoln, NE: Association of Official Seed Analysts. 176 p.

Richardson, D. M., N. Allsopp, C. M. D'Antonio, S. J. Milton, and M. Rejmanek. 2000. Plant invasions: the role of mutualisms. Biol. Rev. 75:65–93.

Robertson, A. W., A. Trass, J. J. Ladley, and D. Kelly. 2006. Assessing the benefits of frugivory for seed germination: the importance of the deinhibition effect. Funct. Ecol. 20:58–66.

Samuels, I. A. and D. J. Levey. 2005. Effects of gut passage on seed germination: do experiments answer the questions they ask? Funct. Ecol. 19:365–368.

Scher, J. 2005. Federal Noxious Weed Disseminules of the U.S. Lucid v. 2. USDA-APHIS Center for Plant Health Science and Technology and California Department of Food and Agriculture. http://www.lucidcentral.org/keys/FNW/FNW%20seeds/html/fact%20sheets/Commelina%20benghalensis.htm. Accessed: June 30, 2008.

Traveset, A., N. Riera, and R. Mas. 2001a. Ecology of fruit-colour polymorphism in *Myrtus communis* and differential effects of birds and mammals on seed germination and seedling growth. J. Ecol. 89:749–760.

Traveset, A., N. Riera, and R. Mas. 2001b. Passage through bird guts causes interspecific differences in seed germination characteristics. Funct. Ecol. 15:669–675.

Walker, S. R. and J. P. Evenson. 1985. Biology of *Commelina benghalensis* L. in south-eastern Queensland. 1. Growth, development and seed production. Weed Res. 25:239–244.

Webster, T. M., M. G. Burton, A. S. Culpepper, A. C. York, and E. P. Prostko. 2005. Tropical spiderwort (*Commelina benghalensis*): a tropical invader threatens agroecosystems of the southern United States. Weed Technol. 19:501–508.

Welty, J. C. and L. Baptista. 1988. The Life of Birds. 4th ed. Orlando, FL: Harcourt Brace Jovanovich. 581 p.

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Rediscovery of *Platanthera chapmanii* in Georgia

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Platanthera chapmanii (Small) Luer (Chapman's yellow fringed orchid) was initially described as *Blephariglottis chapmanii* Small based upon a type specimen collected by A.W. Chapman from Apalachicola, Florida (Small, 1903). Subsequently, Small (1933) suggested *B. chapmanii* was "perhaps a hybrid between *B. ciliaris* and *B. cristata,*" and others formally treated it as a nothotaxon: *Habenaria ×chapmanii* (Small) Ames, with parents *H. cristata* (Michx.) R. Br. and *H. blephariglottis* (Willd.) Hook. (Correll, 1950), or *Platanthera ×chapmanii* (Small) Luer, with parents *P. cristata* (Michx.) Lindl. and *P. ciliaris* (L.) Lindl. (Luer, 1975).

Based upon extensive research in the field, laboratory, and herbarium, including an analysis of the pollination biology of *P. chapmanii*, *P. cristata* and *P. ciliaris*, Folsom (1984) concluded that *P. chapmanii* was indeed a distinct species – not a hybrid. Folsom's chromosomal studies showed no evidence of amphitetraploidy, and he found that populations of *P. chapmanii* are generally pure without the presence of either or both putative parents, and his studies of pollination biology provided evidence for morphological isolating mechanisms involving divergent floral morphologies, especially the form of the terminal portion of the column (rostellum) and the length of the spur (Folsom, 1984). Moreover, Folsom (1984) documented actual hybrids between *P. ciliaris* and *P. cristata*, which he described and named *Platanthera ×channellii* Folsom. In contrast with *Platanthera chapmanii*, *P. ×channellii* is found in mixed populations with its parents *P. cristata* and *P. ciliaris*, and its rostellum lobes are straight and also intermediate between those of *P. cristata* and *P. ciliaris*, whereas the rostellum lobes of *P. chapmanii* are strongly down-curved (Folsom, 1984, 1995). Folsom's interpretation has recently been adopted by others (Sheviak, 2002; Brown, 2002). Excellent photographs of *P. chapmanii, P. cristata, P. ciliaris,* and *P. ×channellii* may be found in Brown (1995, 2002, 2004) and Chafin (2007).

Platanthera chapmanii is known from eastern Texas, northern Florida, and southeastern Georgia (Folsom 1984, 1995; Brown 2002, 2004; Sheviak 2002). There is only a single specimen of *P. chapmanii* from Georgia at the University of Georgia Herbarium (T. Patrick, pers. comm.): "U.S.A. Georgia. Camden County: growing in low sandy humus among scrub-palmetto and pines, (near) Kingsland, 1 August 1949, William J. Dress 869 (GA)." This specimen was annotated as *P. chapmanii* by James P. Folsom (T. Patrick, pers. comm.). According to Chafin (2007), Chapman's yellow fringed orchid is known from Charlton County, Georgia. In Georgia, *P. chapmanii* is listed among *Special*

Concern Plant Species with a Global Rank of G2 (imperiled globally because of rarity, 6-20 occurrences) and a State Rank of SH (of historical occurrence in the state, perhaps not verified in the past 20 years, but suspected to be still extant) (Anonymous 2008).

While conducting an intensive general floristic inventory of Camden County in southeastern Georgia, two populations were located that seemed consistent with Folsom's (1984, 1995) concept of *P. chapmanii* (Figures 1,2; page 7). Both populations were pure, i.e., without either *P. ciliaris* or *P. cristata* present. Because of the long history of disturbance from agriculture, degradation from modern "forestry" practices, fire suppression, and – more recently – rapidly advancing real estate development, for the most part, only small remnants of natural habitats were found in Camden County, and both populations of *P. chapmanii* were found in small relict strips along roadsides where periodic mowing is surrogate for fire. General voucher specimen data follow, with precise locations withheld and geographical coordinates truncated.

U.S.A. Georgia. Camden County: N of Kingsland, N30.9° W81.7°, infrequently mowed right-of-way, with *Acer rubrum, Aletris* sp., *Anthaenantia rufa, Erigeron vernus, Eupatorium rotundifolium, Hypericum* spp., *Ilex glabra, Lobelia glandulosa, Marshallia* sp., *Morella cerifera, Osmunda cinnamomea, Persea palustris, Pinus elliottii, P. palustris, P. serotina, P. taeda, Polygala lutea, Pteridium aquilinum, Quercus nigra, Q. pumila, Rhexia* spp., and *Sarracenia minor,* 21 Jul 2006, R. Carter 17083 and W.W. Baker (VSC); N of Kingsland, N30.9° W81.7°, seepy backslope along right-of-way through bayswamp, with *Arundinaria tecta, Eriocaulon decangulare, Gaylussacia frondosa, Gordonia lasianthus, Ilex coriacea, Lyonia lucida, Morella cerifera, Nyssa biflora, Persea palustris, Quercus nigra, Sphagnum* sp., and *Vaccinium corymbosum,* 11 Aug 2009, R. Carter 19357 and W.W. Baker (VSC).

Both Camden County populations of *Platanthera chapmanii* are small and highly vulnerable, one comprising only 19 flowering plants in 2009, and the other 28. They are potentially at great risk from the injudicious use of herbicides, road widening activities, and real estate development. Therefore, cooperative conservation efforts are currently underway with Matt Richards (Atlanta Botanical Garden) and Tom Patrick (Georgia Department of Natural Resources) to collect seeds from these populations and artificially propagate plants from them.

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Valdosta State University kindly provided assistance in obtaining copies of Folsom (1995) and Brown (1995). Financial support for field work was provided by the Georgia Botanical Society, the Foundation of Valdosta State University, and Georgia Department of Natural Resources.

Literature Cited

Anonymous. 2008. Georgia Rare Species and Natural Community Information – Protected Plants, Special Concern Plants, Watched Plants. Date of information - 5/27/2008. Georgia Department of Natural Resources, Natural Heritage Program. Social Circle, Georgia. http://georgiawildlife.dnr.state.ga.us. [last accessed 03 October 2009].

Brown, P.M. 1995. The real identity of *Platanthera chapmanii*. North American Orchid Journal 1(3):211-212.

Brown, P.M. 2002. Wild orchids of Florida. University Press of Florida. Gainesville. 409 pp.

Brown, P.M. 2004. Wild orchids of the southeastern United States. University Press of Florida. Gainesville. 416 pp.

Chafin, L.G. 2007. Field guide to the rare plants of Georgia. State Botanical Garden of Georgia. Athens. 526 pp.

Correll, D.S. 1950. Native orchids of North America. Chronica Botanica Company. Waltham, MA. 399 pp.

Folsom, J.P. 1984. Una reinterpretacion del estatus y relaciones de las taxa del complejo de *Platanthera ciliaris* (A reinterpretation of the status and relationships of taxa of the yellow-fringed orchid complex). Orquidea (Mexico City) 9:321-345.

Folsom, J.P. 1995. A reinterpretation of the status and relationships of taxa of the yellow-fringed orchid complex. North American Orchid Journal 1(3):213-238.

Luer, C.A. 1972. The native orchids of Florida. New York Botanical Garden. Bronx, NY. 293 pp.

Luer, C.A. 1975. The native orchids of the United State and Canada. New York Botanical Garden. Bronx, NY. 361 pp.

Sheviak, C.J. 2002. *Platanthera*. Pp. 551-571, in G.W. Argus, K. Gandhi, P. Goldblatt, W.J. Hess, R.W. Kiger, J.L. Strother, F.H. Utech and J.L. Zarucchi (eds.), Flora of North America, vol. 26. Oxford Univ. Press. New York.

Small, J.K. 1903. Flora of the southeastern United States. Published by the author. New York Botanical Garden, New York. 1370 pp.

Small, J.K. 1933. Manual of the southeastern flora. University of North Carolina Press. Chapel Hill. 1554 pp.

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Figures to accompany 'Rediscovery of *Platanthera chapmanii* in Georgia' by Richard Carter (page 1). Images: Richard Carter.
Figures 1 and 2: *Platanthera chapmanii* in Camden County, Georgia.

Spread, Growth Parameters, and Reproductive Potential for Brown Flatsedge (*Cyperus fuscus*)

Charles T. Bryson and Richard Carter*

Brown flatsedge (*Cyperus fuscus*) is widely distributed in Europe, Asia, the Indian subcontinent, and the Mediterranean region of Northern Africa. It was apparently introduced into North America in the late 1800s and has steadily moved southward and westward. Brown flatsedge is reported new to Arkansas and Mississippi herewith. Field observations from early spring until frost were made between 2003 and 2007 from populations present at three sites: Chicot County, Arkansas, and Pearl River and Washington counties, Mississippi. Under natural field conditions, brown flatsedge plants germinated from late March and early April until frost. Inflorescences were observed in mid-May and seed production continued until frost. In field populations, the average numbers of scales per spikelet, inflorescences per plant, and spikelets per inflorescence were 15, 28, and 33, respectively. Greenhouse experiments were established in 2008 at Stoneville, MS, to determine growth parameters and the reproductive potential of brown flatsedge. In greenhouse experiments, by 10 wk after emergence (WAE), brown flatsedge plants were 30.2 cm tall and 63.9 cm in diameter, and dry weights were 1.4, 1.0, 2.0, 0.5, and 1.9 g for roots, culms, leaves, bracts, and inflorescences, respectively. Brown flatsedge culms and inflorescences appeared 5 WAE, and by 9 WAE all plants were producing seed. Brown flatsedge could pose a threat to natural plant communities and rice agriculture in Arkansas, Louisiana, Mississippi, Missouri, Tennessee, and Texas. Additional research is needed to determine seed longevity and ecological range potential, and to develop inexpensive and effective control methods.

Nomenclature: Brown flatsedge, *Cyperus fuscus* L. CYPFU.

Key words: Invasive weed, ecological range, growth parameters, reproductive potential.

The sedge family (Cyperaceae) contains several of the world's worst weeds (Holm et al. 1977). Bryson and Carter (2008) list 447 species in the family and 147 *Cyperus* species as weeds. Brown flatsedge or brown galingale (*Cyperus fuscus* L.) was reported as a weed in semitropical areas of the Old World where it is a significant pest in rice (Holm et al. 1979). It is widely distributed in the Old World in Europe, Asia, the Indian subcontinent, and the Mediterranean region of Northern Africa, from Greenland and Iceland to China, south to Spain, Iran, Egypt, Algeria, and northern India (Kükenthal 1935 to 1936; McGivney 1938). Brown flatsedge was first discovered in the United States in 1877 in ballast or around wharfs in the Boston, MA, area (Knowlton et al. 1911). Since that time, it has been found in two Canadian provinces, Ontario and Quebec, and numerous states of the United States, including California, Connecticut, Kansas, Maryland, Massachusetts, Missouri, Nebraska, Nevada, New Jersey, Pennsylvania, South Dakota, and Virginia (Fernald 1950; McKenzie et al. 1998; Tucker et al. 2002; Weedon and Stephens 1969). In addition to the association with ballast and wharfs, dispersal of brown flatsedge seeds has been attributed to waterfowl and human activities, including construction equipment (Bryson and Carter 2008; McKenzie et al. 1998).

Taxonomically, brown flatsedge is closely related to smallflower umbrella sedge (*Cyperus difformis* L.), one of the world's worst weeds (Holm et al. 1977), and these species share a number of vegetative and habitat similarities. Both occur in disturbed, muddy soils, shallow water, and shorelines and are loosely clumping annuals with soft spongy culms that are easily compressed (Bryson and Carter 2008; Bryson and DeFelice 2009; Tucker et al. 2002). However, they are easily distinguished by inflorescence characteristics (Tucker et al. 2002), with the floral scales and styles of brown flatsedge 0.9 to 1.1 mm long and

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Interpretive Summary

Brown flatsedge is an annual, nonnative, invasive weed that continues to move south and westward in the United States. It was apparently introduced from contaminated ballast in the Boston, MA, area during the late1800s. Brown flatsedge is reported new to Arkansas and Mississippi and biological and ecological growth parameters are presented from field observations and controlled greenhouse experiments. In optimum environmental conditions, brown flatsedge grows rapidly, and populations are capable of producing multiple generations per year and from 69 million to 2.2 billion seeds ha^{-1} annually. Brown flatsedge plants produced seed by 9 wk after emergence, and the first culms and fruiting occurred by 5 wk after emergence. Currently, brown flatsedge seems poised to infest additional native plant communities and rice production areas in the southeastern United States. Additional research is needed to determine seed longevity and ecological range potential, and to develop inexpensive and effective control methods.

0.3 to 0.4 mm long, respectively, compared to 0.6 to 0.8 mm long and 0.1 mm long, respectively, for smallflower umbrella sedge (Tucker et al. 2002).

Because brown flatsedge was recently detected in shallow water environments in disturbed soils adjacent to rice production areas of the Mississippi Delta Region, research was initiated at Stoneville, MS, to study its basic biology and ecology. Our objectives are to report new populations and to investigate growth rate and reproductive potential from field observations and controlled greenhouse experiments.

Materials and Methods

Field Observations. Plants were observed in and collected from Chicot County, Arkansas, and Pearl River and Washington counties, Mississippi (Figures 1 and 2). Following discovery of a population, data were recorded monthly for the number of plants m^{-2}; number of culms

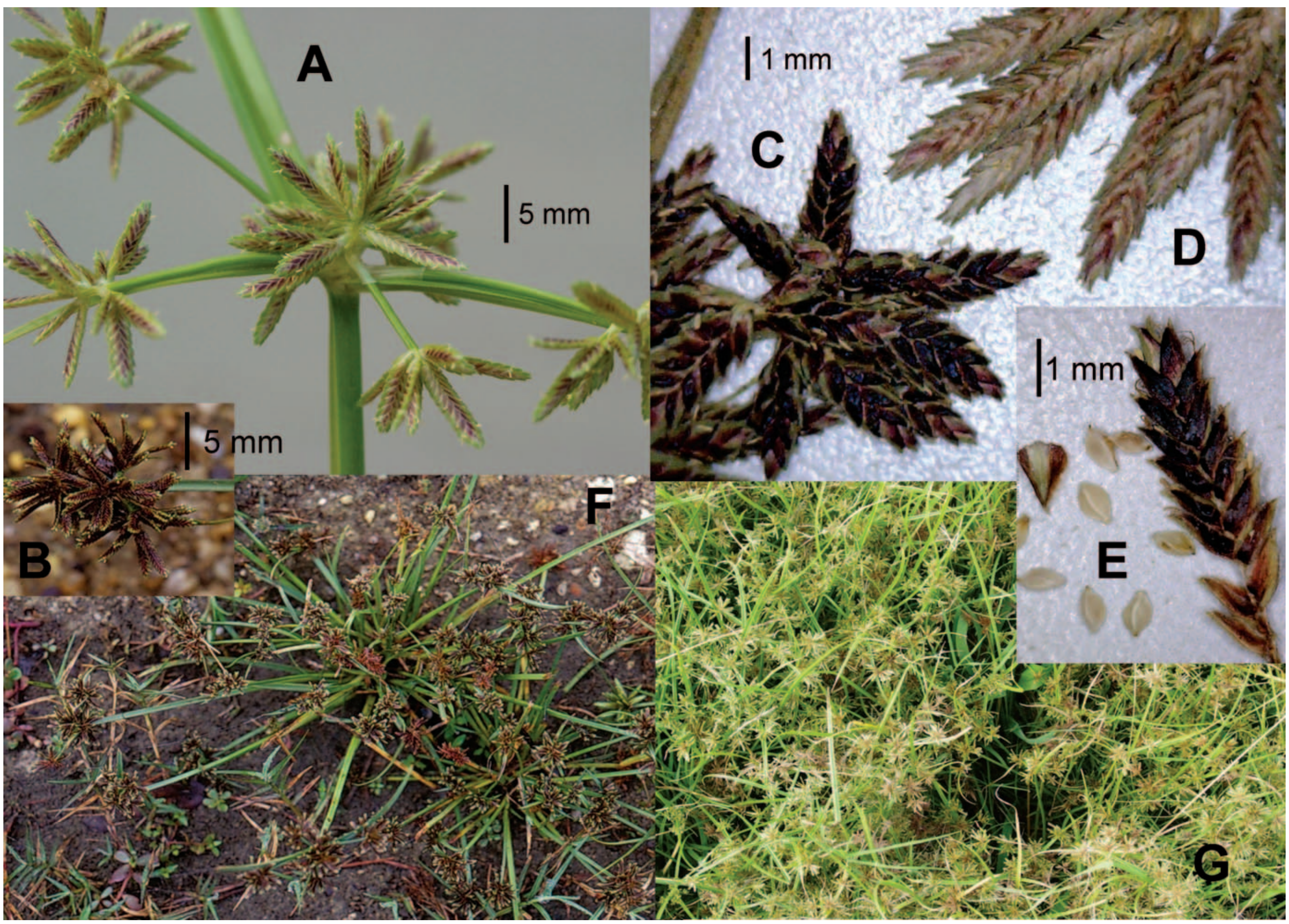

Figure 1. Photos of brown flatsedge: (A) summer inflorescence; (B) autumn inflorescence; (C) spikelet coloration differences between autumn (scales with more pigmentation) and (D) summer (scales with reduced pigmentation); (E) spikelet, scale, and achenes; and plant habit in (F) autumn and (G) summer. Photos of live plants or herbarium specimens correspond to collections as follows: A, D, and G from *Bryson 20,300*; B and F from *Bryson 16878 & Sudbrink*; and E from *Bryson 21944*.

Figure 2. Distribution of brown flatsedge in Canada and the United States. Circles, previously reported distribution; and triangles, new sites from Arkansas and Mississippi.

per plant; number of spikelets per inflorescence; number of seeds, scales, and both per spikelet; and other growth parameters in each of the three populations. The populations in 1998 from Chicot County, Arkansas, and in 2004 from Pearl River County, Mississippi, were present during periods of adequate moisture and were transient from year to year. The Washington County population was observed in 2004 to 2007 and it was the most constant, with adequate moisture being supplied from a leaky fire hydrant following a construction project. Once the hydrant was repaired 3 yr later and the constant soil moisture was eliminated, brown flatsedge plants disappeared during the summer of 2007.

Greenhouse Experiments. Brown flatsedge seed were collected from Washington County, Mississippi, in the fall of 2006 and planted during the summer of 2008. Seeds were planted in 15-cm diam plastic pots filled with a 1 : 1 mixture of potting media[1] and soil (Bosket sandy loam, fine-loamy, mixed thermic Molic Hapludalfs). Plants were thinned to one plant per pot using forceps and grown in a greenhouse set to 30/22 C (± 3 C) day/night temperature. Natural light was supplemented with sodium vapor lamps to provide at least 14 h of photoperiod. Pots were placed in plastic trays, and plants were watered from beneath as needed until harvested.

Plants were grown in the greenhouse for 1 to 10 wk in a randomized complete block arrangement with week of harvest as treatments and 10 repetitions per treatment (individual plants), and the experiment was repeated. Time of emergence, plant height, diameter, and number of leaves and culms per plant, and days to first flower were recorded. At 10 wk after emergence (WAE), plants were harvested weekly, washed, separated by plant part, and oven-dried; dry weights were recorded for roots, culms, leaves, bracts, and inflorescences.

Means and standard errors for quantitative parameters were calculated with SAS.[2] Box plots for selected plant parameters were constructed with Sigma Plot.[3] For other plant parameters, regression analysis was performed and plotted with Sigma Plot.

Results and Discussion

Field Observations. Our collections are the first report of brown flatsedge from Arkansas and Mississippi (Figures 1 and 2) as follows:

Voucher Specimens. *United States, Arkansas. Chicot County.* Chicot Lake County Park, N side of Lake Chicot along lake shoreline on mud flats created by low water level in lake (33°16′44.35″N, 91°13′08.04″W), 15 Oct 2004, *Bryson 20,408* (MO, NY, SWSL, UARK, VDB, VSC, herb. Bryson).

United States, Mississippi. Pearl River County. Picayune, 0.2 mi. E of jct. Hwy I-59 and MS 43 then ca. 0.2 mi. S on frontage road to E of I-59 in open area on sandy to sandy loam soil mudflats S of Hwy MS 43 (30°31′00.43″N, 89°39′40.19″W), 28 Oct 1998, *Bryson 16878 & Sudbrink* (BRIT, DAV, DSC, FLAS, GH, IBE, JSU, MICH, MISS, MISSA, MMNS, MO, NY, SWSL, UARK, USMS, VDB, VSC, herb. Bryson).

Washington County. Stoneville, USDA-ARS, Jamie Whitten Delta States Research Center, behind five-story building, open weedy area, wet, around leaky fire hydrant (33°25′31.68″N, 90°54′42.67″W), 6 Jul 2004, *Bryson 20,300* (BRIT, DAV, DSC, FLAS, GH, IBE, JSU, MICH, MISS, MISSA, MMNS, MO, NY, SWSL, UARK, USMS, VDB, VSC, herb. Bryson); 1 Sep 2004, *Bryson 20326* (BRIT, DAV, DSC, FLAS, GH, IBE, JSU, MICH, MISS, MISSA, MMNS, MO, NY, SWSL, UARK, USMS, VDB, VSC, herb. Bryson); 12 Oct 2006, *Bryson 21929* (BRIT, DAV, DSC, FLAS, GH, IBE, JSU, MICH, MISS, MISSA, MMNS, MO, NY, SWSL, UARK, USMS, VDB, VSC, herb. Bryson); 15 Nov 2006, *Bryson 21944* (DSC, FLAS, IBE, MICH, MISS, MISSA, MMNS, MO, NY, SWSL, USMS, VDB, VSC, herb. Bryson); 1 Dec 2006, *Bryson 21944A* (MISSA, MO, SWSL, VSC, herb. Bryson); Greenville, ca. 0.5 mi. S jct. of Hwy MS 1 and VFW Road in wet open area to W of Hwy MS 1 in front of Lowe's parking lot (33°22′04.10″N, 91°02′23.17″W), 1 Nov 2008, *Bryson 23037 & Bryson* (MO, SWSL, VSC, herb. Bryson).

The Arkansas population of brown flatsedge was found along the shores of Lake Chicot in a natural setting with grasses and other sedges. All of the Mississippi populations of brown flatsedge were from anthropogenically disturbed sites in areas with soil that remained wet for several months of the year. During dry periods, brown flatsedge plants disappeared.

The emergence time and end of seed production were variable among years. The longest period of growth and reproduction was observed in 2006 at Stoneville, MS, when brown flatsedge plants emerged as early as late March and early April, initiated flowering in May, and continued to emerge and produce culms, inflorescences, and seeds as late as December 1, 2006. The following week a frost killed all brown flatsedge plants. In 1998 and 1999, fruiting plants were observed at Picayune, MS, as early as mid-August and continued to flower and fruit until killed by frost. Subsequently, the area was cleared and a restaurant was built over the site. Fruiting brown flatsedge plants were detected in September 2004 following a natural draw-down of the water levels on Chicot Lake near Lake Village, AR; they continued to produce fruits until killed by frost. Few brown flatsedge plants were observed in Chicot County during 2005, because the water levels remained high and open, moist shoreline was unavailable.

Field observations at the three sites in Arkansas and Mississippi showed that brown flatsedge was dependent on persistently moist soil or shallow standing water for establishment, growth, and seed production. Once the soil dried at any one of these locations, brown flatsedge plants begin to die and seedlings were not present until the soil was persistently wet again and temperatures were above 24/16 C day/night. The availability of soil moisture during the dryer summer and fall months in the southeastern United States may explain why brown flatsedge populations are sporadic and only appear in wet soils along exposed margins of lakes and streams and other open habitats with constant soil moisture. For example, average precipitation for Washington County, Mississippi, during the summer and early autumn is less ($\leq$ 9.9 cm mo^{-1}) than late fall, winter, and spring ($\leq$ 11.4 cm mo^{-1}) (MS 2009).

Brown flatsedge plants produced an average of 28 culms and inflorescences when pooled over all field observations (Figure 3). The average number of spikelets per inflorescence was 33 and was variable ranging from 9 to 75 spikelets per inflorescence (Figure 3). The number of scales ranged from 7 to 31 per spikelet and averaged 15 scales per spikelet (Figure 3). The total number of plants m^{-2} was variable from site to site, from year to year, and time of year. Over all observations, brown flatsedge population density ranged from a single plant to 32 plants m^{-2}. Therefore, if one-half of the flowers, subtended by a single scale, produced a seed, the number of brown flatsedge seeds produced could range from 6,900 to 220,800 seeds m^{-2} or 69 million to 2.2 billion seeds ha^{-1} annually. Currently, there are no data on viability and longevity of brown flatsedge seed; however, brown flatsedge plants are not detected each year and were observed only under optimal environmental conditions (P. M. McKenzie et al., unpublished data).

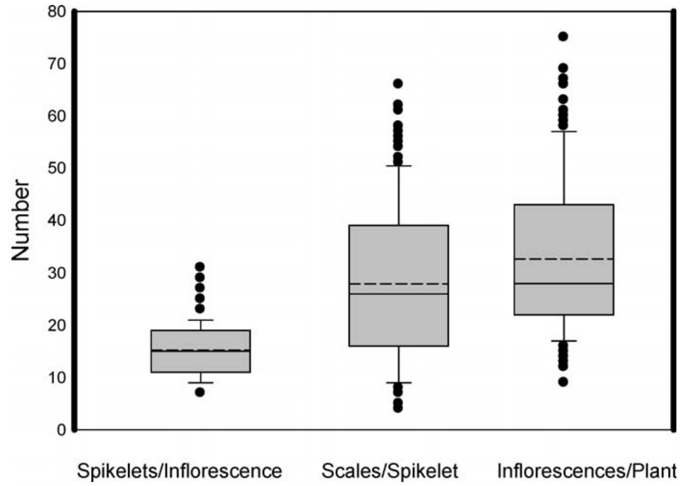

Figure 3. Average number of brown flatsedge spikelets per inflorescence, scales per spikelet, and inflorescences per plant from populations in Chicot County, Arkansas, and Pearl River and Washington counties, Mississippi. Boundary of box closest to zero indicates the 25th percentile, a solid line within the box marks the median, a dashed line within the box delineates the mean, and the boundary of the box farthest from zero indicates the 75th percentile. Error bars above and below the box indicate the 90th and 10th percentiles, and solid dots indicate outliers. The number of independent observations is 175 for each character.

Greenhouse Experiments. Because there was no treatment by experiment interaction, data were combined. Average measurements and dry weights for brown flatsedge are provided in Figure 4. One week after emergence, brown flatsedge plants comprised one to two thread-like leaves and averaged 1.8 cm tall (Figure 4A) and 1.6 cm diameter from leaf tip to leaf tip and had a dry weight of less than 0.5 mg. By 10 WAE, average plant height was 30.2 cm tall (Figure 4A). By 10 WAE, many of the culms were decumbent and plants were about twice as wide (63.9 cm wide) as the plant height (data not shown). The number of new leaves initiated declined following the development of culms (Figure 4B). A maximum average number of leaves (147 leaves plant^{-1}) was recorded at 8 WAE and declined thereafter to an average of 62.0 leaves plant^{-1} by 10 WAE (Figure 4B).

By 10 WAE, whole plant dry weights averaged 6.8 g, and average root dry weight was 1.4 g (Figure 4C). At 10 WAE, average total dry weights of leaves vs. components directly supporting fruit production (i.e., culm, bract, and inflorescence) were 2.0 and 3.4 g plant^{-1}, respectively, and the average dry weights per plant of culm, bract, and inflorescence excluding bracts were 1.0, 0.5, and 1.9 g, respectively (Figures 4D–F). By 9 WAE, the reproductive

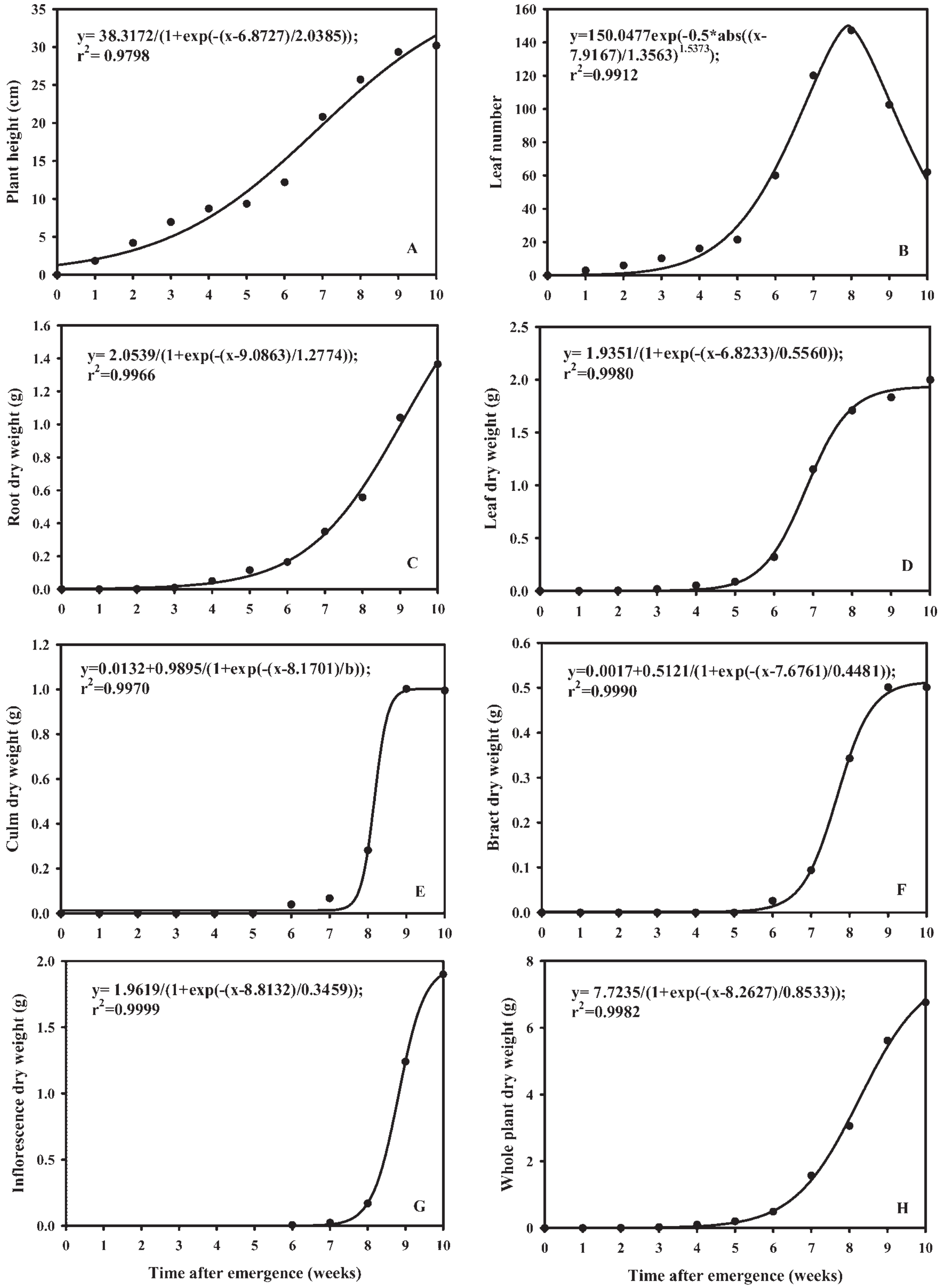

Figure 4. Growth and dry weights of brown flatsedge in greenhouse experiments conducted at Stoneville, MS. (A) Average plant height; (B) number of leaves; and dry weights for (C) roots, (D) leaves, (E) culms, (F) bracts, (G) inflorescences, and (H) whole plants.

portions (i.e., culms, bracts, and inflorescence) of brown flatsedge plants (2.7 g) was greater than 50% of total plant weight (5.6 g) (Figure 4H). Dry weights of bracts and culms were similar between 9 and 10 WAE (Figures 4E and 4F). This trend was similar to field observations in which the length of bracts and culms produced on older plants were shorter than those in younger plants.

The first culm appeared 5 WAE, and all brown flatsedge plants were producing inflorescences and seeds by 9 WAE (Figure 4G). As plants grew and culms developed, older leaves began to die and were not replaced by new leaves. Average dry weight of leaves and culms (Figures 4D and 4E) show the transition from a vegetative mode to a reproductive mode starting at 6 WAE. This phenomenon is not unusual for Cyperaceae. Smallflower umbrella sedge and *Cyperus haspan* L. possess more culms than leaves at maturity (unpublished data), and Bernard and Fiala (1986) determined that as longhair sedge (*Carex comosa* Boott) plants increase in size, flowering culms total and percentage of weight increased in relationship to weights of vegetative shoots.

The life history and population dynamics of brown flatsedge seem to be similar to smallflower umbrella sedge. Holm et al. (1979) reported that smallflower umbrella sedge can produce a generation every 4 to 6 wk in optimum environmental conditions. With the possibility of multiple generations per year and high seed numbers annually, brown flatsedge could pose a threat to the native flora and rice agriculture in Arkansas, Louisiana, Mississippi, Missouri, Tennessee, and Texas. Additional research is needed to determine seed longevity and ecological range potential, and to develop inexpensive and effective control methods for brown flatsedge.

Sources of Materials

[1] Jiffy mix, Jiffy Products of America Inc., Batavia, IL 60510.

[2] SAS software, Version 8.3. SAS Institute Inc., Box 8000, SAS Circle, Cary, NC 27513.

[3] Sigma Plot 10.0, Systat Software Inc., San Jose, CA 95110.

Acknowledgments

We thank J. Paige Goodlett for technical assistance in greenhouse experiments and Nancy B. Bryson and Don L. Sudbrink, Jr., for assistance with field collections.

Literature Cited

Bernard, J. M. and K. Fiala. 1986. The life history strategy reflected in standing crop and biomass allocation patterns of *Carex comosa* Boott: a clump-forming wetland sedge. Ekologia CSSR 5:247–259.

Bryson, C. T. and R. Carter. 2008. The significance of Cyperaceae as weeds. Pages 15–101 *in* R. F. C. Naczi and B. A. Ford, eds. Sedges: Uses, Diversity, and Systematics of the Cyperaceae. Monogr. Syst. Bot. Missouri Bot. Gard. 108.

Bryson, C. T. and M. S. DeFelice. Weeds of the South. Athens, GA, and London: University of Georgia Press, 468 p.

Fernald, M. L. 1950. Gray's Manual of Botany. 8th ed. New York: D. Van Nostrand Co. 1632 p.

Holm, L. G., J. V. Pancho, J. P. Herberger, and D. L. Plucknett. 1979. A Geographical Atlas of World Weeds. New York: J. Wiley. 391 p.

Holm, L. G., D. L. Pucknett, J. B. Pancho, and J. P. Herberger. 1977. The World's Worst Weeds: Distribution and Biology. Honolulu, HI: University Press of Hawaii. 609 p.

Knowlton, C. H., J. A. Cushman, W. Deane, and A. K. Harrison. 1911. Reports on the flora of Boston District-VIII. Rhodora 13:27–29.

Kükenthal, G. 1935 to 1936. Cyperaceae-Scirpoideae-Cypereae. Pages 1–671 *in* A. Engler, ed. Das Pflanzenreich IV, 20 (Heft 101). Leipzig: Wilhelm Englemann.

McGivney, M. V. 1938. A revision of the subgenus *Eucyperus* found in the United States. Cathol. Univ. Am. Biol. Ser. 26:1–74.

McKenzie, P. M., B. Jacobs, C. T. Bryson, G. C. Tucker, and R. Carter. 1998. *Cyperus fuscus* (Cyperaceae), new to Missouri and Nevada, with comments on its occurrence in North America. Sida 18: 325–333.

[MS] Mississippi. 2009. Mississippi Weather—Average Temperatures and Rainfall. http://countrystudies.us/united-states/weather/Mississippi. Accessed: July 30, 2009.

Tucker, G. C., B. G. Marcks, and J. R. Carter. 2002. *Cyperus.* Pages 141–191 *in* P. W. Ball, K. Gandhi, R. W. Kiger, D. Murray, J. L. Zarucchi, A. A. Reznicek, and J. L. Strother, eds. Flora of North America. Volume 23. New York: Oxford University Press.

Weedon, R. R. and H. A. Stephens. 1969. *Cyperus fuscus* in Nebraska and South Dakota. Rhodora 71:433.

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Appendix D. Herbarium related consultations and services 2006-2010.

2006

1. Identified photograph of *Sambucus canadensis* (Caprifoliaceae) for Dr. T. Murphy, University of Georgia (Griffin); 10 January 2006
2. Identified specimen of *Veronica persica* (Scrophulariaceae) for Dr. T. Murphy, University of Georgia (Griffin); 04 March 2006
3. Provided data on *Justicia angusta* (Acanthaceae) to Ms L. Chaffin, State Botanical Garden of Georgia, University of Georgia (Athens); 02 March 2006
4. Identified specimen of *Bromus catharticus* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 10 March 2006
5. Identified photographs of *Abutilon* sp. (Malvaceae) for Dr. S. Culpepper, University of Georgia (Tifton); 10 March 2006
6. Identified photographs of *Senecio (Packera) glabellus* (Asteraceae) for Dr. E. Prostko, University of Georgia (Tifton); 10 March 2006
7. Provided information on disease in oak tree to Mr. H. Gomez, Valdosta, Georgia; 21 March 2006
8. Sent 251 duplicate specimens (mostly my collections) in exchange to Dr. C. Bryson, USDA-ARS, Southern Weed Science Laboratory, Stoneville, Mississippi; 01 April 2006
9. Sent 112 duplicate specimens (mostly my collections) in exchange to Dr. C. Bryson, USDA-ARS, Southern Weed Science Laboratory, Stoneville, Mississippi; 02 April 2006
10. Sent 163 duplicate specimens (mostly my collections) in exchange to Herbarium, Department of Plant Biology, University of Georgia, Athens; 02 April 2006
11. Identified specimen of *Bowlesia incana* (Apiaceae) for Dr. T. Webster, USDA-ARS, Tifton, Georgia; 09 April 2006
12. Identified specimen of *Bromus catharticus* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 09 April 2006
13. Identified photograph of *Piptochaetium avenaceum* (Poaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 13 April 2006
14. Identified photographs of *Cercis siliquastrum* (Fabaceae) for Mr. J. Young, US Army Corps of Engineers, Bagram Air Base, Afghanistan; 13 April 2006
15. Identified specimen of *Alniphyllum fortunei* (Styracaceae) for Dr. J. Ruter, University of Georgia (Tifton); 14 April 2006
16. Identified specimen of *Panicum amarum* (Poaceae) for Mr. N. Richardson and Dr. T. Manning, Chemistry Department, Valdosta State University; 18 April 2006
17. Identified specimens of *Lupinus villosus* (Fabaceae) and *Scutellaria racemosa* (Lamiaceae) for Dr. E. Prostko, University of Georgia (Tifton); 18 April 2006
18. Identified specimen of *Isolepis carinata* (Cyperaceae) for Dr. T. Murphy, University of Georgia (Griffin); 21 April 2006
19. Identified photographs of *Zygophyllum fabago* (Zygophyllaceae) for Mr. J. Young, US Army Corps of Engineers, Bagram Air Base, Afghanistan; 13 May 2006
20. Identified photographs of *Sarracenia flava, S. minor, S. flava* × *S. minor* (Sarraceniaceae) for Mr. C. Miller, Thomas County, Georgia; 16 May 2006
21. Provided herbarium loan of specimens of rare Georgia plants *(Allium speculae, Portulaca biloba, Sedum pusillum, Stewartia malacodendron)* to R. K. Godfrey Herbarium (FSU), Department of Biological Sciences, Florida State University, for use by Ms J. Hancock, illustrator, at request of Ms L. Chaffin, State Botanical Garden of Georgia, University of Georgia (Athens); 17 May 2006
22. Provided loan of 137 *Senecio (Packea)* (Asteraceae) specimens to Dr. D. Trock, Herbarium, California Academy of Science, San Francisco; 17 May 2006

23. Sent 27 duplicate specimens in exchange and four *Carex* (Cyperaceae) duplicate specimens as gift for determination to Dr. C. Bryson, Southern Weed Science Laboratory, USDA-ARS, Stoneville, Mississippi; 18 May 2006
24. Identified photograph of *Baptisia lanceolata* (Fabaceae) for Dr. T. Murphy, University of Georgia (Griffin); 22 May 2006
25. Identified photographs of sterile specimens of *Alternanthera* sp. (Amaranthaceae) for Dr. E. Prostko, University of Georgia (Tifton); 22 May 2006
26. Identified specimens of *Vulpia octoflora, V. myuros* (Poaceae), *Polygonum opelousanum* (Polygonaceae), *Ludwigia glandulosa* (Onagraceae) and *Arachis prostrata* (Fabaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 30 May 2006
27. Identified specimen (sterile) of *Alternanthera* sp. (Amaranthaceae) for Dr. E. Prostko, University of Georgia (Tifton); 04 June 2006
28. Provided loan of 88 *Carex* (Cyperaceae) specimens to Dr. R. Naczi, Claude E. Phillips Herbarium (DOV), Delaware State University, Dover; 06 June 2006
29. Provided data on potential collection sites for *Schoenoplectus pungens* complex (Cyperaceae) to Ms. D. Hurlbut, Central Michigan University; 11 June 2006
30. Identified specimen of *Polypremum procumbens* (Loganiaceae) for Dr. S. Culpepper, University of Georgia (Tifton); 13 June 2006
31. Provided data (and updates) on *Lygodium japonicum* (Lygodiaceae) to Ms A. Van Loan, Florida Division of Forestry, Gainesville; 13 June 2006, 25 June 2006, 26 June 2006
32. Identified specimen of *Heliotropium amplexicaule* (Boraginaceae) for Dr. T. Murphy, University of Georgia (Griffin); 15 June 2006
33. Identified specimen of *Echinochloa polystachya* (Poaceae) for Dr. E. Prostko, University of Georgia (Tifton); 17 June 2006
34. Sent three duplicate specimens of *Senecio (Packera)* (Asteraceae) as gift for determination to Dr. D. Trock, Herbarium, California Academy of Science, San Francisco; 21 June 2006
35. Identified specimen (fertile) of *Alternanthera philoxeroides* (Amaranthaceae) for Dr. E. Prostko, University of Georgia (Tifton); 25 June 2006
36. Provided photograph of *Pteroglossaspis ecristata* (Orchidaceae) for use in Lake Wales Ridge (Florida) plant identification guide, to Mr. B. Miley; 05 July 2006
37. Identified specimen of *Cyperus croceus* (Cyperaeae) for Dr. T. Murphy, University of Georgia (Griffin); 15 July 2006
38. Identified specimen of *Solanum pseudocapsicum* (Solanaceae) for Dr. T. Murphy, University of Georgia (Griffin); 16 July 2006
39. Identified specimen of *Eupatorium hyssopifolium* (Asteraceae) for Dr. E. Prostko, University of Georgia (Tifton); 17 July 2006
40. Identified specimen of *Dysphania ambrosioides* (Chenopodiaceae) for Dr. S. Culpepper, University of Georgia (Tifton); 17 July 2006
41. Identified specimens of *Juncus effusus* and *J. coriaceous* (Juncaceae) for Dr. T. Murphy, University of Georgia (Griffin); 23 July 2006
42. Identified specimen of *Physalis walteri* (Solanaceae) for Dr. E. Prostko, University of Georgia (Tifton); 23 July 2006
43. Identified specimen of *Cyperus iria* (Cyperaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 23 July 2006
44. Provided distributional data on *Cyperus cephalanthus* (Cyperaceae) to Mr. R. Mears, Department of Homeland Security, Miami, Florida; 25 July 2006
45. Identified photograph of *Nelumbo nucifera* (Nelumbonaceae) for Ms J. Glover, Reed Bingham State Park, Adel, Georgia; 19 August 2006

46. Identified specimen of *Scutellaria racemosa* (Scrophulariaceae) for Dr. T. Murphy, University of Georgia (Griffin); 28 August 2006
47. Identified photograph of *Ambrosia bidentata* (Asteraceae) for Dr. T. Murphy, University of Georgia (Griffin); 30 August 2006
48. Identified photograph of *Cuphea carthagensis* (Lythraceae) for Dr. T. Murphy, University of Georgia (Griffin); 19 September 2006
49. Identified photographs of *Sesbania herbacea* (Fabaceae) for Mr. J. Bailey, Woodbine, Georgia; 24 August 2006
50. Identified five *Cyperus* specimens for Dr. D. Rosen, US Fish & Wildlife Service, Houston, Texas; 01 October 2006
51. Identified photograph of *Indigofera hirsuta* (Fabaceae) for Dr. T. Murphy, University of Georgia (Griffin); 02 October 2006
52. Identified photographs of *Ophioglossum* cf. *petiolatum* (Ophioglossaceae) for Ms H. Thornton, Homeowner IPM Specialist, Plant Pathology Department, University of Georgia (Athens); 02 October 2006
53. Sent 344 duplicate specimens (mostly my collections) in exchange to Dr. C. Bryson, USDA-ARS, Southern Weed Science Laboratory, Stoneville, Mississippi; 17 October 2006
54. Provided seeds of *Manfreda virginica* (Agavaceae) to Dr. A. Rodriguez, Department of Botany and Zoology, University of Guadalajara, Jalisco, Mexico; 31 October 2006
55. Identified sterile specimen of *Quercus virginiana* (Fagaceae) for Mr. C. Williams, Auxillary Services, Valdosta State University; 13 November 2006
56. Provided distributional data on *Merremia dissecta* (Convolvulaceae) to Dr. D. Austin, Arizona Sonora Desert Museum, Tucson, Arizona; 16 November 2006
57. Identified photograph of *Crotalaria lanceolata* (Fabaceae) for Dr. E. Prostko, University of Georgia (Tifton); 20 November 2006
58. Sent 391 duplicate specimens (mostly my collections) in exchange to Dr. R. Kral, Curator, Vanderbilt University Herbarium (VDB), Botanical Research Institute of Texas, Fort Worth; 20 December 2006

2007

1. Provided photograph of *Ptelea trifoliata* (Rutaceae) through The University of Georgia Bugwood Network to Sumi Sin, Andrew Stewart Publishing, for use in field guide to trees; 25 January 2007
2. Identified specimen of *Phyllanthus urinaria* (Euphorbiaceae) for Dr. T. Murphy, University of Georgia (Griffin); 05 February 2007
3. Identified specimen of *Vicia sativa* (Fabaceae) and provided information on toxic seeds in case of possible unintentional poisoning in which child ate seeds and flowers for Ms Robin McLendon, Valdosta, GA; 08 February 2007
4. Provided photographs of Robert Kral (Prof. Emeritus, Vanderbilt University) to Dr. Donna Eggers-Ware, William & Mary University; 27 February 2007
5. Provided photograph of Aesculus pavia (Hippocastanaceae) through The University of Georgia Bugwood Network to Mr. R. Kennedy (Lone Pine Publishing) for use in Trees of Illinois; 07 March 2007
6. Provided information on *Ruellia noctiflora* (Acanthaceae) to Mr. Erin Tripp, Duke University; 13 March 2007
7. Identified sterile specimen of *Juncus* cf. *dichotomus* (Juncaceae) for Dr. E. Prostko, University of Georgia (Tifton); 27 March 2007
8. Diagnosed scale insect infestation on houseplant by telephone for Ms Debra Stalvey; 01 April 2007
9. Identified photographs of *Heliotropium amplexicaule* (Boraginaceae) for Dr. T. Murphy, University of Georgia (Griffin); 04 April 2007

10. Provided herbarium specimen data on miscellaneous species to Mr. Lee Echols, University of Georgia (Athens); 08 April 2007
11. Provided herbarium specimen data on *Ophioglossum engelmannii* (Ophioglossaceae) to Mr. Lee Echols, University of Georgia (Athens); 11 April 2007
12. Identified 22 specimens (loan to VSC) of *Cyperus* and *Kyllinga* (Cyperaceae) for Dr. Charles Allen, Fort Polk, LA; 11 May 2007
13. Identified photographs of *Hibiscus aculeatus* (Malvaceae) for Dr. T. Murphy, University of Georgia (Griffin); 17 May 2007
14. Identified specimen of *Commelina erecta* (Commelinaceae) for Dr. E. Prostko, University of Georgia (Tifton); 17 May 2007
15. Identified specimen of *Vulpia myuros* (Poaceae) for Mr. D. McWhorter, Georgia Seed Development Commission (Athens); 17 May 2007
16. Identified specimen of *Danthonia spicata* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 21 May 2007
17. Identified 19 specimens (gift for determination) of *Cyperus* and *Kyllinga* (Cyperaceae) from South America for Mr. J. Abbott, University of Florida Herbarium; 02 June 2007
18. Identified specimens of *Baccharis halimifolia* (Asteraceae) and *Ligustrum sinense* (Caprifoliaceae) for Dr. M. Blackmore, Valdosta State University; 07 June 2007
19. Sent 1 specimen (loan, *Carter 13052*) of *Rorippa* sp. (Brassicaceae) to Dr. I. Al-Shehbaz for determination; 12 June 2007
20. Identified specimen of *Rumex pulcher* (Polygonaceae) for Dr. T. Murphy, University of Georgia (Griffin); 14 June 2007
21. Identified photograph of *Richardia* cf. *scabra/brasiliensis* (Rubiaceae) for Dr. T. Murphy, University of Georgia (Griffin); 19 June 2007
22. Identified specimen of *Scoparia dulcis* (Scrophulariaceae) for Dr. T. Murphy, University of Georgia (Griffin); 19 June 2007
23. Identified specimen of *Plantago wrightiana* (Plantaginaceae) for Dr. S. Culpepper, University of Georgia (Tifton); 20 June 2007
24. Identified specimen (sterile) of *Alternanthera* sp. (Amaranthaceae) for Dr. E. Prostko, University of Georgia (Tifton); 20 June 2007
25. Provided locality data on *Rubus* cf. *armeniacus* (Rosaceae) to Ashley Went, Graduate Student, Western Kentucky University; 21 June 2007
26. Identified photograph of *Silphium compositum* (Asteraceae) for Dr. T. Murphy, University of Georgia (Griffin); 26 June 2007
27. Identified photograph of *Tragia urens* (Euphorbiaceae) for Dr. T. Murphy, University of Georgia (Griffin); 28 April 2007
28. Identified specimen of *Cleome viscosa* (Capparaceae) for Dr. E. Prostko, University of Georgia (Tifton); 28 June 2007
29. Identified photograph of *Parkinsonia aculeata* (Fabaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 13 July 2007
30. Identified specimen of *Digitaria ciliaris* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 20 July 2007
31. Identified photograph of *Paspalum intermedium* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 24 July 2007
32. Identified photograph of *Conyza bonariensis* (Asteraceae) for Dr. E. Prostko, University of Georgia (Tifton); 24 July 2007
33. Identified photograph of *Heliotropium amplexicaule* (Boraginaceae) for Dr. E. Prostko, University of Georgia (Tifton); 27 July 2007

34. Identified specimen of *Juncus coriaceous* (Juncaceae) for Dr. T. Murphy, University of Georgia (Griffin); 31 July 2007
35. Identified specimens of *Physalis angulata* (Solanaceae) and *Argemone albiflora* (Papaveraceae) for Dr. E. Prostko, University of Georgia (Tifton); 04 August 2007
36. Identified specimen of *Eragrostis pectinacea* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 06 August 2007
37. Identified (on site) specimen of *Helianthus annuus* (Asteraceae) for Dr. H. McIntyre, Valdosta, GA; 08 August 2007
38. Identified photograph of *Bothriochloa hybrida* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 08 August 2007
39. Identified photograph of *Tagetes minuta* (Asteraceae) for Dr. E. Prostko, University of Georgia (Tifton); 14 August 2007
40. Sent 2 specimens (gift for confirmation, *Carter 17281, 17902*) of *Bothriochloa ischaemum* and *B. hybrida* (Poaceae) to Dr. K. Allred, New Mexico State University; 14 August 2007
41. Provided photograph of Ilex cassine (Aquifoliaceae) through The University of Georgia Bugwood Network for use by C. Bailey in publication in Scripps Treasure Coast Newspapers; 24 August 2007
42. Identified photograph of *Cleome gynandra* (Capparaceae) for Dr. E. Prostko, University of Georgia (Tifton); 24 August 2007
43. Identified specimen of *Panicum anceps* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 24 August 2007
44. Provided information on fall color potential of local native trees to Mr. Chet Bailey, Naturalist, Reed Bingham State Park; 26 August 2007
45. Identified specimen of *Eragrostis pectinacea* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 16 September 2007
46. Identified specimen of *Hydrocotyle ranunculoides* (Apiaceae) for Mr. J. Bailey, Woodbine, GA; 18 September 2007
47. Identified specimen of *Pluchea foetida* (Asteraceae) for Dr. E. Prostko, University of Georgia (Tifton); 20 September 2007
48. Identified specimens of *Smilax glauca* (Smilacaceae) and *Silphium compositum* (Asteraceae) for Dr. M. Czarnota, University of Georgia (Griffin); 24 September 2007
49. Identified specimen of *Alternanthera caracasana* (Amaranthaceae) for Dr. S. Culpepper, University of Georgia (Tifton); 24 September 2007
50. Identified specimen of *Cyperus bipartitus* (Cyperaceae) for Dr. L. Anderson, Godfrey Herbarium, Florida State University; 25 September 2007
51. Identified photograph of *Eupatorium serotinum* (Asteraceae) for Dr. T. Murphy, University of Georgia (Griffin); 28 September 2007
52. Identified photograph of *Diodia virginiana* (Rubiaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 05 October 2007
53. Introduction to the VSU herbarium and tour for Amaryllis Garden Club (ca. 20 participants), Valdosta; 16 October 2007
54. Provided photograph of *Lyonia lucida* (Eriaceae) for use in publication on flowering shrubs, vines and small trees (Pineapple Press) by Ms M. Harrison; 05 December 2007
55. Identified specimen of *Aeschynomene americana* (Fabaceae) for Dr. E. Prostko, University of Georgia (Tifton); 17 October 2007
56. Identified photograph of *Fagopyrum esculentum* (Polygonaceae) for Dr. E. Prostko, University of Georgia (Tifton); 24 October 2007
57. Identified photograph of *Hydrocotyle bowlesioides* (Apiaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 24 October 2007

58. Provided five (5) herbarium tours for ca. 135 participants in Hidden History series, coordinated by Ms. D. Davis, Archivist, Odum Library, Valdosta State University; 29 October – 03 November 2007
59. Identified 182 specimens (loan) of *Cyperus* and *Kyllinga* (Cyperaceae) at the request of Dr. G. Nelson, Tall Timbers Research Station Herbarium; 06 November 2007
60. Provided data on populations of *Coreopsis integrifolia* (Asteraceae) for Heather Alley, State Botanical Garden of Georgia (Athens); 18 November 2007
61. Provided seeds of *Portulaca biloba* (Portulacaceae) to Dr. J. Matthews, Habitat Assessment and Restoration Program, Inc. (HARP), Charlotte, NC; 21 November 2007
62. Provided information on 10 characteristic plants of the Georgia Coastal Plain for use in preparing a lesson plan for 3rd grade students by Ms. Jamie Akin, K-12 Curriculum Director, Bibb County (GA) Public School System; 01 December 2007
63. Provided photograph of Ilex cassine (Aquifoliaceae) through The University of Georgia Bugwood Network for use by Mr. J. Lucas in an educational article for DavesGarden.com; 06 December 2007
64. Provided habitat data on *Eleocharis melanocarpa* (Cyperaceae) to Mr. C. Reid, Louisiana Natural Heritage Program; 24 & 26 December 2007

2008

1. Provided information to Dr. T. Murphy, University of Georgia (Griffin) on contacts in Argentina related to identification of photographs of grasses in Argentina; 02 January 2008
2. Identified photographs of and provided information on *Apios americana* (Fabaceae) for J. Glover, Interpretive Naturalist, Reed Bingham State Park, Adel, GA; 05 January 2008
3. Herbarium introduction and tour to VSU Parent's Council on 09 February 2008
4. Provided information on *Carex acidicola* and *C. impressinervia* to T. Patrick, Botanist, Georgia Nongame Conservation Section, Department of Natural Resources; 25 February 2008
5. Identified smut infected *Rhynchospora* sp. for Dr. W. Holmes, Baylor University, Waco Texas; 26 February 2008
6. Identified specimen of *Descurainia pinnata* (Cruciferae) for Dr. E. Prostko, University of Georgia (Tifton); 15 March 2008
7. Identified *Riccia fluitans* (Ricciaceae/Hepatophyta) from Long Pond canals by telephone for H. Wyatt, Fisheries Biologist, Lake Park, Georgia; 26 March 2008
8. Provided information on native plants for use in ornamental landscaping to B. Ganas, Ganas Landscape Designs, Inc., Valdosta, Georgia; 17 April 2008
9. Identified specimens of *Polypogon monspeliensis* (Poaceae) for Dr. E. Prostko, University of Georgia (Tifton); 06 May 2008
10. Identified photographs of *Verbena rigida* (Verbenaceae) for Dr. J. Ruter, University of Georgia (Tifton); 08 May 2008
11. Identified specimen of *Sesbania punicea* (Fabaceae) for Dr. E. Prostko, University of Georgia (Tifton); 13 May 2008
12. Identified photograph of *Cirsium horridulum* var. *horridulum* (Asteraceae) for Dr. M. Czarnota, University of Georgia (Griffin); 19 May 2008
13. Identified specimen of *Trifolium vesiculosum* (Fabaceae) for Dr. E. Prostko, University of Georgia (Tifton); 23 May 2008
14. Herbarium introduction and tour to Prof. Jeffrey Vasseur's ENGL 4300/6000 class – *Global Images of Nature* – on 26 May 2008
15. Identified *Panicum hemitomon* (Poaceae) on site at Rivercreek WMA for P. Spivey, Georgia Department of Natural Resources, Thomasville, Georgia; 05 June 2008
16. Identified specimen of *Paspalum intermedium* (Poaceae) for Dr. E. Prostko, University of Georgia (Tifton); 05 June 2008

17. Identified specimen of *Lechea mucronata* (Cistaceae) for Dr. T. Murphy, University of Georgia (Griffin); 18 June 2008
18. Provided information on non-native species at Banks Lake National Wildlife Refuge, to O. van den Ende, Environmental Scientist, Dynamac Corporation, Cape Canaveral, Florida; 25 June 2008
19. Identified photograph of *Sideroxylon* sp. (Sapotaceae) for Dr. G. Wade, Department of Horticulture, University of Georgia (Athens); 27 June 2008
20. Provided information on various *Cyperus* spp. (Cyperaceae) to W. McAvoy, Botanist, Delaware Natural Heritage and Endangered Species Program, Smyrna, Delaware; 30 June 2008
21. Provided information on the distribution of *Cyperus lanceolatus* (Cyperaceae) to Dr. C. Bryson, USDA-ARS, Stoneville, Mississippi; 03 July 2008
22. Provided information on rare plant species at Banks Lake National Wildlife Refuge, to O. van den Ende, Environmental Scientist, Dynamac Corporation, Cape Canaveral, Florida; 11 July 2008
23. Provided information on propagation of *Firmiana simplex* (Sterculiaceae) to B. Flowers, Department of Grounds, Valdosta State University, Valdosta, Georgia; 17 July 2008
24. Identified specimen of *Ptilimnium capillaceum* (Umbelliferae) for Dr. T. Murphy, University of Georgia (Griffin); 18 July 2008
25. Provided loan of specimens of *Schoenoplectus americanus* (Cyperaceae) to Tulane University Herbarium for study by Dr. M. Blume; 19 July 2008
26. Provided information on *Halesia* spp. (Styracaceae) to Dr. G. Wade, Department of Horticulture, University of Georgia (Athens); 23 July 2008
27. Identified specimen of *Lechea mucronata* (Cistaceae) for Dr. T. Murphy, University of Georgia (Griffin); 04 August 2008
28. Identified photograph of plant in Order Gentianales, Loganiaceae, for Dr. M. Chappell, Department of Horticulture, University of Georgia (Athens); 06 August 2008
29. Identified photographs of *Silphium compositum* (Asteraceae) for Dr. M. Czarnota, University of Georgia (Griffin); 15 August 2008
30. Identified specimens of *Epidendrum magnoliae* for Dr. D. Bechler, Biology Department, Valdosta State Univesity; 28 August 2008
31. Identified photographs of *Pluchea* cf. *camphorata* (Asteraceae) for Dr. E. Prostko, University of Georgia (Tifton); 26 August 2008
32. Identified specimen of *Eragrostis amabilis* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 28 August 2008
33. Identified specimen of *Solanum rostratum* (Solanaceae) for Dr. S. Culpepper, University of Georgia (Tifton); 28 August 2008
34. Identified specimen of *Pyrrhopappus carolinianus* (Asteraceae) for Dr. S. Culpepper, University of Georgia (Tifton); 28 August 2008
35. Identified specimen of *Amaranthus blitum* (Amaranthaceae) for Dr. S. Culpepper, University of Georgia (Tifton); 28 August 2008
36. Identified specimens of *Commelina erecta* (Commelinaceae) for Dr. E. Prostko, University of Georgia (Tifton); 09 September 2008
37. Provided information for herbarium survey of Charophyte holdings for Dr. R. Scribailo, Aquatic Plant Herbarium, Purdue University, Westville, Indiana; 10 September 2008
38. Identified photograph of *Scoparia dulcis* (Scrophulariaceae) for Dr. E. Prostko, University of Georgia (Tifton); 17 September 2008
39. Identified photograph of *Elephantopus nudatus* (Asteraceae) for Dr. E. Prostko, University of Georgia (Tifton); 23 September 2008
40. Identified photograph of *Pilea microphylla* (Urticaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 01 October 2008

41. Identified specimens of *Fraxinus pennsylvanica* (Oleaceae), *Ipomoea lacunosa* (Convolvulaceae), *Morus rubra* (Moraceae), *Rumex obtusifolius* (Polygonaceae) and *Salix nigra* (Salicaceae) for Dr. J. Spencer, Chemistry Department, Valdosta State University; 01 October 2008
42. Provided distributional data on *Cyperus pseudothyrsiflorus* and *C. floribundus* (Cyperaceae) to R. Mears, Miami, Florida; 02 October 2008
43. Identified specimen of *Cyperus flavicomus* (Cyperaceae) for Dr. A. Krings, Herbarium, Department of Plant Biology, North Carolina State University, Raleigh; 02 October 2008
44. Identified photograph of *Conyza canadensis* (Asteraceae) for Dr. T. Murphy, University of Georgia (Griffin); 09 October 2008
45. Identified specimen of *Spermacoce* cf. *assurgens* (Rubiaceae) for Dr. T. Murphy, University of Georgia (Griffin); 21 October 2008
46. Identified photograph of *Polypogon monspeliensis* (Poaceae) for Dr. E. Prostko, University of Georgia (Tifton); 21 October 2008
47. Identified photographs of *Merremia dissecta* (Convolvulaceae) for Dr. T. Webster, USDA-ARS, Tifton, Georgia; 03 November 2008
48. Provided information on descriptive terminology to Dr. E. Prostko, University of Georgia (Tifton); 09 October 2008
49. Identified *Cyperus compressus* (Cyperaceae) seed contaminants for T. Bowyer, Patten Seed Company, Newnan, Georgia; 01 November 2008
50. Provided silica-gel dried leaf tissue samples for DNA analysis and vouchers of *Ilex cassine* (Aquifoliaceae), *Asimina incana* (Annonaceae), *Ilex opaca* var. *opaca* (Aquifoliaceae) and *Persea borbonia* (Lauraceae) to C. Germain-Aubrey, University of Florida, Gainesville; 05 November 2008
51. Provided information on contacts for access to natural areas in Camden County to J. Thompson, Nongame Conservation Section, Georgia Department of Natural Resources, Brunswick; 06 November 2008
52. Provided herbarium specimen data on phenology of *Cyperus compressus* (Cyperaceae) for T. Bowyer, Patten Seed Company, Newnan, Georgia; 07 November 2008
53. Provided information on longleaf pine / wiregrass communities in Camden County to J. Thompson, Nongame Conservation Section, Georgia Department of Natural Resources, Brunswick; 07 November 2008
54. Provided data from herbarium specimens of *Cyperus alopecuroides* and *C. fuligineus* (Cyperaceae) to R. Mears, Miami, Florida; 13 November 2008
55. Provided information on *Pteroglossapsis ecristata* (Orchidaceae) Kings Bay Submarine Base to M. Elliott, Nongame Conservation Section, Georgia Department of Natural Resources, Social Circle; 11 December 2008

2009

1. Identified specimen of *Fimbristylis annua* (Cyperaceae) for Dr. T. Murphy (Mr. C. Waltz), University of Georgia (Griffin); 23 Jan 2009
2. Identified photograph of *Solanum sisymbriifolium* (Solanaceae) for Dr. T. Murphy, University of Georgia (Griffin); 23 Jan 2009
3. Identified 46 specimens (*Cyperus, Kyllinga,* Cyperaceae – gift for det.) for Dr. C. Allen, Fort Polk Military Reservation, LA; 24 Jan 2009
4. Provided herbarium tour to Chad Hyer and Dr. M. Hyer, English Department, VSU; 19 Jan 2009
5. Identified photographs of *Sagina decumbens* (Caryophyllaceae) for Dr. T. Murphy, University of Georgia (Griffin); 27 Feb 2009
6. Identified specimen of *Packera anonyma* (Asteraceae) for Dr. P. McCullough, University of Georgia (Griffin); 05 Mar 2009

7. Identified specimen of *Indigofera caroliniana* (Fabaceae) for Dr. W. Zomlefer, University of Georgia (Athens); 07 Mar 2009
8. Provided information on plant drier to Dr. A. Harvey, Georgia Southern University, Statesboro; 07 Mar 2009
9. Provided information on *Cyperus filiculmis* and *C. lupulinus* (Cyperaceae) to Dr. R. Naczi, Curator of North American Botany, New York Botanical Garden; 13 Mar 2009
10. Provided information on graminoids to Dr. E. Prostko, University of Georgia (Tifton); 13 Mar 2009
11. Identified specimens of *Carex* spp. (Cyperaceae) for Mr. S. Brown, University of Georgia Extension Service, Moultrie, GA; 19 Mar 2009
12. Identified photograph of cf. *Axonopus* spp. (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 28 Mar 2009
13. Identified specimens of *Briza minor* (Poaceae), *Veronica peregrina* (Veronicaceae), and *Triodanis biflora* (Campanulaceae) for Dr. E. Prostko, University of Georgia (Tifton); 09 Apr 2009
14. Identified photograph of *Baptisia lanceolata* (Fabaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 13 Apr 2009
15. Identified specimen of *Valerianella radiata* (Valerianaceae) for Dr. E. Prostko, University of Georgia (Tifton); 15 Apr 2009
16. Identified photograph of *Cyclospermum leptophyllum* or *Spermolepis divaricata* (Apiaceae) for Dr. P. McCullough, University of Georgia (Griffin); 01 May 2009
17. Identified specimen of *Rubus flagellaris* (Rosaceae) for Dr. E. Prostko, University of Georgia (Tifton); 01 May 2009
18. Identified photograph of *Trifolium arvense* (Fabaceae) for Dr. P. McCullough, University of Georgia (Griffin); 11 May 2009
19. Identified photograph of *Vulpia myuros* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 12 May 2009
20. Identified photograph of *Anthriscus caucalis* (Apiaceae) for Dr. T. Murphy, University of Georgia (Griffin); 22 May 2009
21. Identified photograph of *Plantago wrightiana* (Plantaginaceae) for Dr. E. Prostko, University of Georgia (Tifton); 24 May 2009
22. Provided information on native species - potential models in plant life history studies for Coastal Plains RESA MSP Summer Institute – to Mr. E. Gant, North Dade Elementary School, Dade County, FL; 25 May 2009
23. Identified specimen of *Rhynchospora globularis* var. *saxicola* (Cyperaceae) for Dr. H. Norse, University of Georgia (Athens); 01 Jun 2009
24. Identified specimens of *Carex lupulina, Carex cherokeensis* (Cyperaceae), *Smilax glauca* (Smilaceae), *Chamaesyce maculata, Phyllanthus tenellus* (Euphorbiaceae), *Rorippa palustris* var. *palustris, Berteroa incana* (Brassicaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 03 Jun 2009
25. Identified specimen of *Mirabilis jalapa* (Nyctaginaceae) for Dr. T. Murphy, University of Georgia (Griffin); 10 Jun 2009
26. Identified specimen of *Imperata cylindrica* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 16 Jun 2009
27. Identified specimen of *Anthriscus caucalis* (Apiaceae) for Mr. G. Shephard, University of Georgia Cooperative Extension, Dahlonega, GA; 16 Jun 2009 (cf. photo det. 05/22/2009)
28. Identified specimen of *Cuphea carthagensis* (Lythraceae) for Dr. T. Webster, USDA-ARS, South Atlantic Area, Crop Protection and Management Research Unit, Tifton, GA; 17 Jul 2009
29. Identified specimen of *Oldenlandia corymbosa* (Rubiaceae) for Dr. P. McCullough, University of Georgia (Griffin); 10 Jul 2009

30. Identified specimen (fragment) of *Cyperus refractus* (Cyperaceae) for Dr. C. Bryson, USDA-ARS, Stoneville, MS; 03 Sep 2009.
31. Identified photograph of *Fimbristylis* cf. *annua* (Cyperaceae) for Dr. P. McCullough, University of Georgia (Griffin); 09 Sep 2009
32. Identified specimen of *Aristolochia tomentosa* (Aristolochiaceae) for Dr. J. Ruter, University of Georgia (Tifton); 10 Sep 2009
33. Identified specimen of *Dioscorea alata* (Dioscoreaceae) for Ms K. Rawlins, University of Georgia (Tifton); 10 Sep 2009
34. Identified photograph of *Eleocharis* cf. *obtusa* (Cyperaceae) for Dr. P. McCullough, University of Georgia (Griffin); 19 Sep 2009
35. Identified tubers of *Cyperus esculentus* (Cyperaceae) for Dr. E. Prostko, University of Georgia (Tifton); 19 Sep 2009
36. Identified photograph of *Lonicera maackii* (Caprifoliaceae) for Dr. G. Wade, University of Georgia (Athens); 21 Sep 2009
37. Provided information on milkweeds *(Asclepias* spp., Asclepiadaceae) to Ms S. Jackson, rose2ryan@yahoo.com; 29 Sep 2009
38. Identified photograph of *Fimbristylis schoenoides* (Cyperaceae) for Dr. P. McCullough, University of Georgia (Griffin); 29 Sep 2009
39. Identified specimen of *Setaria parviflora* (Poaceae) for Dr. E. Prostko, University of Georgia (Tifton); 01 Oct 2009
40. Identified specimen of *Sicyos angulatus* (Cucurbitaceae) for Mr. F. Ruttinger, Valdosta, GA; 02 Oct 2009
41. Identified specimen of *Cuscuta campestris* (Cuscutaceae) for Georgia Department of Agriculture, Atlanta; 02 Oct 2009
42. Identified specimen of *Digitaria ischaemum* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 21 Oct 2009
43. Identified specimens of *Fimbristylis autumnalis, Cyperus retrorsus* and *Cyperus polystachyos* var. *texensis* (Cyperaceae), and *Andropogon virginicus (Poaceae)* for Dr. M. Czarnota, University of Georgia (Griffin); 09 Dec 2009
44. Identified specimen of *Andropogon virginicus* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 09 Dec 2009
45. Identified specimen of *Panicum dichotomiflorum* (Poaceae) for Dr. C. Johnson, University of Georgia (Tifton); 09 Dec 2009
46. Assisted in identification of photograph of *Carica papaya* (Caricaceae) for Ms Karen Rawlings, University of Georgia (Tifton); 14 Dec 2009

2010

1. Responded to query about *Cyperus difformis* (Cyperaceae) from Dr. D. Webb, Tennessee Valley Authority, Muscle Shoals, AL; 22 Jan 2010
2. Responded to query about *Cyperus articulatus* (Cyperaceae) from Dr. C.T. Bryson, USDA-ARS, Stoneville, MS; 03 Feb 2010
3. Provided determinations of 10 specimens of *Cyperus* (Cyperaceae) for Dr. C. Allen, Fort Polk, LA; 06 Feb 2010
4. Provided photographs of *Agalinus georgianus* (Scrophulariaceae) specimen to Dr. J.M. Hilliker, Botany Department, University of Guelph; 12 Feb 2010
5. Sent 243 vascular plant specimens in exchange to University of North Carolina Herbarium (NCU), Chapel Hill; 27 Feb 2010

6. Sent 134 vascular plant specimens in exchange to North Carolina State University Herbarium (NCSC), Raleigh; 28 Feb 2010
7. Conducted herbarium tours for ca. 200 students (BIOL 1030) at the request of Mr. S. Thompson, Biology Department, Valdosta State University; 01 and 02 Mar 2010
8. Identified photograph of *Pluchea foetida* (Asteraceae) for Dr. S. Culpepper, University of Georgia (Tifton); 02 Mar 2010
9. Hosted visit to confer about *Cyperus* research, Mr. C. Reid, Graduate Student, Botany Department, Louisiana State University, Baton Rouge; 15-16 Mar 2010
10. Provided information on *Cyperus entrerianus* (Cyperaceae) to Dr. C. Jacono, Center for Aquatic and Invasive Plants, University of Florida (Gainesville); 01 Apr 2010
11. Identified photograph of *Leucothoe racemosa* (Ericaceae) for Ms Elaine Nash, Conyers, GA; 30 Apr 2010
12. Provided reprints and pdf file of my general article on sedges *(Tipularia* 2005) for use in wetlands vegetation class, at the request of Ms L. Chafin, State Botanical Garden of Georgia, University of Georgia (Athens); 07 May 2010
13. Identified photograph of *Scutellaria racemosa* (Lamiaceae) for Dr. E. Prostko, University of Georgia (Tifton); 12 May 2010
14. Confirmed specimen determination of *Lonicera japonica* (Caprifoliaceae) for Ms K. Rawlins, University of Georgia (Tifton); 19 May 2010
15. Identified specimen of *Glyceria striata* (Poaceae) for Dr. P. McCullough, University of Georgia (Griffin); 28 Apr 2010
16. Identified specimen of *Vulpia octoflora* (Poaceae) for Mr. J. Price, Lowndes County Extension Agent, University of Georgia Extension Service; 05 May 2010
17. Identified specimen of *Carex longii* (Cyperaceae) for Dr. E. Prostko, University of Georgia (Tifton); 05 May 2010
18. Provided information on *Kyllingia brevifolia* and *Schoenoplectus etuberculatus* (Cyperaceae) to Mr. B. Spencer, Florida Department of Environmental Protection, Tallahassee; 24 May 2010
19. Provided information on *Cyperus strigosus* and *C. odoratus* (Cyperaceae) to Ms N. Wellendorf, Florida Department of Environmental Protection, Tallahassee; 25 May 2010
20. Identified specimen of *Carex digitalis floridana* for Ms L. Duever, Conway Conservation LLC, Micanopy, FL; 25 May 2010
21. Visit to study specimens of Acanthaceae, Dr. T. Daniel, California Academy of Sciences, San Francisco; 9 Jun 2010
22. Identified photograph of *Kyllinga* cf. *pumila* (Cyperaceae) for Dr. P. McCullough, University of Georgia (Griffin); 11 Jun 2010
23. Identified photographs of *Arundinaria* sp. (Poaceae), *Eupatorium rotundifolium* (Asteraceae), *Conyza canadensis* (Asteraceae), *Ambrosia artemisiifolia* (Asteraceae) and *Rubus cuneifolius* (Rosaceae) for Dr. T. Murphy, University of Georgia (Griffin); 10 Jun 2010
24. Sent loan of 8 specimens of Acanthaceae (for study by Dr. T. Daniel) to California Academy of Sciences, San Francisco; 23 Jun 2010
25. Sent 7 specimens (misc. southeastern Acanthaceae) as gift for confirmation by Dr. T. Daniel, California Academy of Sciences, San Francisco; 23 Jun 2010
26. Sent 92 vascular plant specimens in exchange to California Academy of Sciences, San Francisco; 23 Jun 2010
27. Identified photograph of *Baccharis halimifolia* (Asteraceae) for Mr. P. Schoenfeld, Wildlife Biologist, Kings Bay Submarine Base, Kings Bay, Georgia; 24 Jun 2010
28. Identified specimen of *Elymus virginicus* (Poaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 29 Jun 2010

29. Identified specimen of *Carex frankii* (Cyperaceae) for Dr. P. McCullough, University of Georgia (Griffin); 29 Jun 2010
30. Assisted with placement of voucher specimen of *Sarracenia minor okefenokeensis* (Sarraceniaceae) in VSC for Mr. J. Thompson, Georgia DNR, Brunswick; 06 Jul 2010
31. Confirmed identification of photograph of *Desmodium incanum* (Fabaceae) for Dr. P. McCullough, University of Georgia (Griffin); 13 Jul 2010
32. Identified specimen of *Cuscuta campestris* (Cuscutaceae) for Ms E. Calkins, Georgia Department of Agriculture; 15 Jul 2010
33. Sent loan (for study by Mr. I. Park) of 177 specimens – *Cornus florida, C. asperifolia, C. amomum, Cercis canadensis, Sanguinaria canadensis* – to Clemson University Herbarium, Clemson, SC; 15 Jul 2010
34. Identified specimen of *Mitchella repens* (Rubiaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 21 Jul 2010
35. Provided information on *Platanthera chapmanii* (Orchidaceae) to Mr. M. Richards, Atlanta Botanical Garden; 22 Jul 2010
36. Sent loan (for study by Dr. J. Mena-Ali) of 43 specimens of *Solanum carolinense* (Solanaceae) to Franklin and Marshall College Herbarium, Lancaster, PA; 26 Jul 2010
37. Identified photograph of *Juncus tenuis* (Juncaceae) for Dr. P. McCullough, University of Georgia (Griffin); 10 Aug 2010
38. Provided bibliographic information on botanical references to Dr. G. Nelson, Herbarium, Florida State University; 17 Aug 2010
39. Identified photograph of *Phyllanthus urinaria* (Euphorbiaceae) for Dr. E. Prostko, University of Georgia (Tifton); 21 Aug 2010
40. Provided information on habitat and management of *Platanthera chapmanii* (Orchidaceae) site in Camden County, GA, to Mr. M. Richards, Atlanta Botanical Garden; 24 Aug 2010
41. Identified photograph of *Panicum virgatum* (Poaceae) for Dr. M. McClure, Georgia Forestry Commission, Albany, GA; 08 Sep 2010
42. Identified photograph of *Parthenocissus tricuspidata* (Vitaceae) for Dr. G. Wade, Horticulture, University of Georgia (Athens); 08 Sep 2010
43. Identified specimen of *Lonicera maackii* (Caprifoliaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 13 Sep 2010
44. Identified specimen of *Scirpus georginaus* (Cyperaceae) for Mr. W. Bland, Rock Spring Farm, Atlanta, GA; 13 Sep 2010
45. Provided information on Pohlstoffe to Ms E. Nash, Conyers, GA; 13 Sep 2010
46. Hosted visit to confer about *Cyperus* research with Mr. C. Reid, Graduate Student, Botany Department, Louisiana State University, Baton Rouge; 26 Sep 2010
47. Identified specimens of *Panicum verrucosum* (Poaceae) and *Syngonanthus flavidulus* (Eriocaulaceae) for Mr. J. Price, Lowndes County Extension Agent, University of Georgia Extension Service; 27 Sep 2010
48. Provided photograph and information of *Platanthera* x *bicolor* to Dr. P. Catling, Research Scientist, Agriculture and Agri-Food Canada, Ottawa; 05 Oct 2010
49. Identified photographs of *Saccharum giganteum* and *S. contortum* (Poaceae) for Dr. T. Murphy, University of Georgia (Griffin); 05 Oct 2010
50. Provided determinations of 20 specimens of *Cyperus* (Cyperaceae) for Mr. C. Reid, Botanist, Louisiana Department of Wildlife and Fisheries, Baton Rouge; 10 Oct 2010
51. Confirmed identification of photograph of *Boerhaavia coccinea* (Nyctaginaceae) for Dr. P. McCullough, University of Georgia (Griffin); 11 Oct 2010

52. Identified specimen of *Carex decomposita* (Cyperaceae) for Dr. G. Nelson, Herbarium, Florida State University; 16 Oct 2010
53. Hosted visit to confer about *Cyperus* research and conduct field work, Mr. C. Reid, Graduate Student, Botany Department, Louisiana State University, Baton Rouge; 24 Oct 2010
54. Confirmed identification of photograph of *Pluchea foetida* (Asteraceae) for Dr. E. Prostko, University of Georgia (Tifton); 25 Oct 2010
55. Provided photographs of specimen of *Hypocheris microcephala albiflora* (Asteraceae) to Dr. J. Pruski, Missouri Botanical Garden, St. Louis; 25 Oct 2010
56. Sent specimen of *Hypocheris microcephala albiflora* (Asteraceae) to Dr. J. Pruski, Missouri Botanical Garden, St. Louis; 25 Oct 2010
57. Provided data for Jackson County, FL, *Websteria confervoides* (Cyperaceae) site to Mr. C. Reid, Botanist, Louisiana Department of Wildlife and Fisheries, Baton Rouge; 02 Nov 2010
58. Identified specimen of *Oplismenus hirtellus setarius* (Poaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 05 Nov 2010
59. Identified photograph of *Melochia corchorifolia* (Malvaceae) for Dr. E. Prostko, University of Georgia (Tifton); 05 Nov 2010
60. Identified specimen of *Passiflora lutea* (Passifloraceae) for Dr. M. Czarnota, University of Georgia (Griffin); 06 Dec 2010
61. Identified specimens of *Gynandropsis gynandra* (Capparaceae) and *Fimbristylis miliacea* (Cyperaceae) for Dr. D. McWhorter, Georgia Seed Development Commission, Athens; 03 Dec 2010
62. Identified photograph of *Acalypha gracilens* (Euphorbiaceae) for Dr. M. Czarnota, University of Georgia (Griffin); 06 Dec 2010
63. Identified photograph of *Saccharum giganteum* (Poaceae) for Dr. E. Prostko, University of Georgia (Tifton); 10 Dec 2010
64. Provided determinations of 13 specimens of *Cyperus* (Cyperaceae) for Dr. C. Allen, Fort Polk, LA; 27 Dec 2010

Appendix E. Annual evaluations 2006-2010.

Valdosta State University
Annual Faculty Evaluation (2006)

Date of Evaluation: February 6, 2007

I. BIOGRAPHICAL INFORMATION

College: Arts and Sciences

Department: Biology

Name: J. Richard Carter

Highest Degree Earned:. Ph.D. Year: 1984

Appointment Year: 1984 Appointment Rank: Instructor

Present Rank: Professor:

Year First Promotion: 1986 Year Second Promotion: 1991

Total Years at VSU: 22 Years in Present Rank: 10

II. TEACHING PERFORMANCE

Dr. Carter taught five courses (3 with labs) with a combined total enrollment of 213 students. Dr. Carter continues to make extensive use of WebCT Vista in his courses.

Dr. Carter's average student evaluations for spring and fall 2006 were:

Organization and presentation of lecture = Good
Attitude toward students = Fair to Average
Overall quality of instruction = Average to Good

Students choose from the following scale: Poor-Fair-Average-Good-Excellent

III. NON-TEACHING PERFORMANCE

Dr. Carter has served on one Departmental Committee and six University Committees (Chair of two). Dr. Carter is also a member of one City of Valdosta committee.

Dr. Carter continues to serve as an expert botanist as has provided consultant services and specimen exchanges on nearly sixty occasions to universities and museums around the nation.

IV. PROFESSIONAL DEVELOPMENT

A. Research/Scholarly Activities:

Dr. Carter published one journal article and has one book chapter in press. Dr. Carter published four abstracts and gave four presentations, one local, one at the state level and two at the national level. He has eight manuscripts in preparation.

Dr. Carter received one extramural award and was a co-investigator on another submission. Dr. Carter has reviewed three manuscripts, one plant list, and one field guide.
Dr. Carter served as an off-campus member of a doctoral dissertation committee at Texas A&M University.

B. Professional Activities:

Dr. Carter is a current member of eight professional associations, six of which are specific to his discipline.
Dr. Carter attended one state and two national scientific meetings.

V. ACADEMIC HONORS, ACHIEVEMENTS, AND RECOGNITIONS

Dr. Carter was nominated for the VSU Award for Excellence in Professional Activity.

VI. ADVISING

Dr. Carter advises about 25 undergraduate stud

I was unaware of this.

VII. OTHER

Dr. Carter continues to serve as the VSC Herba
extensive amount of time.

VIII. SUMMARY EVALUATION

RC

Dr. Carter is a good teacher and continues to m
technologies in his courses. Dr. Carter had an e
that included publications, grant proposals and numerous presentations along with his heavy workload as curator of the Valdosta State College Herbarium. Dr. Carter had an excellent year of service to VSU and the community. Overall, Dr. Carter's performance in 2006 was outstanding.

In conclusion, the evaluator assesses the faculty member's performance over the evaluation period as (circle the appropriate word):

Satisfactory Non-satisfactory

Robert Gannon
Signature of Evaluator

Date 2-15-07

I certify that I have read this evaluation.

J R Carter
Signature of Person Evaluated

02.20.2007
Date

Valdosta State University
Annual Faculty Evaluation
Calendar Year 2007

Date of Evaluation: February 6, 2008

I. BIOGRAPHICAL INFORMATION

College/Division: Arts & Sciences

Department: Biology

Name: J. Richard Carter

Highest Degree Earned: Ph.D. Year: 1984

Appointment Year: 1984 Appointment Rank: Instructor

Present Rank: Professor

Year First Promotion: 1986 Year Second Promotion: 1991

Total Years at VSU: 23 Years in Present Rank: 11

Next Scheduled Personnel Action: Post-tenure review

Eligibility Date: 2011

FACULTY ANNUAL EVALUATION

After reading the faculty member's Faculty Activity Report and Action Plan, department/unit heads will complete this annual evaluation. The statement should evaluate the faculty member's performance in the areas of teaching and instruction, professional growth and productivity, and college and community service. It should also include recommendations if activity in any given area is determined to need improvement. Attention should be given in cases where a faculty member has any form of load adjustment related to their duties within the department/unit. The department/unit head should address the faculty member's planning and goals for the following year and determine if they are aligned with departmental, college, and university goals, and if they are prioritized in a manner that facilitates appropriate levels of activity that may lead to tenure and promotion. The department/unit head's assessment of the faculty member should be based on departmentally established standards of performance.

SATISFACTORY: Satisfactory performance is demonstrated by performance levels that are recognized as meeting all reasonable and acceptable standards compared to other professional faculty within the department.

UNSATISFACTORY: Unsatisfactory performance is demonstrated by performance levels that are clearly recognized as not meeting reasonable and minimal standards compared to other professional faculty within the department, or documentation is not provided by faculty when requested or prescribed in the evaluation process.

1. Teaching and Instruction

Dr. Carter taught multiple sections of two courses with labs for a combined total enrollment of 121 students. Dr. Carter continues to make extensive use of WebCT Vista in his courses and updates his laboratory exercises.
Dr. Carter mentored one student in a directed study project.

Dr. Carter's average student evaluations for 2007 were:

Organization and presentation of lecture = Good
Attitude toward students = Fair to Average
Overall quality of instruction = Average to Good

Students choose from the following scale: Poor-Fair-Average-Good-Excellent

_X_Satisfactory **___Unsatisfactory**

2. Professional Growth and Productivity

Dr. Carter published six journal articles in 2007 and has several more in press.
Dr. Carter obtained two external grant awards in 2007.

_X_Satisfactory **___Unsatisfactory**

3. College and Community Service

Dr. Carter is a member of three university committees and chair of another. He is also a member of one departmental committee and one civic committee for the city of Valdosta.
Dr. Carter is the Director of the VSC Herbarium and in this capacity he has provided extensive volunteer services to the larger scientific community as he identifies plant specimens for other individuals and universities.

_X_Satisfactory **___Unsatisfactory**

4. Recommended Activities for Improvement

Dr. Carter continues to excel in his scholarly activity and he conscientiously works to improve student learning is his courses. His goals are essentially to continue what he has been doing and I concur as his activities bring merit to the Department of Biology. The only suggestion I can make is that he should consider attending and presenting at scientific meetings.
Overall, Dr. Carter's performance in 2007 was outstanding.

Progress toward next personnel action (List next scheduled personnel action and earliest date, or due date for that action): Excellent progress is being made toward the next post-tenure review.

Overall Evaluation: Satisfactory Unsatisfactory

Department/Unit Head	Date: 2-7-08	Faculty Member	Date: 02.13.2008

The faculty member's signature on this document does not indicate agreement with its contents but that the faculty member has read the evaluation and discussed it with the evaluator. The faculty member has the right to append a response to this evaluation.

Dean's Signature ____ Date ____

VPAA Signature ____ Date ____

Valdosta State University
Annual Faculty Evaluation
Calendar Year 2008

Date of Evaluation: January 22, 2009

I. BIOGRAPHICAL INFORMATION

College/Division: Arts & Sciences

Department: Biology

Name: J. Richard Carter

Highest Degree Earned: Ph.D. Year: 1984

Appointment Year: 1984 Appointment Rank: Instructor

Present Rank: Professor

Year First Promotion: 1986 Year Second Promotion: 1991

Total Years at VSU: 24 Years in Present Rank: 12

Next Scheduled Personnel Action: Post-tenure review

Eligibility Date: 2012

FACULTY ANNUAL EVALUATION

After reading the faculty member's Faculty Activity Report and Action Plan, department/unit heads will complete this annual evaluation. The statement should evaluate the faculty member's performance in the areas of teaching and instruction, professional growth and productivity, and college and community service. It should also include recommendations if activity in any given area is determined to need improvement. Attention should be given in cases where a faculty member has any form of load adjustment related to their duties within the department/unit. The department/unit head should address the faculty member's planning and goals for the following year and determine if they are aligned with departmental, college, and university goals, and if they are prioritized in a manner that facilitates appropriate levels of activity that may lead to tenure and promotion. The department/unit head's assessment of the faculty member should be based on departmentally established standards of performance.

SATISFACTORY: Satisfactory performance is demonstrated by performance levels that are recognized as meeting all reasonable and acceptable standards compared to other professional faculty within the department.

UNSATISFACTORY: Unsatisfactory performance is demonstrated by performance levels that are clearly recognized as not meeting reasonable and minimal standards compared to other professional faculty within the department, or documentation is not provided by faculty when requested or prescribed in the evaluation process.

1. Teaching and Instruction

Dr. Carter taught two sections of botany and two upper-level biology courses, one with a lab, for a combined total enrollment of 72 students. I agree with Dr. Carter's evaluation of his SOIs and am encouraged to see so many student comments indicating their respect for his knowledge of the subject.

Dr. Carter mentored one student in a directed study project.

Dr. Carter's average student evaluations for 2008 were:

Organization and presentation of lecture = Good
Attitude toward students = Average
Overall quality of instruction = Good

Students choose from the following scale: Poor-Fair-Average-Good-Excellent

_X_Satisfactory **___Unsatisfactory**

2. Professional Growth and Productivity

Dr. Carter published six journal articles in 2008 and has many projects in progress that will lead to technical reports and journal articles.
Dr. Carter obtained one external grant award in 2008.
Dr. Carter attended two professional meetings, giving a presentation at one of these. He also attended one workshop.
Dr. Carter reviewed numerous manuscripts and one grant proposal for the NSF.

_X_Satisfactory **___Unsatisfactory**

3. College and Community Service

Dr. Carter is a member of two university committees and chair of another. He is also a member of one departmental committee ~~and one civic committee for the city of Valdosta~~. pre - 2008 RC
Dr. Carter is the Director of the VSC Herbarium and like every year he provided extensive consultations to the scientific community by identifying plant specimens for other individuals and universities. He also assisted with one of the VSU visitation days and gave tours of the Herbarium whenever asked.

_X_Satisfactory **___Unsatisfactory**

4. Recommended Activities for Improvement

Dr. Carter is a good teacher and a truly outstanding scholar. He publishes, consults, reviews, obtains grant money; all the things that bring merit to himself and VSU. I suggested last year that he present his work at meetings, which he did this year. He continues to be active in service work to the college and community. I have no suggestions for improvement this year. Well, I'm not adverse to him bringing in even more money!

Overall, Dr. Carter's performance in 2008 was outstanding.

Progress toward next personnel action (List next scheduled personnel action and earliest date, or due date for that action): Excellent progress is being made toward the next post-tenure review.

Overall Evaluation: Satisfactory Unsatisfactory

[signature]	1-22-09	Richard Carter	01/28/09
Department/Unit Head	Date	Faculty Member	Date

The faculty member's signature on this document does not indicate agreement with its contents but that the faculty member has read the evaluation and discussed it with the evaluator. The faculty member has the right to append a response to this evaluation.

Dean's Signature Date

VPAA Signature Date

Valdosta State University
Annual Faculty Evaluation
Calendar Year 2009

Date of Evaluation: January 21, 2010

I. BIOGRAPHICAL INFORMATION

College/Division: Arts & Sciences

Department: Biology

Name: J. Richard Carter

Highest Degree Earned: Ph.D. Year: 1984

Appointment Year: 1984 Appointment Rank: Instructor

Present Rank: Professor

Year First Promotion: 1986 Year Second Promotion: 1991

Total Years at VSU: 25 Years in Present Rank: 13

Next Scheduled Personnel Action: Post-tenure review

Eligibility Date: 2012

FACULTY ANNUAL EVALUATION

After reading the faculty member's Faculty Activity Report and Action Plan, department/unit heads will complete this annual evaluation. The statement should evaluate the faculty member's performance in the areas of teaching and instruction, professional growth and productivity, and college and community service. It should also include recommendations if activity in any given area is determined to need improvement. Attention should be given in cases where a faculty member has any form of load adjustment related to their duties within the department/unit. The department/unit head should address the faculty member's planning and goals for the following year and determine if they are aligned with departmental, college, and university goals, and if they are prioritized in a manner that facilitates appropriate levels of activity that may lead to tenure and promotion. The department/unit head's assessment of the faculty member should be based on departmentally established standards of performance.

SATISFACTORY: Satisfactory performance is demonstrated by performance levels that are recognized as meeting all reasonable and acceptable standards compared to other professional faculty within the department.

UNSATISFACTORY: Unsatisfactory performance is demonstrated by performance levels that are clearly recognized as not meeting reasonable and minimal standards compared to other professional faculty within the department, or documentation is not provided by faculty when requested or prescribed in the evaluation process.

1. Teaching and Instruction

Dr. Carter is on a 3/3 load since he is the curator of the VSC Herbarium.
Dr. Carter taught three courses, two with labs and one with multiple sections for a combined total enrollment of 69 students. One course was a new preparation.
Dr. Carter mentored one student in a directed study project.
Dr. Carter is the thesis advisor for three students.

The written comments on Dr. Carter's SOIs frequently comment on how clear he is in his expectations of the students and that in the end most do appreciate that (even if he is not warm and fuzzy).

Dr. Carter's average student evaluations for 2009 were good.

Students choose from the following scale: Poor-Fair-Average-Good-Excellent

_X_Satisfactory **___Unsatisfactory**

2. Professional Growth and Productivity

Dr. Carter published three journal articles and has one in press.
Dr. Carter also completed one technical report.
Dr. Carter obtained one external grant award in 2009, and is awaiting word on two others.
Dr. Carter reviewed numerous manuscripts and one grant proposal for the NSF.

_X_Satisfactory **___Unsatisfactory**

3. College and Community Service

Dr. Carter is a member of four departmental and one university committee.

Dr. Carter is the Director of the VSC Herbarium and like every year he provided extensive consultations to the scientific community by identifying plant specimens for other individuals and universities. He listed 46 separate such services for various groups in 2009.

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_X_Satisfactory **___Unsatisfactory**

4. Recommended Activities for Improvement

Dr. Carter continues his prolific scholarly work and service as the curator of the Herbarium. He now has three graduate students to supervise, so I am sure he will be able to produce even more scholarly activity in the next few years. His efforts to secure outside funding are very much appreciated by the department and VSU.

Overall, Dr. Carter's performance in 2009 was outstanding.

Progress toward next personnel action (List next scheduled personnel action and earliest date, or due date for that action): Excellent progress is being made toward the next post-tenure review.

Overall Evaluation: Satisfactory Unsatisfactory

Robert Gannon	1-25-10	J Richard Carter	01/25/2010
Department/Unit Head	Date	Faculty Member	Date

The faculty member's signature on this document does not indicate agreement with its contents but that the faculty member has read the evaluation and discussed it with the evaluator. The faculty member has the right to append a response to this evaluation.

______________________ ________

Dean's Signature Date

______________________ ________

VPAA Signature Date

Valdosta State University
Annual Faculty Evaluation
Calendar Year 2010

Date of Evaluation: January 12, 2011

I. BIOGRAPHICAL INFORMATION

College/Division: Arts & Sciences

Department: Biology

Name: J. Richard Carter

Highest Degree Earned: Ph.D. Year: 1984

Appointment Year: 1984 Appointment Rank: Instructor

Present Rank: Professor

Year First Promotion: 1986 Year Second Promotion: 1991

Total Years at VSU: 26 Years in Present Rank: 14

Next Scheduled Personnel Action: Post-tenure review

Eligibility Date: 2012

FACULTY ANNUAL EVALUATION

After reading the faculty member's Faculty Activity Report and Action Plan, department/unit heads will complete this annual evaluation. The statement should evaluate the faculty member's performance in the areas of teaching and instruction, professional growth and productivity, and college and community service. It should also include recommendations if activity in any given area is determined to need improvement. Attention should be given in cases where a faculty member has any form of load adjustment related to their duties within the department/unit. The department/unit head should address the faculty member's planning and goals for the following year and determine if they are aligned with departmental, college, and university goals, and if they are prioritized in a manner that facilitates appropriate levels of activity that may lead to tenure and promotion. The department/unit head's assessment of the faculty member should be based on departmentally established standards of performance.

SATISFACTORY: Satisfactory performance is demonstrated by performance levels that are recognized as meeting all reasonable and acceptable standards compared to other professional faculty within the department.

1. Teaching and Instruction

Dr. Carter is on a 3/3 load since he is the curator of the VSC Herbarium.
Dr. Carter taught five courses, three with labs for a combined total enrollment of 86 students. Three courses were a new preparation.
Dr. Carter is the thesis advisor for one student.

More than 80 % of Dr. Carter's students completed their SOIs online in the undergraduate courses, and their evaluations were good. The written comments were extensive and supportive of his efforts and knowledge. It is obvious that Dr. Carter puts a lot of effort into his teaching.

Dr. Carter's average student evaluations for 2010 were good (agree).

Students rank from 1 (strongly disagree) to 5 (strongly agree) on the SOIs.

_X_Satisfactory **___Unsatisfactory**

2. Professional Growth and Productivity

Dr. Carter published one journal article.
Dr. Carter also completed one technical report (more than 250 pages long).
Dr. Carter presented one workshop and one short course at regional botanical meetings.
Dr. Carter had one VSU award and submitted a major proposal to the NSF.
Dr. Carter also had two paid consultancies and he donated those funds to the VSU Foundation.
Dr. Carter reviewed numerous manuscripts.

_X_Satisfactory **___Unsatisfactory**

3. College and Community Service

Dr. Carter is a member of ~~four~~ five departmental and one university committee.
Dr. Carter also compiled a survey of trees on the property of a local church, a copy of which is included in this package.
Dr. Carter is the Director of the VSC Herbarium and like every year he provided extensive consultations to the scientific community by identifying plant specimens for other individuals and universities. He listed 67 separate such services for various groups in 2010.

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_X_Satisfactory ___Unsatisfactory

4. Recommended Activities for Improvement

Dr. Carter continues to excel in all three areas of teaching, service and scholarly work. His efforts and accomplishments are a credit to VSU.

Overall, Dr. Carter's performance in 2010 was outstanding.

Progress toward next personnel action (List next scheduled personnel action and earliest date, or due date for that action): Excellent progress is being made toward the next post-tenure review.

Overall Evaluation: Satisfactory Unsatisfactory

[signature]	1-31-11	JR Carter	02/01/2011
Department/Unit Head	Date	Faculty Member	Date

The faculty member's signature on this document does not indicate agreement with its contents but that the faculty member has read the evaluation and discussed it with the evaluator. The faculty member has the right to append a response to this evaluation.

Dean's Signature ________ Date ________

VPAA Signature ________ Date ________

Appendix F. Current curriculum vitae.

J. RICHARD CARTER, PH.D.
Department of Biology, Valdosta State University, Valdosta, Georgia 31698-0015
Telephone: (229) 333-5759, ext. 5763 – Fax: (229) 245-6585
rcarter@valdosta.edu – www.valdosta.edu/~rcarter/

PERSONAL

Date and place of birth: 15 March 1953, Vicksburg, Mississippi
Married: Sharon McCormick, 1984
Progeny: two, ages 20 and 22

EDUCATION

Bachelor of Science, May 1975
Mississippi State University, Mississippi State, Mississippi
Major: Zoology

Master of Science, May 1978
Mississippi State University, Mississippi State, Mississippi
Major: Botany
Thesis title: A floristic study of the Delta National Forest and adjacent areas

Doctor of Philosophy, December 1984
Vanderbilt University, Nashville, Tennessee
Major: General Biology
Dissertation title: A systematic study of the New World species of section *Umbellati* of *Cyperus*

EMPLOYMENT

Professor of Biology, 1996-present
Department of Biology, Valdosta State University, Valdosta, Georgia

Associate Professor of Biology, 1991-1996 (tenured 1991)
Department of Biology, Valdosta State University, Valdosta, Georgia

Assistant Professor of Biology, 1986-1991
Department of Biology, Valdosta State University, Valdosta, Georgia

Temporary Instructor of Biology, 1984-1986
Department of Biology, Valdosta State University, Valdosta, Georgia

PEER-REVIEWED PUBLICATIONS

*Student**

47. Bryson, C.T., and R. Carter. Growth, reproductive potential, and control strategies for deeproot sedge *(Cyperus entrerianus).* Invasive Plant Science and Management. In review.
46. Bryson, C.T., and R. Carter. 2010. Spread, growth parameters and reproductive potential for brown flatsedge (*Cyperus fuscus*). Invasive Plant Science and Management. 3: 240-245.
45. Carter, R. 2009. Rediscovery of *Platanthera chapmanii* in Georgia. Native Orchid Conference Journal 6(4): 1-3, Figs. 1, 2, and cover.
44. Goddard, R.H., T.M. Webster, R. Carter and T.L. Grey. 2009. Resistance of Benghal Dayflower *(Commelina benghalensis)* seeds to harsh environments and the implications for dispersal by Mourning Doves *(Zenaida macroura)* in Georgia, U.S.A. Weed Science 57: 603-612.
43. Carter, R., C.W. Allen, P. and D. Lewis. 2009. *Cyperus pilosus* Vahl (Cyperaceae) new to the flora of Texas. J. Bot. Res. Inst. Texas 3: 457-459.
42. Carter, R., W.W. Baker and M.W. Morris. 2009. Contributions to the flora of Georgia, U.S.A. Vulpia 8: 1-54.
41. Bryson, C.T., and R. Carter. 2008. The significance of Cyperaceae as weeds. Pp. 15-101 in R. F. C. Naczi and B. A. Ford (editors), *Sedges: Uses, Diversity, and Systematics of the Cyperaceae*. Monogr. Syst. Bot. Missouri Bot. Gard. 108.
40. Carter, R. 2008. Floristic highlights from Camden County. Tipularia 23: 34-42.
39. Bergstrom, B.J., and R. Carter. 2008. Host tree selection by an epiphytic orchid, *Epidendrum magnoliae* Muhl., in an inland hardwood hammock in Georgia. Southeastern Naturalist 7: 571-580.
38. *Rosen, D.J., S.R. Hatch and R. Carter. 2008. Taxonomy and nomenclature of three closely related species of *Eleocharis* subg. *Limnochloa* (Cyperaceae). Blumea 53: 235-246.
37. Bryson, C.T., V.L. Maddox and R. Carter. 2008. Spread of Cuban Club-rush [*Oxycaryum cubense* (Poeppig & Kunth) Palla] in the Southeastern United States. Invasive Plant Science and Management 1: 326-329.

36. Bryson, C.T., and R. Carter. 2008. A novel design for a light weight and durable field press. J. Bot. Res. Inst. Texas 2(1): 517-520.
35. Whittier, D.P., and R. Carter. 2007. The gametophyte of *Lycopodiella prostrata*. Amer. Fern J. 97(4): 230–233.
34. Carter, R. 2007. Nomenclatural notes on *Cyperus retrorsus* Chapm. and «*Cyperus retroversus* Chapm.» (Cyperaceae). Vulpia 6: 1-3.
33. González-Elizondo, M.S., *D.J. Rosen, R. Carter and P.M. Peterson. 2007. *Eleocharis reznicekii* (Cyperaceae), a new species from the Mexican High Plateau. Acta Botanica Mexicana 81: 35-43.
32. Carter, R., C.T. Bryson and S.J. Darbyshire. 2007. Preparation and use of voucher specimens for documenting research in weed science. Weed Technology 21: 1101-1108.
31. *Rosen, D.J., S.R. Hatch and R. Carter. 2007. Infraspecific taxonomy and nomenclature of *Eleocharis acutangula* (Cyperaceae). J. Bot. Res. Inst. Texas 1(2): 875-888.
30. *Rosen, D.J., and R. Carter. 2007. Additional noteworthy collections of *Cyperus drummondii* (Cyperaceae) from Texas and first report from Mexico. J. Bot. Res. Inst. Texas 1(1): 779-780.
29. *Rosen, D.J., R. Carter and C.T. Bryson. 2006. The spread of *Cyperus entrerianus* (Cyperaceae) in the southeastern United States and its invasive potential in bottomland hardwood forests. Southeastern Naturalist 5: 333-344.
28. Carter, R. 2005. An introduction to the sedges of Georgia. Tipularia 20: 17-45.
27. Bryson, C.T., and R. Carter. 2004. Biology of pathways for invasive weeds. Weed Technology 18: 1216-1220.
26. Tucker, G.C., B.G. Marcks and J.R. Carter. 2002. *Cyperus*, pp. 141-191 in: *Flora of North America*, vol. 23, Cyperaceae. Oxford Univ. Press, New York.
25. Townsend, J.F., R. Carter, R.D. Porcher and P.D. McMillan. 2000. Noteworthy collections: Georgia and South Carolina – *Sesbania drummondii*. Castanea 65: 231-232.
24. Carter, R., and R.L. Mears. 2000. *Cyperus* (subg. *Queenslandiella*) *hyalinus* (Cyperaceae) new to the United States and the Western Hemisphere. Sida 19: 345-350.
23. Carter, R., and C.T. Bryson. 2000. *Cyperus sanguinolentus* (Cyperaceae) new to the southeastern United States, and its relationship to the supposed endemic *Cyperus louisianensis*. Sida 19: 325-343.
22. Carter, R., *D.K. Alexander, C.T. Bryson and A. Lazari. 1999. The taxonomy of *Cyperus virens* and *Cyperus drummondii* (Cyperaceae) in the southeastern United States. Sida 18: 1049-1063.
21. McKenzie, P.M., B. Jacobs, C.T. Bryson, G.C. Tucker and R. Carter. 1998. *Cyperus fuscus* L. (Cyperaceae), new to Missouri and Nevada, with comments on its occurrence in North America. Sida 18: 325-333.
20. Carter, R., and S.D. Jones. 1997. Notes on the *Cyperus retroflexus* complex (Cyperaceae) with three nomenclatural proposals. Rhodora 99: 319-334.
19. Bryson, C.T., R. Carter, L.B. McCarty and F.H. Yelverton. 1997. *Kyllinga*, a genus of neglected weeds in the continental United States. Weed Technology 11: 838-842.
18. Jones, S.D., J.K. Wipff and R. Carter. 1996. Nomenclatural combinations in *Cyperus* (Cyperaceae). Phytologia 80: 288-290.
17. Carter, R., and C.T. Bryson. 1996. *Cyperus entrerianus*: A little known aggressive sedge in the southeastern United States. Weed Technology 10: 232-235.
16. Carter, R., R.L. Mears, K.C. Burks and C.T. Bryson. 1996. A report of four exotic *Cyperus* (Cyperaceae) species new to Florida, U.S.A. Sida 17: 275-281.
15. Bryson, C.T., J.R. MacDonald, R. Carter and S.D. Jones. 1996. Noteworthy *Carex*, *Cyperus*, *Eleocharis*, *Kyllinga*, and *Oxycaryum* (Cyperaceae) from Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, Tennessee, and Texas. Sida 17: 501-518.
14. Bryson, C.T., and R. Carter. 1994. Additional notes on *Carex*, *Cyperus*, and *Kyllinga* (Cyperaceae) in Mississippi with records of eight species previously unreported to the state. Sida 16: 175-186.
13. Bryson, C.T., and R. Carter. 1993. Cogongrass, *Imperata cylindrica*, in the United States. Weed Technology 7: 1-5.
12. Carter, R. 1993. Animal dispersal in the North American sedge, *Cyperus plukenetii* (Cyperaceae). American Midland Naturalist 129: 352-356.
11. Bryson, C.T., and R. Carter. 1992. Notes on *Cyperus* and *Kyllinga* (Cyperaceae) in Mississippi with records of six species new to the state. Sida 15: 119-124.
10. Carter, R., and C.T. Bryson. 1991. A second station and new county record for *Cyperus retroflexus* (Cyperaceae) in Missouri. Missouriensis 12: 33.

9. Carter, R., and S.D. Jones. 1991. Additional records of *Cyperus entrerianus* (Cyperaceae) in the United States. Sida 14: 615-616.
8. Carter, R., and C.T. Bryson. 1991. A report of *Cyperus grayioides* and *Cyperus retroflexus* (Cyperaceae) new to Missouri and notes on other selected Missouri *Cyperus*. Sida 14: 475-481.
7. Carter, R., and R. Kral. 1990. *Cyperus echinatus* and *Cyperus croceus* the correct names for North American *Cyperus ovularis* and *Cyperus globulosus*. Taxon 39: 322-327.
6. Carter, R., M.W. Morris, and C.T. Bryson. 1990. Some new or otherwise interesting vascular plants from the Delta Region of Mississippi. Castanea 55: 40-55.
5. Carter, R. 1990. *Cyperus entrerianus* (Cyperaceae), an overlooked species in temperate North America. Sida 14: 69-77.
4. Carter, R. 1988. *Cyperus hystricinus* (Cyperaceae) new to Florida. Sida 13: 118-119.
3. Carter, R., C.T. Bryson, and B.L. Lipscomb. 1987. *Cyperus uniflorus* (Cyperaceae) east of the Mississippi River. Sida 12: 250.
2. Carter, R., and W.R. Faircloth. 1986. *Osmunda cinnamomea* forma *frondosa* in the coastal plain of Georgia and Florida. Amer. Fern J. 76: 189.
1. Carter, R., and C.E. Jarvis. 1986. Re-evaluation and lectotypification of *Scirpus echinatus* L. Rhodora 88: 451-456.

MISCELLANEOUS PUBLICATIONS, ABSTRACTS AND REPORTS

*Student**

41. Carter, R. In press. Book Review: *Guide to the Vascular Plants of Florida,* Third Edition. Florida Scientist.
40. Carter, R. 2010. Status survey and search efforts for pondberry *(Lindera melissifolia)* and pondspice *(Litsea aestivalis)* in Georgia, with special attention to Laurel Wilt Disease – Final Report. Unpublished report to Georgia Department of Natural Resources. Social Circle, Georgia. 253 pp.
39. Carter, R. 2010. Survey of trees at St. Barnabas Episcopal Church. Unpublished report submitted to St. Barnabas Episcopal Church, Valdosta, Georgia on 10 August 2010. 20 pp.
38. Jarvis, T.A., R. Carter, and R.H. Goddard. 2010. Agricultural significance of seed dispersal by migratory doves. Proceedings of the Southeastern Microscopy Society 30: 27 (abstract).
37. Goddard, R.H., T.M. Webster, R. Carter, and T. Grey. 2010. Functional morphology and seed anatomy of the invasive weed, Benghal dayflower (*Commelina benghalensis*): Implications for dispersal by mourning doves. Proceedings of the Southeastern Microscopy Society 30: 23 (abstract).
36. Carter, R. and W.W. Baker. 2009. Status survey and search efforts for *Schwalbea americana* L. (American chaffseed) in Georgia – Final report. Unpublished report to Georgia Department of Natural Resources. Social Circle, Georgia. 191 pp.
35. Carter, R. 2008. Obituary – Wayne R. Faircloth (1932-2008). Southeastern Biology 55: 501-504.
34. Bryson, C.T., and R. Carter. 2008. Brown Flatsedge (*Cyperus fuscus*): A potential rice weed. Proc. South. Weed Sci. Soc. 61: 39 (abstract).
33. Carter, R., R.H. Goddard, T.M. Webster, J.T. Flanders, A.S. Culpepper and T.L. Grey. 2006. Do mourning doves disperse seeds of tropical spiderwort? Proceedings of the 38th Annual Meeting of the American Peanut Research and Education Society, Savannah, Georgia. Abstract 117.
32. *Rosen, D.J., R. Carter and C.T. Bryson. 2006. The potential for spread of *Cyperus entrerianus* (Cyperaceae) into native habitats of the southeastern United States. Proc. South. Weed Sci. Soc. 59: 252 (abstract).
31. Bryson, C.T., R. Carter and *D.J. Rosen. 2006. Dispersal, biology, and control of deeprooted sedge. Proc. South. Weed Sci. Soc. 59: 253 (abstract).
30. Carter, R., C.T. Bryson, and *D.J. Rosen. 2006. Invasive sedges: Impending problems. Proc. South. Weed Sci. Soc. 59: 254 (abstract).
29. *Stewart, K., J.R. Carter, J.A. Nienow, J. Rudloe and J.T. Baxter. 2006. Phytochemical Investigations of *Thalassia testudinum.* Georgia J. Sci. 64(1): 33 (abstract).
28. Carter, R., C.T. Bryson and *D.J. Rosen. 2005. Cyperaceae: Emerging invasive weeds of natural areas. Simposio Internacional "El Conocimiento Botánico en la Gestión Ambiental y el Manejo de Ecosistemas" y 2° Simposio Botánico del Norte de México, Resumenes, pp. 24-25, CIIDIR IPN Unidad Durango, Instituto Politécnico Nacional, Victoria de Durango, Dgo., México (abstract).

27. *Rosen, D.J., Carter, R. and C.T. Bryson. 2005. The spread of *Cyperus entrerianus* (Cyperaceae) in the southeastern United States and its invasive potential in bottomland hardwood forests. Simposio Internacional "El Conocimiento Botánico en la Gestión Ambiental y el Manejo de Ecosistemas" y 2° Simposio Botánico del Norte de México, Resumenes, pp. 53-54, CIIDIR IPN Unidad Durango, Instituto Politécnico Nacional, Victoria de Durango, Dgo., México (abstract).
26. *Emanuel, D.L., J.R. Carter, J.A. Nienow and J.T. Baxter. 2005. Phytochemical investigation of *Sargassum fluitans* Georgia J. Sci. 63(1): 29 (abstract).
25. Bryson, C.T., and R. Carter. 2003. Biology of pathways for invasive weeds. *Invasive Plants in Natural and Managed Systems: Linking Science and Management* at 7th International Conference on the Ecology and Management of Alien Plant Invasions. Abstracts: 13.
24. *Lynn, B.A., R. Carter and J.T. Baxter. 2003. Phytochemical investigation of *Rumex hastatulus* and *Rumex acetosella*. Georgia J. Sci. 61(1): 29 (abstract).
23. Bryson, C.T., and R. Carter. 2003. Reproductive potential and control strategies for deeprooted sedge (*Cyperus entrerianus*). Proc. Weed Sci. Soc. Am. 43: 13-14 (abstract).
22. Carter, R. 2003. What to do with an unknown specimen: preparation and storage of vouchers. Proc. South. Weed Sci. Soc. 56: 372 (abstract).
21. Bryson, C.T., R. Carter and D.J. Rosen. 2003. Deeprooted sedge (*Cyperus entrerianus*). Proc. South. Weed Sci. Soc. 56: 370 (abstract).
20. Rosen, D. J., C. T. Bryson, R. Carter and C. Jacono. 2003. Deeprooted sedge: an overlooked aggressive weed in the southeastern United States. Aquaphyte 23(1): insert.
19. Carter, R., and C.T. Bryson. 2001. Bloodscale sedge *(Cyperus sanguinolentus)*, a new weed in the United States. Proc. Weed Sci. Soc. 41: 93 (abstract).
18. Carter, R., and C.T. Bryson. 2000. Taxonomy of weedy *Cyperus* species. Third International Weed Science Congress, Abstracts, p. 47.
17. Carter, R., and C.T. Bryson. 2000. Distribution, ecology and taxonomy of *Cyperus louisianensis* (Cyperaceae). Georgia J. Sci. 58: 50 (abstract).
16. Carter, R. 1997. Rare plant survey of Kings Bay Submarine Base, Camden County, Georgia. Grant No. 1995CCD002. Unpublished report to Georgia Department of Natural Resources, Social Circle, GA. 65 pp.
15. Carter, R., and C.T. Bryson. 1995. *Cyperus entrerianus* Boeckeler, a new weed in temperate North America. Proc. Weed Sci. Soc. Am. 35: 92 (abstract).
14. Bryson, C.T., and R. Carter. 1995. Introduction and spread of weedy *Cyperus* species in the United States. Proc. Weed Sci. Soc. Am. 35: 36 (abstract).
13. Carter, R. 1995. General botany laboratory studies. 2nd Ed. Kendall/Hunt Publishing Company. Dubuque, Iowa. 170 pp. ISBN 0-7872-0738-1.
12. Bergstrom, B.J., J.R. Carter, A.E. Davis, and K.A. Lutz. 1995. Moody Air Force Base natural heritage inventory: final report. Contract No. M6700491D0010-5W01. Unpublished report to U.S. Department of Defense, Department of the Air Force, Moody Air Force Base, Georgia. 262 pp.
11. Carter, R. 1994. Status report: *Cyperus louisianensis* (Cyperaceae). Unpublished report to U.S. Fish & Wildlife Service, Endangered Species Office, Jackson, Mississippi.
10. Carter, R., and N. McInnis. 1993. Final status report: *Cyperus cephalanthus* (Cyperaceae). Unpublished report to U.S. Fish & Wildlife Service, Endangered Species Office, Jackson, Mississippi. 140 pp.
9. Carter, R. 1993. Fort Stewart floristic inventory: field data – 1992 & 1993. Unpublished report to Nature Conservancy of Georgia. 641 pp.
8. Carter, R., and W.R. Faircloth. 1991. General botany laboratory studies. 1st Ed. Kendall/Hunt Publishing Company. Dubuque, Iowa.
7. Carter, R. 1987. Site survey and report on a *Lindera melissifolia* site in Wheeler County, Georgia. Unpublished report to Nature Conservancy of Georgia, Atlanta.
6. Carter, R. 1985. Lectotypification of *Scirpus echinatus* L. ASB Bulletin 32: 71 (abstract).
5. Carter, R. 1984. Master plan and floristic inventory of Grassmere Farm. Unpublished report to Cumberland Museum and Science Center, Nashville, Tennessee.
4. Carter, R. 1982. The flora of Delta National Forest. ASB Bulletin 29: 55 (abstract).
3. Carter, R. 1982. Morphological relationships among species of *Cyperus* section *Umbellati* from North America. ASB Bulletin 29: 55 (abstract).

2. Carter, R. 1983. Rare plant survey of Snead Road Glade. Unpublished report to Nature Conservancy, Tennessee Field Office, Nashville.
1. Carter, R. 1980. Master plan and floristic survey of Taylor Hollow, Sumner County, Tennessee. Unpublished report to Nature Conservancy, Tennessee Field Office, Nashville.

CONTRIBUTED PAPERS, POSTERS, WORKSHOPS AND SHORT COURSES

*Presenter's name in **bold;** invited contributions**

22. *__Carter, R.__ Learn to love the sedges. Short-course: Certificate in Native Plants Program, 11 September 2010, State Botanical Garden of Georgia, University of Georgia (Athens).
21. *__Carter, R.__ Sedge Identification Workshop. 30th Annual Conference of the Florida Native Plant Society, 23 May 2010, Tallahassee, Florida.
20. **Bryson, C.T.**, R. Carter, and D.J. Rosen. Update on the biology and dispersal of deeproot sedge (*Cyperus entrerianus*). *Managing Invasive Plants in Disturbed Landscapes,* Southeast Exotic Pest Plant Council 10th Annual Symposium, 20-21 May, 2008, Biloxi, Mississippi.
19. **Bryson, C.T.**, and R. Carter. Brown Flatsedge (*Cyperus fuscus*): A potential rice weed. *Managing Invasive Plants in Disturbed Landscapes,* Southeast Exotic Pest Plant Council 10th Annual Symposium, May 20th—21st, 2008, Biloxi, Mississippi.
18. ***Carter, R.** Appreciating Native Grasses. Presented at the 2008 Symposium of the Georgia Native Plant Society, Mercer University, Atlanta, Georgia; 16 February 2008.
17. **Carter, R.**, R.H. Goddard, T.M. Webster, J.T. Flanders, A.S. Culpepper and T.L. Grey. Do mourning doves disperse seeds of tropical spiderwort? Paper presented at *Symposium – Tropical Spiderwort: A New Troublesome Exotic-Invasive Weed in Peanut*. 38th Annual Meeting, American Peanut Research and Education Society, Savannah, Georgia; 11-14 July 2006.
16. ***Carter, R.** An introduction to sedges. Presented to Florida Native Plant Society, Magnolia Chapter, Tallahassee; 08 March 2006.
15. ***Carter, R.**, C.T. Bryson, and D.J. Rosen. Invasive sedges: Impending problems. Paper presented at *Symposium – Invasive Grasses and Sedges: Deep-rooted Issues* sponsored by U.S. Fish and Wildlife Service and SWSS at 59th Annual Meeting of Southern Weed Science Society, San Antonio, Texas; 23-25 January 2006.
14. ***Carter, R.**, C.T. Bryson and D.J. Rosen. Cyperaceae: Emerging invasive weeds of natural areas. Paper presented at *Simposio Internacional* "El Conocimiento Botánico en la Gestión Ambiental y el Manejo de Ecosistemas" y *2° Simposio Botánico del Norte de México*, Resumenes, pp. 24-25, CIIDIR IPN Unidad Durango, Instituto Politécnico Nacional, Victoria de Durango, Dgo., México; 13-15 September 2005.
13. ***Carter. R.** Invasive graminoids and vines. Paper presented at *Invasive Plant Control Workshop*, sponsored by the Georgia Exotic Plant Pest Council. University of Georgia, Tifton; 13 April 2005.
12. ***Carter, R.** Tracking pathways of dispersal of invasive plants. Paper presented at *Conservation Education and Interpretive Services: A Natural Connection* 2004 National Conference sponsored by the U.S. Forest Service, St. George, Utah; 1-5 March 2004.
11. ***Carter, R.** Botanizing the Coastal Plain of Georgia. Research seminar series sponsored by *Sigma Xi* at the Coastal Plain Experiment Station, University of Georgia, Tifton; 18 December 2003.
10. ***Carter, R.** What to do with an unknown specimen: preparation and storage of vouchers. Paper presented at *Invasive Weeds Symposium* co-sponsored by U.S. Fish & Wildlife Service and Southern Weed Science Society at the Annual Meeting of the SWSS, Houston, Texas; 28-29 January 2003.
9. ***Bryson, C.T.** and R. Carter. Impact of Cyperaceae as weeds. Paper presented at *Sedges 2002: International Conference on Uses, Diversity and Systematics of Sedges,* Delaware State University, Dover, Delaware; 6 June 2002.
8. **Carter, R.** and C.T. Bryson. Bloodscale sedge *(Cyperus sanguinolentus),* a new weed in the United States. Paper presented at the 41st Meeting of the Weed Science Society of America in Greensboro, North Carolina; 13 February 2001.
7. **Carter, R.** and C.T. Bryson. Distribution, ecology and taxonomy of *Cyperus louisianensis* (Cyperaceae). Paper presented at the 77th Annual Meeting of Georgia Academy of Science in Valdosta, Georgia; 25 March 2000.

6. *Carter, R. and **C.T. Bryson.** Taxonomy of weedy *Cyperus* species. Paper presented at Third International Weed Science Congress, Abstracts, p. 47, Foz do Iguaçu, Brazil; 6-11 June 2000. Note: I was unable to attend the meeting, because of the lack of matching travel support by VSU.
5. **Carter, R.** and C.T. Bryson. *Cyperus entrerianus* Boeckeler, a new weed in temperate North America. Poster presented at the Annual Meeting of the Weed Science Society of America in Seattle, Washington; 31 January 1995.
4. **Carter, R.** Systematics and ecology of North American *Cyperus*. Seminar presented to Biology Department, University of Southern Mississippi, Hattiesburg, Mississippi; 28 February 1994.
3. **Carter, R.** Lectotypification of *Scirpus echinatus* L. Paper presented at the Annual Meeting of the Association of Southeastern Biologists in Murphreesboro, Tennessee; April 1985.
2. **Carter, R.** The flora of Delta National Forest. Paper presented at the Annual Meeting of the Association of Southeastern Biologists in Richmond, Kentucky; April 1982.
1. **Carter, R.** Morphological relationships among species of *Cyperus* section *Umbellati* from North America. Paper presented at the Annual Meeting of the Association of Southeastern Biologists in Richmond, Kentucky; April 1982.

RESEARCH FUNDING

*Funded projects involving students**

*Carter, R. (PI). Collaborative Research: The GA-VSC Herbaria Collaborative: Phase I of a Statewide Consortium. National Science Foundation, Biological Research Collections, Award #1054366, $199,336; 2011-2014.

*Carter, R. (PI). Floristic Inventory and Vegetation Survey of the Banks Lake National Wildlife Refuge, Lanier County, Georgia; U.S. Fish & Wildlife Service, $4,000; 2009-2011.

Carter, R. (PI). Survey of known and potential populations of pondberry (*Lindera melissifolia*) and pondspice (*Litsea aestivalis*) in Georgia; contract funded by Georgia Department of Natural Resources, $20,000; 2008-2009.

*Carter, R. (PI), J. Pascarella (Co-I). Effects of Prescribed Burning on Representative Forest Communities at Moody Air Force Base and Grand Bay Wildlife Management Area, Lowndes and Lanier counties, Georgia; cooperative agreement with Moody Air Force Base; U.S. Army Medical Research Acquisition Activity (USAMRAA); $87,000; 2007-2011.

Carter, R. (PI). Status Survey and Search Efforts for American Chaffseed (*Schwalbea americana*) in Georgia; contract funded by Georgia Department of Natural Resources, $18,800; 2007-2008.

*Carter, R. (PI). Flora of Camden County, Georgia, with emphasis on Crooked River State Park; Marie Mellinger Field Botany Research Grant funded by the Georgia Botanical Society, $1,500; 2006.

*Goddard, R. (PI), J. Nienow, R. Carter, M. Smith, T. Manning, L. Wood, M. Groszos, M. Leake (Co-I). Acquisition of a variable pressure scanning electron microscope for interdisciplinary research and teaching, $245,505; 2005-2007.

*Carter, R. (PI). Federal noxious weed survey: *Orobanche minor;* funded by USDA-APHIS through University of Georgia (Tifton), $3,000; 2004.

*Carter, R. (PI). Federal noxious weed survey: *Orobanche minor;* funded by USDA-APHIS through University of Georgia (Tifton), $2,500; 2003.

*Carter, R. (PI). Vegetation survey: Grand Bay Wildlife Management Area; funded by Georgia Department of Natural Resources, $4,000; 2003.

Carter, R. (PI). Rare plant and plant community survey of Kings Bay Submarine Base, Kings Bay, Georgia; funded by Department of Defense through the Georgia Department of Natural Resources, $19,500; 1996-1997.

Carter, R. (PI). Status survey of *Lilium iridollae* (Liliaceae) in Georgia; funded by U.S. Fish & Wildlife Service, $2,500; 1994.

*Carter, R. (PI). Floristic inventory of Moody Air Force Base and Grassy Pond Recreational Area, Lowndes and Lanier counties, Georgia; funded by the U.S. Air Force through The Nature Conservancy of Georgia, $7,500; 1993-1994.

Carter, R. (PI). Status survey of *Cyperus louisianensis* (Cyperaceae); funded by U.S. Fish & Wildlife Service, $2,500; 1993.

Carter, R. (PI). Status survey of *Cyperus cephalanthus* (Cyperaceae) funded by the Louisiana Department of Wildlife and Fisheries and the U.S. Fish & Wildlife Service, $5,000; 1992-1993.

*Carter, R. (PI). Floristic inventory of Fort Stewart, Georgia; funded by the U.S. Army through The Nature Conservancy of Georgia, $9,800; 1992.

Carter, R. (PI). Floristic inventory of *Lindera melissifolia* (Lauraceae) site in Wheeler County, Georgia; funded by The Nature Conservancy of Georgia, $500; 1987.

Carter, R. (PI). Thesis-parts appointment, Argonne National Laboratory, to use scanning electron microscope; 1981.

Carter, R. (PI). Floristic inventory of Taylor Hollow, Sumner County, Tennessee; The Nature Conservancy, $1,500; 1980.

Manuscripts in Preparation

Carter, R., C.T. Bryson, and D.J. Rosen. The taxonomy, distribution, ecology, and status of *Cyperus cephalanthus* (Cyperaceae) in the southeastern United States. In prep.

Carter, R. and C.C. Davis. The invasion of an urban woodland in southern Georgia, U.S.A. In prep.

Carter, R. Systematic revision of the North American species of *Cyperus* section *Umbellati* subsection *Umbellati* (Cyperaceae, Cypereae). In prep.

Carter, R. and W.W. Baker. Notes on the federally endangered *Schwalbea americana* in Georgia, U.S.A. In prep.

Carter, R. The vascular flora of Camden County, Georgia, U.S.A. In prep.

Carter, R. Notes on *Lindera melissifolia* and *Litsea aestivalis* in Georgia, U.S.A. In prep.

Carter, R. Noteworthy floristic records for Georgia, U.S.A. In prep.

Carter, R., C.T. Bryson, R.F.C. Naczi, and D.J. Rosen. A *Kyllinga* species (Cyperaceae) new to the flora of North America. In prep.

Kral, R., and R. Carter. *Paspalum quadrifarium* (Poaceae) new to the United States, with notes on *Paspalum intermedium* and a synopsis of *Paspalum* in Georgia. In prep.

Carter, R. A synopsis of the Cyperaceae of Georgia, U.S.A. In prep.

Carter, R. *Cyperus excurrens* (Cyperaceae), an undescribed species in the southeastern United States. In prep.

Carter, R. *Eleocharis angusticeps* (Cyperaceae), an undescribed species in the southeastern United States. In prep.

Goddard, R.H., R. Carter, T.M. Webster, and T.L. Grey. Seed dispersal by Mourning Doves *(Zenaida macroura)* in southern Georgia, U.S.A. In prep.

Herbarium Curator/Director

Valdosta State University, 1985-present

The Valdosta State University Herbarium (VSC) is a regional collection of more than 60,000 vascular plant, bryophyte and lichen specimens and is particularly rich in plants of the Georgia coastal plain. Since 1985, the size of the collection has doubled. In addition to maintaining the collection and sending and receiving research loans and exchange specimens, I have been heavily involved with all other aspects of herbarium work, such as correspondence and determination, mounting, and filing of specimens, and supervision of undergraduate herbarium assistants. My activities as Curator of the Herbarium have also included routine identification of plant specimens for weed scientists and others, and providing data to scientists at other institutions.

Professional Service

Committee Service

Department of Biology, Valdosta State University

Curriculum Committee, 1994-1996, 2000-2002, Chair (1995-1996, 2001-2002)
Assessment Committee, 2003-2006, Chair (2004-2005)
Introductory Biology Committee, 1994-1995
Connell Lecture Committee, 1987, 1990-1992, Chair (1991)
Bylaws Revision Committee, 1998-1999
Master of Science Program Committee, 1996-2004
Facilities Planning Committees for Botany Laboratories, Herbarium, and Greenhouse, 1995-1997
Faculty Search Committees, 1986, 1994, 1996, 1997, 1999
Science Education Search Committee, 2003-2004, Chair
Department Head Search Committee, 1993-1994, 1994-1995
Graduate Committee, 2009-present
Promotion & Tenure Review Committee
Awards Committee, 2010-present

College of Arts & Sciences, Valdosta State University
Promotion & Tenure Advisory Committee, elected faculty representative, 2004-2005
Promotion & Tenure Guidelines Revision Committee, 1998-1999
Middle School Science Education Major Science Course Development Committee, 1999
Lake Louise Oversight Committee, 1996-1999
Programming Committee for Biology Chemistry Building, 1996-1998
Dean of Arts & Sciences Screening Committee, 1994-1995
Academic Council, 1987-1989
Committee on General Education (COGE), 1987-1988
Concerts & Lectures Committee, 1987-1988

Valdosta State University
Ropes Course Committee, 2006-2007
University Council, 2006-2007
Faculty Senate, 2004-2008
Committee on Committees, 2004-2005
Environmental Issues Committee, 2004-2008, Vice-Chair (2005-2006), Chair (2006-2007)
Campus Beautification & Stewardship Subcommittee, 1993-present, Chair (2005-2006, 2008)
University Council, 2006-2007
Faculty and Staff Campaign Committee, 2002-2005
Executive Committee, VSU Chapter, American Association of University Professors, 2003-2005
Science Discipline Committee, 2001-2003
Honorary Piano Scholarship Committee, 2001
Georgia Systemic Teacher Education Program (GSTEP), 2000-2001

External
Valdosta Tree Commission, 2004-2007
One-Mile Branch Stream Restoration Steering Committee, 2004-2005
St. John School Board, 2003-2004
Grand Bay-Banks Lake Council, 1995-1999
Association of Southeastern Biologists Graduate Student Support Award Committee, 2009-2012

Graduate Student Committees
David J. Rosen, Doctoral Dissertation Committee, Department of Range Science & Ecology, Texas A&M University; 2003-2006 (member)
Stephanie Nichols Yarbrough, M.S. Thesis Advisor, Biology Department Valdosta State University; 2009-present

Reviewing
Peer-reviewer for the following journals:

Brittonia	*J. Bot. Res. Institute of Texas*	*Sida*
Castanea	*Monogr. in Systematic Botany*	*Southeastern Naturalist*
Florida Scientist	*Novon*	*Systematic Botany*
Georgia Journal of Science	*Phytologia*	*Taxon*
Harvard Papers in Botany	*Plant Ecology & Evolution*	*Tipularia*
Invasive Plant Sci. and Manag.	*Rhodora*	*Weed Technology*

Peer-reviewer for United States Department of Agriculture, Agricultural Research Service
Regional Reviewer, *Flora of North America*; 2006-present
Merit-reviewer, National Science Foundation; 2007, 2008, 2009

Book reviewer for:
Benjamin Cummings Publisher, San Francisco, California
Menasha Ridge Press, Birmingham, Alabama
University of Georgia Press, Athens

Miscellaneous Service

Contributed family descriptions to DeFelice, M.S., C.T. Bryson, A.W. Evans and K.L. DeFelice. 2004. *Interactive Encyclopedia of North American Weeds,* DVD-ROM, Version 3.0. Southern Weed Science Society, Champaign, Illinois.

Contributed photographs for CD-ROM by Bargeron, C.T., D.J. Moorhead, G.K. Douce, R.C. Reardon and A.E. Miller. 2003. *Invasive Plants of the Southeastern United States: Identification and Control*. USDA Forest Service FHTET-2003-08. November 2003

Contributed photographs to *Forestry Images: The Source for Forest Health, Natural Resources and Silviculture Images* and *IPM Images: The Source for Agricultural Images* joint project between the Bugwood Network (University of Georgia) and US Forest Service and the NSF Center for Integrated Pest Management, Image Archive and Database, University of Georgia. http://www.forestryimages.org and http://www.ipmimages.org/

Secretary, VSU Chapter, American Association of University Professors; 2003-2005

Led botanical forays at Reed Bingham State Park at the request of Mr. Chet Powell, Park Naturalist, Georgia Department of Parks & Recreation.

Identification of plant specimens for agricultural scientists at University of Georgia, Athens, Griffin, Tifton campuses; 2000-present

Diagnostician for *Distance Diagnostics through Digital Imaging System* (DDDI), University of Georgia, Athens; 2002-present

Led field trips for Georgia Botanical Society and organized field trips for Georgia Botanical Society Annual Spring Wildflower Pilgrimage held in Valdosta; 17-19 April 1998

Served on Local Arrangements Committee for Georgia Academy of Science Annual Meeting in Valdosta; 1989.

Secretary-Treasurer, Southeastern Section of Botanical Society of America; 1992-1993

Member, Editorial Board of *Castanea*, Journal of the Southern Appalachian Botanical Club; 1991-1994

CURRENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

American Association of University Professors
Association of Southeastern Biologists
Georgia Academy of Sciences
Georgia Botanical Society
Georgia Exotic Pest Plant Council
Georgia Native Plants Alliance
Society of Herbarium Curators
Southeastern Regional Network of Expertise and Collections (SERNEC)

TEACHING EXPERIENCE

Department of Biology, Valdosta State University

Elements of Biological Science I

An introductory level, mixed majors/non-majors course in basic principles of biology, including cellular chemistry, structure and function of cells, genetics, and microevolution.

Elements of Biological Science II

An introductory level, mixed majors/non-majors course in basic principles of micro- and macroevolution, diversity, and structure and function of representative organisms.

Introduction to Biology: The Evolution and Diversity of Life

An introductory level, non-majors course in the principles of micro- and macro-evolution and diversity of life.

Biodiversity Lab

A non-majors laboratory course to accompany *Introduction to Biology: The Evolution and Diversity of Life*.

Natural History for Middle School Teachers
An upper level course for Middle Grades Education majors, using the biota of southern Georgia as a model for studying basic ecological principles, population structure and dynamics, life history patterns, and reproductive strategies and behaviors common to living systems.

History and Use of Medicinal Plants
A brief history of medicinal plants from prehistory to the present, including the use of herbal and non-timber forest products found locally and in different cultures and countries.

General Botany
A sophomore-level majors course comprising a survey of diversity, evolution, and reproductive cycles of the plant kingdom and development, structure and function of representative seed-bearing plants.

Ecology and Evolution
An introduction to major topics in ecology and evolution for biology majors, including population, community, and ecosystem ecology.

Local Flora
An upper level, field-oriented, elective course in descriptive botany and diversity, emphasizing identification, distribution, and ecology of locally occurring seed-bearing plants. Also cross-listed for graduate credit.

Taxonomy of Seed Plants I
An upper level, elective course in descriptive botany and diversity, dealing with principles of classification and nomenclature; classification, evolution, and a survey of diversity of the major families; and identification of local representatives, using dichotomous keys in a technical floristic manual. Also cross-listed for graduate credit.

Taxonomy of Seed Plants II
An advanced upper level, elective course in descriptive botany, dealing with a survey of diversity, classification, and evolution of selected, technically difficult, specialized families (e.g., Asteraceae, Poaceae, Cyperaceae, Juncaceae) and the identification of local representatives, using dichotomous keys in technical floristic manuals. Also cross-listed for graduate credit.

Plant Systematics (subsumes *Taxonomy of Seed Plants*)
An upper level, elective course surveying the principles of plant systematics, including identification, nomenclature, evolution, and classification within the plant kingdom, and a systematic survey of plant families, with emphasis on local representatives. Also cross-listed for graduate credit.

Morphology of Land Plants
An upper level, elective course emphasizing vegetative organization, reproductive cycles, phylogenetic and ecological relationships of bryophytes, pteridophytes and seed plants. Also cross-listed for graduate credit.

Directed Study
An upper level, elective course for majors, involving supervised investigation of a specific problem and preparation of a final report.

Senior Seminar
An upper level, capstone course for the Biology major, assessing the student's ability to research topics in biology independently, assimilate information, and disseminate information in an organized and understandable manner in both written and oral forms.

Laboratory Practicum
An upper level course for Biology majors involving individualized instruction and practice in assisting with the preparation and teaching of biology laboratory exercises.

Graduate Seminar
A graduate level course involving discussion and reports of current topics in biology and related sciences, in which students are expected to demonstrate comprehension of topics and communication skills, both oral and written.

REFERENCES

A list of references will be provided upon request.

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