WINTER.

EDINBURGH, WILLIAM OLIPHANT & SON, 1832

SACRED PHILOSOPHY

OF THE

SEASONS.

WINTER.

Day of St. Bernard.—Page 362.

Edinburgh.
PUBLISHED BY WILLIAM OLIPHANT AND SON.
1838.

SACRED PHILOSOPHY

OF THE

SEASONS;

ILLUSTRATING

THE PERFECTIONS OF GOD

IN THE

PHENOMENA OF THE YEAR.

BY THE

REV. HENRY DUNCAN, D. D.

RUTHWELL.

WINTER.

"He giveth snow like wool: He scattereth the hoar-frost like ashes. He casteth forth his ice like morsels. Who can stand before his cold?"—

PSALMS.

THIRD EDITION.

EDINBURGH:

WILLIAM OLIPHANT AND SON;

WILLIAM COLLINS, GLASGOW; W. CURRY & CO. DUBLIN;

AND HAMILTON, ADAMS, & CO. LONDON.

MDCCCXXXVIII.

" There is a philosophy which nobly exercises our reasonable faculties, and is highly serviceable to religion:—Such a study of the works of God as leads us to the knowledge of God, and confirms our faith in Him. But there is a philosophy which is vain and deceitful, which sets up the wisdom of man against the wisdom of God, and, while it pleases men's fancies, hinders their faith."—DAVENANT.

EDINBURGH: W. OLIPHANT, JUN. AND CO. PRINTERS, 23, SOUTH BRIDGE.

PREFACE.

Of all the works on Natural Theology, which, in former or recent times, have enlightened and delighted the pious mind, none of any great extent, or of much importance, have been devoted to the illustration of the Divine perfections, in connexion with the Seasons of the Year. Yet this is a view at once interesting and popular. The changes of the seasons display, in themselves, a remarkable and beneficent arrangement; and the adaptations by which vegetable and animal life are fitted to exist, and to fulfil the end of their creation, during these changes, afford ample materials for a beautiful and striking exhibition of the power, wisdom, and goodness of the Creator.

In investigating this subject, we meet every where also, with the most remarkable analogies in the character of the material world, with that which is so distinctly impressed on Revealed Truth; and, while we hence derive a very satisfactory argument in proof of their origin from the same Almighty and Intelligent Author, we find that these kindred sources of information continually throw a light, clear, consistent, and useful on each other, the latter exalting the former, and raising it to the dignity of a perfect science.

The attention of scientific men, while it has of late been very successfully, has, perhaps, been too exclusively, directed to the book of Nature, in illustration of the Divine perfections; and those, who peruse their writings, may be induced to overlook the highly important truth, that, after all, natural religion affords but an imperfect glimpse into the moral attributes of the Eternal; and that, without the aid of a direct communication from Heaven, a most ominous gloom hangs over these attributes, and sheds mystery, anxiety, and doubt, on the future destiny of man.

One great object of the Author, in the following pages, is to counteract this unhappy tendency, and to show that the God of Nature can only be known, in the perfection of his character, when regarded as the God of Grace; and that it is not till the light of Revelation shines on the Divine operations, that the clouds and darkness, which surround the throne of the Most High, are dispersed. Under the illumination of this celestial light, the study of creation is, in the highest degree, calculated to expand the understanding, enlighten the judgment, and improve the heart. If it be true, that the human mind takes its character from the nature of the subjects with which it is conversant, we may assuredly expect that it will be ennobled and refined, when it is humbly, judiciously, and piously occupied in investigating the attributes and works of Him, who is the First and the Last, the Greatest and the Best.

The most important and animating views of the Creator and His operations, in reference to the Seasons, are found scattered through many publications, which it has been the agreeable task of the Writer to combine in a new series, and render generally accessible. In doing this, he has frequently quoted the precise words of the various authors from whom he has borrowed his facts. He has no ambition to acquire fame as an original writer; his more humble, but perhaps not less useful aim, being to instruct and edify those who may not be in possession of many works on Natural Theology, by rendering them acquainted with the discoveries, which have been made by others, in the most interesting of all sciences.

The plan adopted by the well-known, but somewhat antiquated, German author, STURM, in his "Reflections," has been so far imitated, that the Work contains a paper for every day of the year, and is thus well suited for stated family reading. The chief reasons which induced STURM to give his Work this form, as he himself observed in the advertisement to the first German edition, were,—"First, to provide a sufficient variety; and, secondly, that the reader might be led to sanctify each day, by contemplating the works of God." These are also the motives of the present writer; but the desultory manner and declamatory style of this author he has endeavoured to avoid; and a more systematic method has been attempted, replete with facts and illustrations, so as to form a whole, containing, what the title expresses, the "SACRED PHILOSOPHY OF THE SEASONS."

It is customary, in enumerating the Seasons, to

commence with *Spring;* and it may be proper, in a few words, to state one or two reasons which induced the Author to depart from that order, and begin with *Winter*.

Winter is not the death of Nature, neither is it merely the season of Nature's sleep after the labours of the vegetable world are finished: It is much more. It is the season of gestation, when nature is preparing in her womb the embryo of the coming year. A thousand secret operations are in progress, by which the seeds, buds, and roots of future plants and flowers, are not only preserved but elaborated, that, when the prolific months of Spring arrive, they may burst into life in all the freshness and vigour of a new birth. This, which is both a more important and a more interesting view than that which is commonly entertained, represents winter as the first stage in the processes and developments of the revolving year, and fixes it as the natural commencement of a Work, which has for its object an exhibition of the SACRED PHILOSOPHY OF THE SEASONS.

There is another circumstance, too, which involves no principle, indeed, like the former, but which renders the plan adopted a matter at least of convenient arrangement. Winter is the season in which, although the hand of a beneficent and wonder-working Creator is every where to be distinctly traced, there are fewer objects of interest, in comparison with the other seasons, to arrest the attention, and to engage the mind in devout contemplation of the Divine perfections. An Author, studying to gain the public favour, must, doubtless, regard this as a disadvantage in making his first appearance; but then, it has this counterbalancing use, that space is thus gained for some necessary introductory papers on the broader and more general cosmical arrangements, which are peculiar to none of the seasons, but common to them all. As the plan of *daily* reflections, of a certain moderate length, obliges the Author to stretch his literary offspring, as it were, on Procrustes' bed, the convenience of including such papers in the volume devoted to Winter will be readily acknowledged.

The expressions "contrivance," "ingenuity," "compensation for defects," &c., as applied to the operations of the Eternal, seem, in some sense, to detract from the infinite perfection of His character, and to bring the exercise of His attributes too much on a level with the operations of the human mind. But this arises from a defect, not merely in the language, but the conceptions of men; and while we are sensible of the inadequacy of these expressions, we know not how to apply a remedy. In this, the Writer only follows in the track of others.

The Sunday papers contain religious and moral reflections, generally suggested by the subject of discussion on the preceding week.

A few papers have been kindly furnished by ingenious friends, which are distinguished from those of the Author, by being subscribed with their initials.

RUTHWELL MANSE,
October 20, 1836.

NOTE TO THE THIRD EDITION.

A SECOND Edition of the two first Volumes of this Work having been called for, while the third and fourth volumes were going through the press, large impressions of these two latter volumes were printed to meet the expected demand; and the whole Series having now been completed, and sold off, a new issue of the entire Work is required. This has induced the Author to revise it with care, and to make such additions and alterations, as the rapid advance of science, even during the short interval that has elapsed since the production of the first Volume, has rendered proper. He trusts that the improvements which have been made in this Edition, will show that he is not insensible to the value of that approbation with which the Public has honoured his humble labours.

RUTHWELL MANSE,
Feb. 1, 1838.

CONTENTS.

SACRED PHILOSOPHY

OF THE

SEASONS.

WINTER.

FIRST WEEK—SUNDAY.

GOODNESS OF GOD TO HIS RATIONAL CREATURES.

We are about to commence a course of study which will lay before us, in detail, abundant proofs of beneficent design, exhibited in the various departments of creation; and we surely cannot better employ this first day of the first week of our delightful and edifying task, than in considering some of the more obvious and general evidences of the paternal regard, which the Creator bestows on our race—the chief of his sublunary works.

But the difficulty lies in knowing where to begin, and what to select; for we cannot turn in any direction where His love does not smile around us. In Him we live, and move, and have our being; and all that we possess flows entirely from the exhaustless source of His bounty. From the first moment of our existence, His guardian arm surrounded us, and at this instant we are the objects of his providential care. He listened to our helpless cries, and supplied all our infant wants, before our hearts had learned to acknowledge their benefactor, or

our tongues to pronounce His name. It was He who opened the bosoms of our parents to impressions of tenderness, and taught them to experience a nameless delight in those little attentions which our tender years required. To secure the good offices of the generous, He clothed our countenances in the smiles of innocence; and, to soften the hearts of the cruel, He caused our eyes to overflow with tears. He strengthened our bodies and enlarged our minds. Through all the slippery paths of youth, His hand unseen conducted us, guarding us from temptation, delivering us from danger, and crowning our days with His goodness. And whatever period of life we have now reached, we owe our continued lives to His preserving care, and our blessings, both past and present, to His paternal bounty.

Let us look at particulars. If we turn to our connexion with surrounding nature, it is God's air which we breathe, and God's sun that enlightens us. The grateful vicissitudes of day and night, the revolutions of the seasons, marked by the regular return of summer and winter, seed-time and harvest, are all appointed by His unerring wisdom. It is His pencil which paints the flower, and His fragrance which it exhales. By His hand the fields are clothed in beauty, and caused to teem with plenty. At His command the mountains rose, the valleys sank, and the plains were stretched out. His seas surround our coasts, and his winds blow, to waft to us the treasures of distant lands, and to extend the intercourse of man with man.

But we are made capable of more exalted enjoyments than can be derived from external nature; and He, who formed us with these capacities, has not left us without the means of exercising them. Originally created in the image of God, the human soul, though apostate, fallen, and degraded, still retains the embers, as it were, of the fire which came down from heaven to animate it; and, as if conscious of its celestial origin, finds permanent enjoyment only in the cultivation of those faculties

which prove its resemblance to its Creator. Nor has the Father of mercies left us without the means of such enjoyment. In society, the pleasures of beneficence and the movements of compassion; in friendship, the interchange of good offices, and the balm of sympathy; in domestic life, the tenderness of conjugal affection, and the endearments of filial and parental duty; and, to crown all, in religion, the sublime enjoyments of devotion, and the blessed hopes of immortality, give an unspeakable charm to existence, and prove the Divine Being who bestowed these gifts, to be full of condescending kindness to his rational offspring.

It is true, however, that we derive a taint from our first parents which blights all these blessings; and that, so long as we remain in our natural state of alienation and rebellion, an unexpiated curse rests upon our heads. But here it is especially that the bounty of the Eternal is displayed. Man, indeed, was expelled from paradise; and the fair world, of which he had proved himself unworthy, was rendered suitable to his fallen condition.

But it was not the will of God that the human race should be abandoned to perish in their misery; and, while His justice executed the merited sentence, His mercy gave assurance of future deliverance, and

"Hope, the charmer, lingered still behind."

Nothing can be conceived more beneficent or more wonderful, than the scheme of Divine grace revealed to us in the Gospel of Christ, by which apparent contradictions are reconciled; by which a holy God is rendered propitious to the unholy, and a just God becomes "the justifier of the ungodly;" by which sin is punished, and yet the sinner is not only suffered to escape, but is advanced to a higher grade in the scale of existence, and crowned with eternal blessings! That, for the accomplishment of this most astonishing scheme of mercy, God should send his own Son into the world, "in the likeness of sinful flesh;" that this uncreated Being, becoming a

creature, should tabernacle on earth, and pass through the various stages of human life, a man of sorrows, and acquainted with grief; that he should come to his own, and his own should reject and despise him; nay, more, that sinful men should be permitted to lay their impious hands on the "Lord of Life," and put him to a cruel and ignominious death; and that all these mysterious transactions should be the means of removing the impassable gulph which our sins had placed between heaven and earth, and of opening a new way to the regions of immortal felicity, marked by the tract of his bleeding feet,—these are events, the high import and matchless grace of which, angels desire to look into, and the human intellect is too feeble adequately to conceive. When the believer thinks of them, his heart overflows with gratitude; and the deep emotion which they excite, finds no language more suitable for its expression, than the short, but emphatic exclamation of an apostle,—"Thanks be to God for his unspeakable gift!"

FIRST WEEK—MONDAY.

THE CHARACTER IMPRESSED ON NATURE.—COMPENSATION.

Before proceeding to the examination of particulars, with the view of exhibiting the attributes of the great Creator, as manifested in the seasons of the year, it is of importance to discover the nature of the principles which are to form the subject of our investigation; more especially, as there is certainly something very remarkable in the character impressed on the created objects within the sphere of our observation. Were we to commence the inquiry without the aid of experience, founding our expectations on the abstract theories of perfection which we might form in the closet, we should assuredly meet with difficulties and disappointments at

every step of our progress. We shall in vain seek for proofs of absolute perfection, either in the physical or moral condition of this lower world. It is a scene of perpetual change; of beauty, ending in deformity; of pleasure, succeeded by pain; of success, giving way to disappointment; of life, vigour, and brightness, alternating with gloom, decay, and death; and, if the actions of rational agents be regarded, it is a union of wisdom and folly, nobility and meanness, virtue and vice. Instead of perfection, we have here the very reverse. Where, then, are we to seek for the wisdom and goodness of an All-powerful and intelligent First Cause? Our answer is,—In the general character and tendencies of the system; in the arrangements by which evils are averted or mitigated, and excellence is drawn from the very bosom of apparent defect and worthlessness. We are not to expect absolute, but only relative good; not the absence of evil, but compensations for it; not perfection, but a bias towards it. In regarding the whole system, we seem to behold a piece of vast and amazing mechanism, of which the materials are defective or positively unsound, but the workmanship perfect. The wisdom lies in the admirable execution of a work apparently full of difficulties and obstructions; and the goodness, in the conversion of what would seem to be naturally evils, into agents of virtue and instruments of enjoyment.

This, however, is certainly not the real, but only the apparent state of things. That the power of the Eternal, as well as his intellectual and moral perfections, is infinite, it is on other grounds impossible to doubt: that we cannot perceive these perfections in all their extent manifested in his works, must therefore proceed from a deficiency in the grasp of our minds; but we must treat of them according to our own perceptions, and the evidence of Divine wisdom and goodness which, under the modification we have endeavoured to explain, breaks in upon us from every side, is probably, in some respects, better suited to call forth the wonder, admiration, and

gratitude of such limited creatures as we are, than even if we were to see the hand of the Creator less darkly. The view might be too vast, and the glory too effulgent for our mortal vision.

An apt illustration of the kind of defect and compensation, which seem to be inherent in the system of our world, may be found by attending to the state of external nature in the present season of the year. That there are disadvantages and privations in winter, under which all animated nature seems to shrink and groan, is undeniable; yet how many abatements, and how much positive enjoyment have we to place in the opposite scale!

It will be my duty to examine these abatements of evil, and these actual blessings, separately, in the course of our inquiry; but let us take one example by way of illustration. In our climate, and in all the regions which verge toward the poles, within certain limits, one of the discomforts of winter, which must occur to every person who thinks on the subject, is the shortness and gloom of the day. The sun rises late, looks down for a few hours with diminished glory on a blasted world, and then goes rapidly away, leaving all nature to the darkness of a tedious night. This is dreadful; yet see how it is rendered a source of pleasure and improvement! If, during the absence of the sun, we look at the starry heavens, what an inexhaustible fund of wonders does astronomy unfold, at once to exalt and to humble the human mind,—to fill us with admiration of the Divine perfections, and to teach us the salutary lesson of our own insignificance. It does not require that we should dive into the mysteries of this science, by means of the telescope, before these sentiments arise. They belong to every age of the world, to every stage of advancement in science, and to every station in life. There is no expression of devotional feeling to which even "babes and sucklings," as it is emphatically said, more readily respond, than that of the psalmist, "When I consider thy heavens, the work of thy fingers, the moon and the stars

which thou hast ordained, what is man, O Lord, that thou art mindful of him? and the son of man that thou visitest him?" How blank and dismal would be the darkness of a long winter night, were it not cheered and rendered sublime by the splendour of the starry firmament!

Look, again, at the comforts and domestic endearments of a winter evening fire-side. Who, that has experienced these, will allege that winter is inferior to summer, either in its enjoyments or in its means of improvement? When early night has spread its shade over external nature, and labour has ceased in the fields, and the sound of busy feet is more rarely heard along the streets; when the shutters are closed, and the curtains drawn, and the fire blazes in the grate, and the candle stands on the table shedding artificial day, and an united family, shutting out the world, retire within their own beloved circle, to enjoy the social hours; when the father and mother occupy their wonted chimney corners, and the children, while their hands, perchance, are engaged in some light employment, listen with interest to the instruction of some well-chosen book, or bear their parts in edifying and endearing conversation,—who will not confess that there are advantages in this intercourse, which longer days, and a more genial atmosphere, with all the attractions of vocal woods and flowery meads, can scarcely equal?

Here, then, we have compensation for an acknowledged evil:—we have even more. This evil is converted into means of pleasure and improvement; and such is precisely the character of Creative Wisdom and Goodness, into which we have to inquire. He, who expects to find a higher grade of perfection in those manifestations of nature with which he is surrounded, will assuredly be disappointed.

Yet this is a state of things far from being satisfactory to the inquiring mind; and the question still recurs,—Whence is this seeming contrariety and defect? Why does evil exist at all, under the government of an All-

wise and All-powerful Providence? Again, and above all,—Whence is moral evil? How comes it that ingratitude to a benefactor of infinite perfection, and rebellion against the eternal laws of the great Moral Governor, should exist for a single instant, and should be permitted to brave, as it were, the Majesty of the Eternal?

These are questions too deep for human reason; at the bare statement of which, indeed, human nature stands aghast and confounded. Revelation, however, takes up the important subject, and utters its response. The world came from its Creator an image of his own perfections;—but it has been smitten with a curse. The chief of the Creator's sublunary works,—he for whose abode the earth was prepared, and clothed in beauty, who was made but a little lower than the angels, and bore on his breast the impress of his Maker,—that lord of this nether sphere, received the precious gift of liberty, but abusing it, converted it into the means of his own miserable degradation. His destiny was altered, and the world in which he was for a season to dwell was altered also. To fallen man, the earth was no longer to be a place of rest, but of pilgrimage; from a paradise of enjoyment, it has been converted into a school of discipline. That heavenly blessing which had filled the earth, the sea, and the air, with beauty and happiness, was withdrawn. Darkness and tempest, change and decay, were thenceforth to brood over inanimate nature; want, suffering, and death, were to invade the living creation; and the guilty author of this universal blight was himself to be blighted more than all!

But why? Not that this intelligent creature should exist a few unhappy years in a stricken world, and then perish for ever; but that, under the chastisement of a father's rod, he might learn wisdom; and, becoming the object of Divine mercy, might, by means of labours not his own, aspire to honours greater than those he had forfeited, and be made an heir of immortality in a higher and brighter world.

FIRST WEEK—TUESDAY.

THE CHARACTER IMPRESSED ON NATURE.—CONTRIVANCE.

From the example stated yesterday, some idea may be formed of the kind of compensation for permitted evils which is every where to be discovered in the works of creation; but another, and equally marked feature in the face of nature, is that of the most ingenious contrivances, to avoid evils which would otherwise occur, or to insure advantages which could not otherwise be obtained. An example or two of this unequivocal proof of a wise and beneficent Designer will illustrate this subject.

For these I shall take advantage of the ingenious Treatise of Sir Charles Bell on the Human Hand, which is, throughout, a most masterly exposition of the argument, arising from this very view. The first which I select is taken from his chapter on the "Sensibility of the Surface, compared with the deeper parts." That the skin is extremely sensible to pain, no one need be informed; but few, perhaps, have sufficiently attended to the fact, which is yet within the reach of any person's observation, that the pain does not increase in proportion to the depth of the wound, the sensibility being almost exclusively confined to the outward covering of the body. This has been very convincingly proved to be a contrivance of much wisdom and benevolence. After stating the fact, and showing it to be a matter of daily surgical experience, the author justly observes, that the obvious intention is, that the skin should be a safeguard to the delicate textures which are contained within, by forcing us to avoid injuries; and that it does afford us a more effectual defence than if our bodies were covered with the hide of a rhinoceros.

"In pursuing the inquiry," says he, "we learn with much interest, that when the bones, joints, and all the

membranes and ligaments which cover them are exposed, they may be cut, pricked, or even burned, without the patient or the animal suffering the slightest pain. These facts must appear to be conclusive; for who, witnessing these instances of insensibility, would not conclude that the parts were devoid of sensation; but when we take the true philosophical, and, I may say, religious view of the subject, and consider that pain is not an evil, but given for benevolent purposes, and for some important object, we should be unwilling to terminate the investigation here.

"In the first place, we must perceive, that, if a sensibility similar to that of the skin had been given to these internal parts, it must have remained unexercised. Had they been made sensible to pricking and burning, they would have possessed a quality which would never have been useful, since no such injuries can reach them, or never without warning being received through the sensibility of the skin.

"But, further, if we find that sensibility to pain is a benevolent provision, and is bestowed for the purpose of warning us to avoid such violence as would affect the functions or uses of the parts, we may yet inquire, whether any injury can reach these internal parts, without the sensibility of the skin being excited. Now, of this there can be no doubt, for they are subject to sprain, and rupture, and shocks, without the skin being implicated in the accident. If we have been correct in our inference, there should be a provision to guide us in the safe exercise of the limbs; and, notwithstanding what has been apparently demonstrated of the insensibility of these internal parts, they must possess an appropriate sensibility, or it would imply an imperfection. With these reflections we recur to experiment, and we find that the parts which are insensible to pricking, cutting, and burning, are actually sensible to concussion, to stretching, or laceration.

"How consistent, then, and beautiful is the distribution of this quality of life! The sensibility of pain varies with the function of the part. The skin is endowed with sensibility to every possible injurious impression which may be made upon it; but had this kind and degree of sensibility been made universal, we should have been racked with pain in the common motions of the body; the mere weight of one part on another, or the motion of the joint, would have been attended with that degree of suffering which we experience in using or walking upon an inflamed limb.

"But, on the other hand, had the deeper parts possessed no sensibility, we should have had no guide in our exertions. They *have* a sensibility limited to the kind of injury which it is possible may reach them, and which teaches us what we can do with impunity. If we leap from too great a height, or carry too great a burden, or attempt to interrupt a body whose impetus is too great for us, we are warned of the danger as effectually by this internal sensibility, as we are of the approach of a sharp point, or a hot iron to the skin."*

To this striking pathological argument for benevolent contrivance, might be added proofs without end, from the principles of mechanics. The whole animal frame, indeed, is a piece of the most exquisite mechanism, and the studies of the anatomist abound with demonstrations of the most satisfactory kind. Not only do we find every joint, bone, and sinew, of every species of animal, so adapted to all the rest, and to the nature of its food and habits, as to constitute a perfect system, considered in itself, but when one species of living creatures is compared with others, new kinds of relations and adaptations are discovered, which greatly extend our views of creative contrivance, and increase our admiration. Sir Charles Bell, in the work from which we have quoted, has followed out this inquiry, as respects the human hand, in a very interesting manner; and we cannot better close this paper, than by extracting a few sentences from a

* Bell's Bridgewater Treatise, pp. 155-157.

passage where he opens up the principle on which he so successfully expatiates.

"Were I to indulge in the admiration naturally arising out of this subject, and point out the strength and freedom of motion in the upper extremity at the ball and socket joint of the shoulder,—the firmness of the articulation of the elbow, and yet how admirably it is suited to the co-operation of the hands,—the fineness of the motion of the hand itself, divided among the joints of twenty-nine bones, it might be objected to with some show of reason, and it might be said,—The bones and the forms of the joints which you are admiring, are so far from being peculiarly suited to the hand of man, that they may be found in any vertebrated animal. But this would not abate our admiration; it would only induce us to take a more comprehensive view of nature, and remind us that our error was in looking at a part only, instead of embracing the whole system; where, by slight changes, and gradations hardly perceptible, the same bones are adjusted to every condition of animal existence.

"We recognise the bones which form the upper extremity of man, in the fin of a whale, in the paddle of the turtle, in the wing of the bird. We see the same bones, perfectly suited to their purpose, in the paw of the lion or the bear, and equally fitted for motion in the hoof of the horse, or in the foot of the camel, or adjusted for climbing or digging, in the long-clawed feet of the sloth or bear [beaver?]. * * * * *

"The wonder still is, that, whether we examine this system in man, or in any of the inferior species of animals, nothing can be more curiously adjusted or appropriated; and we should be inclined to say, whatever instance occupied our thoughts for the time, that to this particular object the system had been framed."*

* Bell's Bridgewater Treatise, pp. 20-22.

FIRST WEEK—WEDNESDAY.

GLOBULAR FIGURE OF THE EARTH.

THE character which, in the two preceding papers, we stated as belonging to the works of God, consisting as it does, not in absolute perfection, but rather in contrivances and compensations to abate imperfection, runs through every thing in nature, and may be equally traced in the moral and physical worlds. It may be useful and interesting to examine this character in some of the great arrangements of external nature.

That the universe should be governed by general laws impressed on matter, is a providential arrangement, the consummate wisdom of which it requires no effort of reasoning to demonstrate; and that these laws should be fixed and undeviating, is a necessary consequence of their existence; for, were they to any great extent to yield to circumstances, they would cease to possess the character of principles, on the results of which it would be possible either to reason or to act,—that is, they would cease to be general laws. Now, one of these general laws, as simple in its nature, as it is universal in its operations, and amazing in its effects, is the principle of gravitation, of which it has been beautifully said,—

"The very law which moulds a tear,
And makes it trickle from its source,
That law preserves the earth a sphere,
And guides the planets in their course."*

The globular figure of the earth, which is the result of this law, and which may easily be shown to possess many important advantages, presents this formidable difficulty,—that the rays of the sun, issuing in parallel lines from that luminary, must fall directly upon that part of the terrestrial ball which is immediately opposed

* Rogers.

to them, and obliquely, and therefore less powerfully, upon all other parts of its convex surface, till, at the extremes of the hemisphere, they would entirely cease to reach the earth. Were the earth stationary, therefore, the consequence of its globular form would be, that the sun would shine intensely and constantly on a single spot, while one-half of its surface would be left in total darkness, and the other would be illuminated with greater or less force, according to its distance from the sun's direct rays. The disadvantages of such an arrangement need no comment. Now, one way in which this evil is abated, is by what is called the *diurnal rotation of the earth*. Our globe is made to whirl round as on two pivots, which are called the poles* of the earth, once in twenty-four hours. This, while it causes the grateful alternation of day and night, conveys light and heat round the world, so as to diffuse them with nearly equal force on every spot within the same parallel of latitude. Were the earth in the form of a cylinder or roller, this rotatory motion would cause the sun, in the course of the annual revolution, to shine equally on every part of its *round* surface, while his rays would never reach the wide flat regions at either end; the days and nights would then be invariably of the same length; there would be no change of climate, and all the habitable parts of the earth would be one burning tropical region, without abatement and without variety. If, on the other hand, the earth, in its present form of a ball, were to have no yearly as well as daily motion, or, having an yearly motion, were to move round its own axis in what may be considered the most simple manner, that is, in an erect position with reference to the sun, the effect would be, that he would constantly shine with his direct rays only on that single line of the earth's surface which is called the equator. There would still be no

* The extended line through the centre of the globe, on which it turns, is called the axis of the earth,—taking the metaphor from the axis of carriage wheels.

change of seasons, and the accumulated heat in the equatorial regions would be so excessive, as to destroy, in all probability, both animal and vegetable life; while, in the neighbourhood of the polar circle, and even in a vast extent of those countries to which we now give the name of temperate, the globe would be uninhabitable, from the contrary cause of extreme and uniform cold.

The contrivance, by which this inconvenience is, to a desirable extent, removed, is well known. The earth, which, in common with the other planets, performs an annual revolution round the sun, is made to take this course, not in an erect, but in an inclined position; by which means the pole, which leant toward the sun in one part of the course, leans away from it in another. The consequence of this is, that the sun, instead of shining constantly with his direct rays upon the equator, appears to be continually traversing a considerable space in the heavens, shifting from tropic to tropic, and presenting himself for one half of the year to the north, and for the other half to the south of the equator. The various parts of the earth's surface, within the tropics, are thus exposed alternately to the direct and indirect rays of the sun at different periods, and the position and influence of this source of light and heat, is also varied over the whole globe, or, in common language, the diversified appearances of the seasons are produced.

This is a most beneficial arrangement; but it is evident that it could only be salutary within a certain range, for this simple reason, that, were the sun to traverse from pole to pole, it would necessarily happen, that while he was shining vertically on the south pole, the north would be left to total darkness, and the tenfold rigours of a polar winter; and, *vice versa*, while he was pouring the unmitigated radiance of his burning rays on the regions of the north, the south would be doomed to undergo the extreme, which, a few months before, had carried desolation to the north. The fatal consequences of this need not be described; the whole

balance of nature, at present so nicely adjusted, would be upset, the elements would be in constant and furious commotion, and no organized existence, such, at least, as is at present to be found on the earth, could survive the conflict; or, if it did, could endure the violent changes of the seasons, for a single year.

It would be by no means difficult to prove, that the extent to which the range of the sun is actually confined, is precisely that which manifests the most consummate intelligence in the great Artificer. Had it been either more or less than we actually find it, the same advantages would not have been secured, other things remaining as they are, nor would inconveniences have been so effectually avoided. Evils, indeed, still remain; it is part of the system of a world of discipline that it should be so,—but the proof of Divine contrivance lies in this, that these evils are at the *minimum*, while the advantages, on the contrary, are at the *maximum*; that is to say, that any alteration either way would be for the worse. Here, then, we have, what we are taught to look for by the general analogy of nature,—a proof of supreme wisdom in the adjustment of materials,—the adaptation of means with admirable skill to a beneficent end.

FIRST WEEK—THURSDAY.

CIRCULATION IN THE ATMOSPHERE AND OCEAN.

We have mentioned the inclination of the earth's axis to the plane of its annual orbit, as the cause of the variety of seasons on its surface; but there are other beneficial arrangements which concur with, and are influenced by this, and without which it would but imperfectly secure what is obviously the main design of the Creator, namely, the furnishing of an extensive and varied surface, fit for the habitation of living creatures, and especially of man, the only creature endowed with the higher

attributes of reason, and therefore a subject of moral discipline. Among these arrangements we shall, in the present paper, only allude to the circulation established in the fluid elements which surround our globe.

The expansion of fluid substances by heat, and their contraction, within certain bounds, by cold, is a universal law of nature. Now, this law has an obvious tendency to create circulation. The fluid becoming lighter by being expanded, and heavier when contracted, rises towards the surface, or falls towards the bottom, in proportion to the partial application of heat or cold, and thus tends to diffuse an equable temperature through the whole mass. But this principle has also another effect, which we have more immediately in view. When the fluid expands, it occupies a greater space, and must therefore displace some of the mass with which it is surrounded; when it is contracted, the contrary effect follows,—its diminished bulk is supplied by the rushing in of the contiguous fluid. In either case a current is created.

In regarding the effects thus produced on the atmosphere, it is scarcely possible not to recognize the impress of wisdom and goodness. It is to this cause, operating on the combined air and vapour, that we owe alternate clouds and sunshine, winds and calms, drought, moisture, and rain,—every thing, in short, that we call weather,—the changes of which are so essential to the fertility of the earth and salubrity of the climate. But, in the midst of these alternations, there is another and more extensive operation constantly going on. The atmosphere, heated and expanded at the equator, is continually flowing in the upper regions towards the poles, where, being cooled and contracted, it acquires a retrograde motion, and flows back in a perpetual under-current towards the equator. This, at least, is its general bias, happily modified, however, by various circumstances and disturbing forces, which retard, divert, and mingle the opposing currents; and while they reduce the temperature of the one, increase that of the other. This, then, is one of

those providential contrivances by which the fervid heat of the torrid zone is alleviated, and the excessive rigour of the polar regions is subdued, while the intervening temperate climates are rendered more salubrious, and the wide extent of earth is prepared for the comfortable sustenance of animal life.

A similar effect is produced by the movements of the ocean. The expanded waters of the equatorial circle rush towards the poles, carrying with them some of the warmth of those burning regions, which they perpetually pour into the atmosphere of the temperate and frigid divisions of the earth; while the chilled and contracted waters of the extreme north and south, throw back their currents upon the tropics, and thus, in their turn, modify the temperature in these latter climates. In our own quarter of the globe, we observe this effect exemplified in what is called the Gulf-stream of the Atlantic, which is a perpetual current,—occasioned partly by the law already alluded to, and partly by the form of the African and American coasts,—running from the northern shore of South America, where the heat is at its *maximum*, along the coast of the United States, sweeping across from Newfoundland to the Icy Sea, enveloping the British islands, and thence returning along the shores of France, Spain, and Africa, till it completes its circuit by again reaching the southern continent of America and the Western Indies. That the effect which might be anticipated from this circulation is actually produced, we have a proof in the comparative mildness of the temperature in insular countries. The climate of Great Britain, for example, is more equable than that of the adjoining continent, being considerably cooler in summer, and warmer in winter.

"Great as the difference of temperature is in different climates," says Whewell, "it would be still greater if there were not this equalizing and moderating power exerted constantly over the whole surface. Without this influence, it is probable that the two polar portions

of the earth, which are locked in perpetual snow and ice, and almost destitute of life, would be much increased." *

It thus appears, that there is a constant circulation going on in the two great fluids of air and water, analogous in some degree to that of blood through the living body, and productive of the most beneficial effects. The manner in which these are attempered and combined is truly wonderful, and has been the subject of philosophical investigation. In regard to the air, Mr Whewell has shown in what manner its composition and laws are adjusted, so as to correspond with, or to counteract and regulate, the different and sometimes antagonist laws of the vapour which constantly circulates through it, and to produce the most salutary effects. This is a question on which I cannot fully enter; but a few observations on the subject of weather, with which it is connected, will occupy our attention to-morrow.

FIRST WEEK—FRIDAY.

THE ATMOSPHERE.

From the expansive power of the atmosphere, and the irregular distribution of heat and cold, combined with the inequalities on the earth's surface, arise those storms and tempests which form one of the most forbidding features in the aspect of winter. This may be regarded as an evil; and it is not to be denied, that such elemental commotions are sometimes attended with very disastrous consequences. When the tremendous powers of nature are in motion, indeed, we might well tremble and despair, did we not know that they are under the guidance of infinite perfection. In rare instances, at long intervals, and in limited spots, we are permitted to witness proofs of the desolation which the uncontrolled elements

* Whewell's Bridgewater Treatise, p. 82.

might produce, that by the contrast we may be more deeply affected with a sense of the paternal care under which we daily live. We have heard of hurricanes and tornadoes sweeping whole districts with the besom of destruction,—of the sirocco and simoon carrying instant death on their poisoned wings,—of mountain torrents and swelling seas bursting their ancient boundaries, and bearing wide desolation in their raging waters,—of thunder rending the heavens, and bolts of fire skathing the earth,—of earthquakes swallowing up whole cities, or volcanoes overwhelming them with floods of lava. But these are only the infrequent exceptions to a general rule, which has order and happiness for its object, teaching us at once a lesson of humility and gratitude.

If we turn from this view of what might be the universal state of nature, to real events as they occur under our own eye, and are the subject of daily experience, we shall have abundant cause to acknowledge the presence of an overruling hand. How seldom do we actually observe any extensive desolation produced by a winter storm. "All the changes of the weather," Mr Whewell well observes "even the most violent tempests and torrents of rain, may be considered as oscillations about the mean or average condition belonging to each place. All these oscillations are limited and transient; the storm spends its fury, the inundation passes off, the sky clears, the calmer course of nature succeeds. In the forces which produce this derangement, there is a provision for making it short and moderate. The oscillation stops of itself, like the rolling of a ship when no longer impelled by the wind. Now, why should this be so? Why should the oscillations produced by the conflict of so many laws, seemingly quite unconnected with each other, be of this converging and subsiding character? Is it a matter of mechanical necessity, that disturbance must end in the restoration of the medium condition? By no means. There may be an utter subversion of the equilibrium. The ship may roll too far, and may capsize. The oscillations may go on, becoming larger and larger, till all trace of the original condition is lost; till new forces of inequality and disturbance are brought into play; and disorder and irregularity may succeed, without apparent limit or check in its own nature, like the spread of a conflagration in a city. This is a possibility in any combination of mechanical forces. Why does it not happen in the one before us? By what good fortune are the powers of heat, of water, of steam, of air, the effects of the earth's annual and diurnal motions, and probably other causes, so adjusted, that, through all their struggles, the elemental world goes on, upon the whole, so quietly and steadily? Why is the whole fabric of the weather never utterly deranged, its balance lost irrecoverably?"*

The complicated nature of the elements, which enter into the constitution of the atmosphere, renders it difficult, perhaps impossible, to give a distinct answer to these interesting questions, by pointing to the precise law which regulates and controls these elements. Mr Whewell refers to the very peculiar adjustments which were requisite, and are actually discoverable, in the comparatively simple problem of the solar system, by which its motions have their cycles, and its perturbations their limits and period; and, from this analogy, he conjectures, with much probability, that could the investigation be followed out, it would land us in a similar result. However this may be, it cannot but be regarded as a mark of the interference of an intelligent and beneficent mind, that the intensity of those tremendous forces which are employed in our atmosphere should be so adjusted, as not only to preserve the permanence of the system, but also to be adapted to the existence and comfort of the animal creation.

In adverting to the general properties of that wonderful fluid which envelopes our globe as with a mantle, the distinguished philosopher from whom we have already

* Whewell's Bridgewater Treatise, p. 107.

quoted, makes the beautiful observations, with which we close this paper.

"If the atmosphere be considered as a vast machine, it is difficult to form any just conception of the profound skill and comprehensiveness of design which it displays. It diffuses and tempers the heat of different climates; for this purpose it performs a circulation occupying the whole range from the pole to the equator; and, while it is doing this, it executes many smaller circuits between the sea and the land. At the same time, it is the means of forming clouds and rain; and, for this purpose, a perpetual circulation of the watery part of the atmosphere goes on between its lower and upper regions. Besides this complication of circuits, it exercises a more irregular agency in the occasional winds which blow from all quarters, tending perpetually to restore the equilibrium of heat and moisture. But this incessant and multiplied activity discharges only a part of the functions of the air. It is, moreover, the most important and universal material of the growth and sustenance of plants and animals; and is for this purpose every where present, and almost uniform in its quantity. With all its local motion, it has also the office of a medium of communication between intelligent creatures, which office it performs by another set of motions, entirely different both from the circulation and occasional movements already mentioned; these different kinds of motions not interfering materially with each other; and this last purpose, so remote from the others in its nature, it answers in a manner so perfect and so easy, that we cannot imagine that the object could have been more completely attained, if this had been the sole purpose for which the atmosphere had been created. With all these qualities, this extraordinary part of our terrestrial system is scarcely ever in the way; and when we have occasion to do so, we put forth our hand and push it aside, without being aware of its being near us."

FIRST WEEK—SATURDAY.

IGNIS FATUUS.

One of the curious atmospheric phenomena of winter, the nature of which is not well understood, and still less its use in the economy of Providence, is that shining vapour which generally makes its appearance in moist weather, in marshy ground, known to the Romans by the name of *ignis fatuus*, and called by people in this country "Will o' Wisp,"—"Jack with the lanthorn," and a variety of other names, all of them indicating the superstitious feeling with which it is associated in the minds of the vulgar. This paper shall be chiefly occupied with some accounts that have been published of the various appearances which the phenomenon assumes. The first I shall quote is that of a writer in a public journal, who subscribes himself "A Farmer," and expresses himself with such amusing naïveté in describing some of the ordinary vagaries of this reputed sprite, that the homeliness of the style requires no apology.

"I was riding through a wet boggy part of the road, that lies between my house and the mill, when a little sleety shower, with a strong blast of wind, came suddenly upon me, and made it so very dark, that I could scarcely see my old mare's white head. I began to consider with myself, whether it would be better to turn my back to the storm, and wait till it was past, or take my chance of letting my horse find its own way, when I saw something bright dancing in the air before me. You may be sure I was startled a little at this; for the rain was pouring so fast, and the wind was blowing so strong, that no ordinary fire could stand it; so I whipt up my horse to get out of the way as fast as I could; but to go fast was out of the question, with such an old mare, such a bad road, and so heavy a burden; and, besides, I soon

found that it served me in no stead, for the light still kept waving before my eyes; so I thought it would be best to go slowly, and try if I could find out what it was.

"You may think how surprised I was, when I discovered, that the top of my whip-lash was all in a flame. I had at first almost thrown it out of my hand in my fright; but, on second thoughts, I did not like to do that, for fear of losing it, as it was nearly new, and a present from my uncle John. I therefore whisked it about in my hand, and whipped my horse with it, thinking to make the flame go out; but, though it turned dim for a few minutes, it soon became brighter than ever. Just at this time, I heard the sound of a foot before me; and, when I looked, I saw very distinctly the marks of footsteps all on fire, close beside me; but it was so dark, I could not see whether any person was there or not. Soon afterward, I got upon better road, and my poor mare, who was herself frightened, jogged faster on; so I saw no more of it. I am happy to tell you, that I got home without a broken neck, and found all well there, which was more than I expected; for I verily believed it was a dead light, or an *elf* candle, or some other bad omen."*

M. Boccari mentions, that a light of this kind appeared to a gentleman of his acquaintance, as he was travelling in the neighbourhood of Bologna, where it is very common. It moved constantly before him for about a mile, and gave a better light than a torch that was carried by his servant, Sometimes it rose and sometimes sunk, but hovered commonly about six feet from the ground. Sometimes it appeared like waves, and, at other times, seemed to drop sparks of fire. It was little affected by the wind; but, during a shower of rain it became brighter.

A very remarkable account of a will o' wisp, is given by Dr Shaw, in his Travels to the Holy Land. It appeared in one of the valleys of Mount Ephraim, and attended him and his company for more than an hour.

* Dumfries Courier, 20th December 1809.

Sometimes it would seem globular, or in the shape of the flame of a candle. At other times, it would spread to such a degree as to involve the whole company in a pale inoffensive light, then contract itself, and suddenly disappear; but, in less than a minute, would appear again. Sometimes, running swiftly along, it would expand itself, at certain intervals, over more than two or three acres of the adjacent mountains. The atmosphere, from the beginning of the evening, had been remarkably thick and hazy; and the dew, as they felt it on the bridles of their horses, was clammy and unctuous.

In the Appendix to Dr Priestley's third volume of Experiments and Observations on Air, M. Waltire gives an account of some very remarkable *ignes fatui* which he observed, about five miles from Birmingham, on the 12th December 1776, before daylight in the morning. A great many of these lights were playing in a neighbouring field, in different directions; from some of which there suddenly sprang up bright branches of light, something resembling the explosion of a rocket, that contained many brilliant stars; and the hedge, with the trees on each side of the hedge, was illuminated. This appearance continued but a few seconds, and then the will o' wisps played as before. M. Waltire was not near enough to observe if the apparent explosions were attended by any report.

From these and other facts which have been recorded, and indeed from the familiar occurrences of the winter months, it appears that the *ignis fatuus* belongs to a class of phenomena which prove that light and heat, though so intimately connected, may exist separately; or, to speak more correctly, that the peculiar substance, whatever it may be, in which these qualities inhere, contains sometimes the one in a latent state, and sometimes the other. This is only another remarkable property of that most wonderful substance which seems to pervade universal nature, and to combine the various phenomena of electricity, of galvanism, and probably also of magnet-

ism, along with those of light and heat, sometimes in a quiescent, and sometimes in a highly active state.

The phenomena of light without heat, are not so frequently the subject of observation as those of heat without light; but various well known, and indeed familiar, instances of the latter do occur. Of this kind is the light of the glow-worm, of fire-flies, of the medusa tribe, which are diffused so plentifully over the surface of the sea, in tropical regions; of other marine productions; of the scales of fish, and of animal and vegetable substances in the process of putrefaction. Nor must we forget the beams of the moon, which, so far from exhibiting the presence of heat, are even said by some to be slightly frigorific.

An attempt, more ingenious, I think, than successful, has been made to connect the light of the *ignis fatuus* with the phenomena of falling stars, which may be shortly stated. It is supposed, that some phosphoric fluid arising from the decomposition of animal or vegetable substances, passes into the atmosphere, and continues to float there, without mixing with the atmosphere itself; that this fluid, when it appears in the form of a will o' wisp, becomes ignited, by some means, near the surface of the earth, at a certain point; and that this ignition communicates itself successively to other portions of the same fluid, with which it comes in contact, occasioning that apparently capricious flitting from place to place, for which this meteor is remarkable; and it is further supposed, that other portions of a similar fluid pass, unilluminated, to the higher regions of the air, in a continued column, till they ascend above the region of the clouds, where from some chemical cause, the upper part of the column takes fire, and the ignition is carried backward to the portions with which it is in connexion. Such is the hypothesis; and it might certainly account for some of the appearances; but it is quite inadequate to the explanation of others; and, as to the phenomena of falling stars, recent discoveries have opened up views

on that subject, of a nature far more extensive and sublime.

In the next paper, I shall advert more particularly to some phosphorescent appearances which seem to resemble those of the *ignis fatuus*, and which may perhaps ultimately assist in discovering the natural cause of the phenomenon; and in the mean time, without attempting to explain it, I shall merely say, that, whatever may be its own sphere of utility, there can be no doubt it is connected with a principle which abundantly exhibits the perfections of the great Creator.

We conclude this account with a beautiful description of these appearances, extracted from the "British Georgics," a work of the amiable author of "The Sabbath."

"Sometimes November nights are thick bedimmed
With hazy vapours floating o'er the ground,
Or veiling from the view the starry host;
At such a time, on plashy mead or fen
A faintish light is seen, by southern swains
Called Will-o-Wisp; sometimes from rushy bush
To bush it leaps, or, cross a little rill,
Dances from side to side in winding race.
Sometimes with stationary blaze it gilds
The heifer's horns; or plays upon the mane
Of farmer's horse returning from the fair,
And lights him on his way, yet often proves
A treacherous guide, misleading from the path
To faithless bogs, and solid seeming ways.
Sometimes it haunts the churchyard, up and down
The tombstones' spiky rail streaming, it shows
Faint glimpses of the rustic sculptor's art,
Time's scythe and hour-glass, and the grinning skull,
And bones transverse, which, at an honr like this,
To him, who passing, casts athwart the wall
A fearful glance, speak with a warning knell.
Sometimes to the lone traveller it displays
The murderer's gibbet, and his tatter'd garb,
As lambently along the links it gleams."

SECOND WEEK—SUNDAY.

GENERAL ASPECT OF WINTER.

The general aspect of winter is forbidding. It is the night of the year; the period when, under a mitigated light, nature reposes, after the active exertions of spring and summer have been crowned with the rich stores of autumn. We now no longer survey with admiration and delight those wonders of creative power, which arrested our attention, in that youthful season when herbs, plants, and trees awoke from their long sleep and started into new life, under the kindly influences of warmer suns and gentler breezes; and when the feathered tribes made the fresh-clothed woods and lawns, and the blue sky itself, vocal with the music of love and joy. Nor do we now expatiate in the maturer beauties of summer, when light and heat flushed the glowing heavens and smiling earth, and when the clouds distilled their grateful showers, or tempered the intense radiance by their flitting shade: And mellow autumn too has passed away, along with the merry song of the reapers, and the hum of busy men, gathering their stores from the teeming fields.

Instead of these genial influences of heaven, our lengthening nights, and our days becoming perpetually darker and shorter, shed their gloom over the face of nature; the earth grows niggardly of her supplies of nourishment and shelter, and no longer spreads beneath the tenants of the field the soft green carpet on which they were accustomed to repose; man seeks his artificial comforts and his hoarded food; the wind whistles ominously through the naked trees; the dark clouds lower; the chilling rain descends in torrents; and, as the season advances, the earth becomes rigid, as if struck by the wand of an enchanter; the waters, spell-bound, lie motionless in crystal chains; the north pours forth its blast,

and nature is entombed in a vast cemetery, whiter and colder than Parian marble.

Yet, even in this apparently frightful and inhospitable season, there are means of pleasure and improvement, which render it scarcely inferior to any other period of the revolving year; while proofs of the power, wisdom, and goodness of the great Creator are not less abundantly displayed to the mind of the pious inquirer. With reference to the angry passions of the human race, it is said that God "causes the wrath of man to praise him, and restrains the remainder of wrath;" and a similar remark applies with a truth equally striking to the troubled elements. The Almighty sets bounds to the raging ocean, saying, "Hitherto shalt thou come, and no further, and here shall thy proud waves be stayed." He regulates by his wisdom the intensity of the tempest, "staying his rough wind in the day of the east wind." All the active powers of nature are his messengers: "Fire and hail, snow and vapour," as well as "stormy winds, fulfil his word." Nothing, indeed, can be more worthy of admiration than the manner in which the rigours of winter are tempered, so as to contribute to the subsistence and comfort of living beings.

It is true that, even in the ordinary occurrences of life, there are, in winter, probably more distressing and fatal incidents than during the other quarters of the year. A snow-storm may sometimes overwhelm a shepherd and his flock; a tempest may cause a gallant vessel and its crew to perish; a fire may lay a village in ashes; disease, attendant on exposure to a rigorous climate, may invade the unwholesome and comfortless huts of the poor; or, in a season when the wages of agricultural labour cease along with the power of working in the open air, famine may emaciate and destroy whole families; but such events as these, melancholy as they are, must be ranked among the common evils of life, and belong to a class, marking a peculiar feature in the government of this fallen world, to which I have previously

adverted, and which can never be far from the mind of the accurate observer of nature. At present let us take a rapid glance at the other side of the picture, and we shall see enough to prove, that, even in these gloomy months, the paternal care of an all-wise and beneficent Governor is not less conspicuous than in other periods of the year.

If we look at the lower animals, how wonderful are the kind provisions of Providence. Among the numerous tribes of insects, reptiles, birds, and quadrupeds, there appears to be a general presentiment of the coming desolation. Some, impelled by a wonderful instinct, provide for themselves comfortable retreats, each tribe adapting its accommodation to its peculiar circumstances, burrowing in the earth, or boring beneath the bark of trees and shrubs, or penetrating into their natural hollows, or lodging in crevices of walls and rocks, or diving beneath the surface of the water, and lying immoveable at the bottom of pools, lakes, or marshy streams. Here they are preserved during this barren period, either by feeding on the stores which, with a foresight not their own, they had collected in the bountiful weeks of harvest, or by falling into a deep sleep, during which they become unassailable either by the attacks of cold or of hunger, or by issuing daily or nightly from their resting places, and gathering the food which a providential care has reserved for them, and taught them how to seek. Others, chiefly belonging to the winged tribes, are taught to migrate, as the rigours of winter approach, to more genial climates, where abundant food and enjoyment are provided for them, and where they are thus permitted to expatiate in all the advantages of a perpetual yet varied summer; while these again have their places supplied by hardier species of the feathered family, which the gathering storms of more northern regions had warned to leave their summer haunts.

If from the inferior animal creation, we turn to man, the same traces of a paternal hand are seen in providing against, or compensating for, the privations of winter. If our natural instincts and defences are not so numerous as those of the brutes, reason and foresight amply supply their place. Influenced by these, we build comfortable houses, of materials which are every where to be found, and collect supplies of fuel from bogs and forests, or dig them out of the bowels of the earth, where they are laid up as in storehouses; and we rear flocks and herds to furnish us with the means of food and clothing. Meanwhile, necessary industry occupies and cheers the dreary season; and books or social intercourse improve and exhilarate the mind.

All these proofs of paternal care deserve and will obtain a separate consideration; but the simple mention of them is calculated to call forth sentiments of pious admiration and gratitude. "Who knoweth not in all these, that the hand of the Lord hath wrought this."

SECOND WEEK—MONDAY.

PHOSPHORESCENCE.

The meteor known by the name of *ignis fatuus*, is connected, as I observed in the paper of Saturday, with some other luminous appearances, by this common property, that it gives out no sensible heat. Among other animals which possess the property of shining with a cold light, I mentioned the Medusa class, which sometimes illuminate the whole surface of the sea, and, in a dark night, show like a stream of liquid fire in the wake of a ship. But, besides these, there is a great variety of the larger inhabitants of the ocean, which have it in their power to emit a kind of phosphoric light from their bodies at pleasure; and this remarkable property is probably given them by the Creator, to enable them to pursue their prey in the dark abysses of the sea, where the beams of the sun cannot penetrate. Among shoals of

herrings and pilchards, flashes of light have been frequently observed to dart, so as to cast a sudden brilliancy across the whole; and oyster-shells, as well as a variety of minerals, have become phosphorescent at certain temperatures. These appearances have been attributed to electricity, which is rendered probable by various circumstances, and seems to be confirmed by the fact, that the electric shock causes substances of the kind last mentioned, to exhibit the same luminous appearance. However this may be, there can be no doubt, that the presence of the electric fluid is not unfrequently shown by the production of a harmless light, similar to that of the *ignis fatuus*. Sailors are not unacquainted with this phenomenon, which they regard with awe, and which is seen at night in the form of a star, illuminating the topmasts and yard-arms, or gliding along the ropes of ships. This light the ancients superstitiously distinguished by the name of Castor and Pollux, considering it a lucky omen. Mrs Somerville mentions, that, in 1831, the French officers at Algiers were surprised to see brushes of light on the heads of their comrades, and at the points of their fingers, when they held up their hands.

One of the most striking appearances of this kind, which occurred at sea, is thus graphically described by the talented authoress above alluded to:—

"Captain Bonnycastle, coming up the Gulf of St Laurence, on the 7th September 1826, was roused by the mate of the vessel, in great alarm from an unusual appearance. It was a star-light night, when suddenly the sky became overcast, in the direction of the high land of Cornwallis County, and an instantaneous and intensely vivid light, resembling the aurora, shot out of the hitherto gloomy and dark sea, on the lee-bow, which was so brilliant, that it lighted every thing distinctly, even to the mast-head. The light spread over the whole sea, between the two shores; and the waves, which before had been tranquil, now began to be agitated. Captain Bonnycastle describes the scene as that of a blazing sheet

of awful and most brilliant light. A long and vivid line of light, superior in brightness to the parts of the sea not immediately near the vessel, showed the base of the high, frowning, and dark land, abreast. The sky became lowering, and more intensely obscure. Long tortuous lines of light showed immense numbers of very large fish, darting about, as if in consternation. The spritsail-yard and mizen-boom were lighted by the reflection, as if gas-lights had been burning directly below them; and, until just before day-break, at four o'clock, the most minute objects were distinctly visible. Day broke very slowly, and the sun rose of a fiery and threatening aspect. Rain followed. Captain Bonnycastle caused a bucket of this fiery water to be drawn up: it was one mass of light, when stirred by the hand, and not in sparks, as usual, but in actual coruscations. A portion of the water preserved its luminosity for seven nights. On the third night, the scintillations of the sea reappeared; this evening, the sun went down very singularly, exhibiting in its descent a double sun; and, when only a few degrees high, its spherical figure changed into that of a long cylinder, which reached the horizon. In the night, the sea became nearly as luminous as before; but, on the fifth night, the appearance entirely ceased. Captain Bonnycastle does not think it proceeded from animalcula, but imagines it might be some compound of phosphorus, suddenly evolved, and dispersed over the surface of the sea; perhaps from the exuviæ or secretions of fish connected with the oceanic salts,—muriate of soda, and sulphate of magnesia."*

Such are some of the facts connected with what has been called phosphorescence. I shall make no attempt to theorize on the subject. When science is further advanced, it may probably be found, that phosphorescence, the *ignis fatuus*, and other innoxious illuminating substances, depend on some common property, which may serve to illustrate the mysterious subject of light and

* "Connexion of the Physical Sciences," 303, 304.

heat, and thus open up a further view of the laws by which the Creator regulates the material world.

SECOND WEEK—TUESDAY.

AURORA BOREALIS.

The aurora borealis is a phenomenon undoubtedly electrical, connected in some way with the magnetic poles, which sometimes beautifully illuminates our northern sky during the autumnal and winter months. Its use in the system of nature has not been distinctly ascertained, though various conjectures have been formed. Dr Halley supposed that the earth was hollow, having within it a magnetical sphere, which corresponded in virtue with all the magnets on the surface; and that the aurora was the magnetic effluvia rendered by some means visible, and passing through or beyond the atmosphere from the north pole of the central magnet to that of the south. Boccaria adopts a similar idea, but attributes the phenomenon to the electric instead of the magnetic fluid, which, indeed, is now proved to be the same thing. The fallacy of this opinion has, however, been since shown by the fact, that the fluid, whatever it is, darts upward toward the zenith in the southern as well as in the northern hemisphere, whereas, were there a circulation such as has been conjectured, the course of the fluid would in the south have been reversed, descending from the zenith to the horizon. The supposition of Dr Faraday, therefore, is, that the electric equilibrium of the earth is restored by the aurora conveying the electricity from the poles to the equator.

Without attempting to settle a point with regard to which sufficient data have not been collected, I shall content myself with describing some of the remarkable appearances of this very curious and interesting phenomenon.

One circumstance worthy of notice has already been stated, namely, that the aurora bears some reference, not

to the poles of the earth's rotation, but to what have been called the magnetic poles. It generally forms a kind of stationary luminous arch, of which the magnetic pole is the centre, and across this arch the coruscations are rapid, sudden, and frequently of various colours. Its history is curious, no very distinct account having been recorded of its appearance in the classic ages of the world, though we do hear of "*trabes*," and "*bolides*," and "*chasmata*," which seem to refer to some celestial phenomena of a similiar nature. The first modern account of the aurora on record, is that mentioned as having been seen at London, on the 30th January 1560; and during the subsequent part of that century, its appearance does not seem to have been very uncommon. During the seventeenth century, however, it seems to have been scarcely observed at all, except in one instance, in 1621, when it excited the astonishment of the inhabitants of France, and first acquired the name of the aurora borealis. Since the beginning of the eighteenth century, its visits in this and other northern countries have been frequent but capricious, there being intervals of several years, during which they have been either intermitted altogether, or have been of such a nature as to attract little observation.

In the northern regions, the aurora appears with the greatest brilliancy; but it does not seem that the intenseness increases, as might be expected, in proportion to the nearness of approach to the magnetic pole. In the Shetland Islands, it cheers the winter nights almost constantly during clear weather. Its phenomena are there called the *merry dancers*, and are thus described; "They commonly appear at twilight, near the horizon, of a dun colour, approaching to yellow; sometimes continuing in that state for several hours, without any sensible motion; after which they break out into streams of stronger light, spreading into columns, and altering slowly into ten thousand different shapes, varying their colours from all the tints of yellow to the obscurest rus-

set. They often cover the whole hemisphere, and then make the most brilliant appearance. Their motions, at these times, are amazingly quick, and they astonish the spectator with the rapid change of their form. They often put on the colour of blood, and make a most dreadful appearance."*

The aurora is said, in the colder latitudes, to be attended with a peculiar hissing noise. Gmelin mentions this very distinctly and positively in the interesting account which he gives of it, as it appears in Siberia. "These northern lights," says he, "begin with single bright pillars, rising in the north, and almost at the same time in the north-east, which, gradually increasing, comprehend a large space of the heavens, rush about from place to place, with incredible velocity, and finally almost cover the whole sky, up to the zenith. The streams are then seen meeting together in the zenith, and produce an appearance as if a vast tent was expanded in the heavens, glittering with gold, rubies, and sapphires. A more beautiful spectacle cannot be painted; but, whoever should see such a northern light, for the first time, could not behold it without terror; for however fine the illumination may be, it is attended, as I have learned from the relation of many persons, with such a hissing, cracking, and rushing noise throughout the air, as if the largest fireworks were playing off. To describe what they then hear, they make use of the expression *spolochi chodjat;* that is, the raging host is passing. The hunters who pursue the white and blue foxes, in the confines of the Icy Sea, are often overtaken in their course by these northern lights. Their dogs are then so much frightened, that they will not move, but lie obstinately on the ground till the noise has passed. Commonly clear and calm weather follows this kind of northern lights. I have heard this account, not from one person only, but confirmed by the uniform testimony of many, who have spent part of several years in these very northern regions,

* Encyclopedia Britannica, article Aurora Borealis.

and inhabited different countries, from the Yenesei to the Lena; so that no doubt of its truth can remain."

In Captain Franklin's narrative of his journey to the Polar Sea, there are some scientific observations on the phenomena of the Aurora, which throw considerable light on this curious and interesting subject. The meteor is usually conceived to have its place very high above the earth; but exceedingly different elevations have been assigned to it by different philosophers. Euler supposed it to be some thousands of miles distant, others have fixed its place at a few hundred miles, and others again much lower. The diffused nature of the appearance in this country, renders it difficult to make any accurate observation on the subject; but if the Aurora should continue occasionally to assume the form of a moveable luminous arch, gliding slowly in a well defined continuous body towards the zenith, as it has lately done in several instances and in different seasons, observations taken from various stations might settle the point. Be this as it may, and however high the northern lights may actually rise in this comparatively southern latitude, it seems to be ascertained by Captain Franklin and his companions, that, in the higher latitudes of North America, and still nearer the Pole, the region of the Aurora is not many miles above the earth. They discovered, by actual observation, that, in several instances, it did not rise higher than six or seven miles; and both there and in Siberia, it would seem to be often much lower even than this. The same kind of appearances, as are described by Gmelin, above quoted, appear sometimes to occur on the other side of the Atlantic. These, however, are not frequent; and the more usual phenomena partake much of the nature of the following, which I quote from Mr Richardson's interesting observations on this meteor:—

"When the Aurora had exhibited itself in this form for a considerable space of time, the whole mass of light suddenly appeared in motion, and, sweeping round on

each side, was gathered together to the southward of the zenith. Immediately thereafter, a large portion of it was seen in the S.E., assuming an exact resemblance to a curtain suspended in a circular form in the air, and hanging perpendicularly to the earth's surface. The lower edge of this curtain was very luminous, and had a waving motion; and the illusion was farther heightened by the momentary appearance of perpendicular dark lines or breaks in the light, in rapid succession round the circle, exactly as the waving of a curtain would cause the dark shades of its folds to move along it. This beautiful curtain of light was about 40° high, and of a pale yellowish colour, and sent forth on the one side a process which approached the S.E by E. point of the horizon, and the other was connected with a long regular arch, terminating in the N.W. horizon, similarly constructed, and having the same waving motion with the curtain itself. All this time the sky was perfectly clear, except in the southern quarter, which, to the height of 4° or 5°, was occupied by dark clouds, apparently intermediate between stratus and cirro-stratus.

"Half an hour after its first appearance, this curtain-formed Aurora was resolved into a number of detached irregular portions, which sometimes increased rapidly in every direction, until they met with other masses, either before existing, or appearing at the instant, and formed an uniform sheet of light, which covered the whole sky. The formation of this great sheet of light was so rapid, that the eye could only trace its progress partially, and its dissolution and reappearance were equally sudden."*

SECOND WEEK—WEDNESDAY.

METEORIC SHOWERS.

I HAVE now to mention another celestial phenomenon of a very singular nature, connected with two days in

* Franklin's Narrative, p. 621.

the present week, which has lately attracted the attention of the scientific world. The following account of it I extract from Mrs Somerville's "Connexion of the Physical Sciences."

"On the morning of the 12th of November 1799, thousands of shooting stars, mixed with large meteors, illuminated the heavens for many hours, over the whole continent of America, from Brazil to Labrador; they extended to Greenland, and even Germany. Meteoric showers were seen off the coast of Spain, and in the Ohio country, on the morning of 13th November 1831; and during many hours on the morning of 13th November 1832, prodigious multitudes of shooting stars and meteors fell at Mocha, on the Red Sea, in the Atlantic, in Switzerland, and at many places in England. But by much the most splendid meteoric shower on record, began at 9 o'clock in the evening of 12th November 1833, and lasted till sunrise next morning.* It extended from Niagara and the northern lakes of America, to the south of Jamaica, and from 61° of longitude in the Atlantic, to 100° of longitude in Central Mexico. Shooting stars and meteors, of the apparent size of Jupiter, Venus, and even the full moon, darted in myriads toward the horizon, as if all the stars in the heavens had started from their spheres. They are described as having been as frequent as flakes of snow in a snow-storm, and to have been seen with equal brilliancy over the greater part of the continent of North America.

"Those who witnessed this grand spectacle, were surprised to see that every one of the luminous bodies, without exception, moved in lines, which converged in one point in the heavens; none of them started from that point; but their paths, when traced backwards, met in it,

* The French Academy of Sciences have taken an interest in the discussion to which this phenomenon has given rise, and it appears, from the recent communication of M. L. Ekberte, that the meteoric shower of 13th November 1832 extended even to the Mauritius, where it is said to have been seen at the same period, and with the same appearances, as in other parts of the world.—*Note to Third Edition, December*, 1837.

like rays in a focus, and the measure of their fall showed that they descended from it in nearly parallel straight lines towards the earth.

"By far the most extraordinary part of the whole phenomenon is, that this radiant point was observed to remain stationary near the star γ Leonis, for more than two hours and a half, which proved the source of the meteoric shower to be altogether independent of the earth's rotation, and its parallax showed it to be far above the atmosphere.

"As a body could not be actually at rest in that position, the group must either have been moving round the earth or the sun. Had it been moving round the earth, the course of the meteors would have been tangential to its surface, whereas they fell almost perpendicularly, so that the earth, in its annual revolution, must have met with the group. The bodies that were nearest, must have been attracted towards the earth by its gravity; and as they were estimated to move at the rate of fourteen miles in a second, they must have taken fire on entering our atmosphere, and have been consumed in their passage through it.

"As all the circumstances of the phenomenon were similar, on the same day, and during the same hours, in 1832, and as extraordinary flights of shooting stars were seen at many places, both in Europe and America, on 13th November 1834, tending also from a fixed point in the constellation Leo, it has been conjectured, with much apparent probability, that this group of bodies performs its revolution round the sun in a period of about 182 days, in an elliptical orbit, whose major axis is 119,000,000 of miles; and that its aphelion distance, where it comes in contact with the earth's atmosphere, is about 95,000,000 of miles, or nearly the same with the mean distance of the earth from the sun."*

These views correspond with those of the most celebrated living astronomers. M. Arago, from the facts mentioned concludes that "a new planetary world is about to be revealed to us;" and, at all events, there does seem to be a stream of innumerable bodies, comparatively small, but of various dimensions, moving constantly round the sun, whose orbit cuts that of our earth, at the point which it occupies, on the 12th or 13th of November every year.* For any thing that we can tell, indeed, there may be vast numbers of bodies circling round the sun, and even round the earth itself, which, on account of their minuteness and opacity escape human observation. Such a supposition serves to explain the meteoric appearances which are constantly occurring in the clear nights of winter, and which might, perhaps, be not less common in summer, were the operations in the upper regions equally visible at that season.

Falling stars would seem to be nothing else than bodies

* Mrs Somerville on the Physical Sciences, pp. 404, 405.

* The phenomenon of meteoric showers, at the above mentioned period, has continued yearly to attract the attention of astronomers down to the present time, and on the 12th November 1837 the appearance again occurred in Britain, as stated in the public papers, in the following terms:—"About eight o'clock in the evening, the attention of observers was directed to the singular and unusual phenomenon of a bright meteor, apparently proceeding from the north, which, after making a rapid descent, in the manner of a rocket, suddenly burst, and scattering its luminous particles into the most beautiful forms, vanished into the atmosphere, from which it seemed to arise. This was succeeded by others all similar to the first, both in shape and the manner of its ultimate disappearance. The whole display terminated at ten o'clock, when dark clouds, which continued up to a late hour, overspread the earth, preventing any further observation."

It may be proper to add that on the same evening a beautiful aurora borealis was seen over the whole extent of Britain, of which the following description has been given:—"About six o'clock a luminous red arch was observed to extend over the western portion of the heavens, and after passing through various gradations, in point of colour and size, disappeared. It soon after re-appeared, and was immediately recognized as a magnificent specimen of the aurora borealis, which has lately been more than ordinarily frequent in the southern regions. The colour, that of a bright crimson, presented a striking but not unpleasing contrast to the softer light of the moon, which was at that time shining in its fullest effulgence. Nothing could be more gorgeous than the scene which the heavens then presented; a clear blue sky, without a cloud, save those which bore the appearance of being spun by the finest gossamer, met the view of the spectator on the east; and in the opposite quarter of the firmament, streaks of the brightest crimson threw uncertain and flickering rays over the landscape, impressing the beholder at the same moment with feelings of the utmost awe and admiration. —*Note to Third Edition, December*, 1837.

of this description, rendered visible from being ignited by the rapidity of their passage through our atmosphere, or by some chemical cause; and meteoric stones, the fall of which is much more frequent than is commonly supposed, may be accounted for in the same way. Some of the latter are of great magnitude, exceeding, in certain instances, seventy miles in diameter. Mrs Somerville mentions one which passed within twenty-five miles of us, and was estimated to weigh about 600,000 tons, and to move with a velocity of about twenty miles in a second. This huge mass was providentially prevented from striking the earth, a detached fragment of it alone having yielded to the force of our planet's gravitation. It is remarkable, that the chemical composition of these meteoric stones, while it materially differs from that of the ordinary strata of our globe, is uniform and almost identical as regards themselves.

What part these mysterious bodies act in the system of the universe, we cannot tell,—perhaps we may never be able even to conjecture; but we may well learn from the analogy of objects with which we are acquainted, that even they are not useless appendages of our solar system; and, at all events, we are bound confidently to believe that such bodies are as much under the control of the Creator, as every other part of the creation, and can never, independent of the Divine fiat, disturb the equilibrium of our planet, or interfere with the happiness of its inhabitants. It is the delightful result of religious belief to be assured, that, however threatening may be the aspect assumed by scientific discoveries, there is not an object in nature left to the reckless sway of chance;—that all things are adjusted with unerring wisdom, managed by infinite power, and over-ruled for good with paternal care.

SECOND WEEK—THURSDAY.

VARIETY OF CLIMATES.

The difference of climates arises, as I have already observed, from the spherical figure and inclined position of the earth, which turns a single ring on its surface to the direct rays of the sun, oscillating between two defined limits, and subjects all the rest, more or less, to his oblique, and therefore less powerful, influence. The effect of this is, the production of all the varieties of heat and cold, from the fervid glow of the tropics, to the perpetual ice and snow in the regions of the poles. The adaptation of plants and animals to these diversities, forms a most curious subject of consideration, which will be afterwards examined with reference to the respective seasons; but as allusion has, in a preceding paper, been made to the advantages derived from a variety of climates, it may be useful here to pursue this subject a little further.

It has been with truth observed, that the development of the human powers depends mainly upon our wants, either natural or artificial, and these again are increased or restrained in proportion to the means of indulgence, so that the influence is reciprocal. We are naturally indolent, but stand in need of activity, for giving vigour both to our mental and physical powers. We, therefore, require a strong stimulus to exertion; and that stimulus is to be found in our wants, a circumstance which has given rise to the well-known proverb, —Necessity is the mother of invention.

Were all the productions of the earth to be spontaneous and abundant, it may well be questioned if man would ever rise above the level of the most degraded savage. This observation is strikingly sustained and illustrated by history, which informs us that a prostration of all the energies of body and mind has been uniformly

found among the native inhabitants of tropical regions, where nature is lavish of her stores, and that it is to the dwellers in countries where the necessaries of life are more scantily produced, that we are to look for a race, hardy, vigorous, and intelligent. To what extent the direct influence of an intense heat co-operates with the more indirect cause we are now considering, in producing this enervated state, it may be difficult to determine; but that it is not the only, or indeed the chief agent, cannot be doubted. While the natives of regions where plenty reigns, indulging their natural appetites without exertion and without restraint, sink deeper and deeper in indolence and effeminacy, those of less bountiful countries, finding an increased population pressing hard on the means of subsistence, are stimulated by their wants to vigorous exertion, and from sheer necessity are rendered active, ingenious, and enterprising. Among the first effects, which history describes as produced by this difference in character and circumstances, are the warlike irruptions of the hardy tribes of the north on the luxuriant inhabitants of the south, accompanied by extensive conquests, and ending in the permanent settlement of these nations in the fertile regions, of which they took forcible possession. The stimulus which was thus given to the human faculties, has frequently been permanent, and has produced extensive, and eventually important, consequences on the improvement of the species.

This, however, is mentioned only incidentally, my object at present being merely to show the salutary effect of a limited and comparatively scanty supply of the necessaries of life, arising from what may, as regards production, be considered an unfavourable climate. But this remark has its limitations; and I must not neglect to state, that cold and consequent privation, when carried to an extreme, have a depressing effect of a different kind. The natives of Greenland, and the other countries bordering on the Arctic Circle, are not less degraded in

the scale of intellect than the Negro race in the torrid wilds of Africa. It is in the regions within the Temperate Zone that the mind of man, along with his bodily powers, seems most freely and vigorously to expand. He is here situated in regions not only peculiarly suited to his bodily constitution, but to the development of his moral and intellectual faculties. The variety of climate, alternating between moderate heat and mitigated cold, while it requires attention to the comforts of clothing and habitation in their adaptation to the changes of the seasons, and thus exercises his ingenuity, presses still more powerfully on the resources of his mind, by the cessation, during a considerable part of the year, of that supply of the necessaries of existence, which, at another season, is afforded in comparative abundance. Under the influence of these circumstances, man becomes, by a kind of moral and physical necessity, a *storing* animal, and habits of forethought, thus engendered, are strengthened and increased by exercise, till the mercantile spirit is produced.

The same tendency is encouraged by the diversified productions of different soils, of changing seasons, of various elevations from the mountain to the valley, of adjoining islands and continents, and even of more distant regions. Placed in the middle, between the two extremes of climate, the productions of the north and of the south are equally within reach of the inhabitant of the temperate zones; and experience soon teaches him the enjoyment and comfort of accumulating from both quarters. The neighbourhood of seas, lakes, and rivers, contributes much to the fostering of this spirit, by affording facilities of intercourse which could not otherwise be obtained; and, accordingly, we find that the early efforts of commercial enterprise have been chiefly confined to such localities, or, at least, have derived their origin or their stimulus from them. It is true, that the first traders of whom we read, were among the descendants of Ishmael, a wandering and active inland tribe; but it

was to the maritime land of Egypt that they were directing their course for conducting their petty traffic. The rise of the mercantile spirit in Egypt is easily accounted for, on the principles to which we have adverted. Situated on the banks of the Nile, a navigable river, with the Red Sea towards the south, and the broad Mediterranean towards the north, it is no wonder that the Egyptians should have been among the earliest and most successful merchants of ancient times. A similar remark may apply to Tyre, Sidon, and Carthage, where the mercantile spirit also prevailed. And, indeed, it is impossible not to regard the subsequent civilization of European nations, surrounded as they are by facilities for navigation, and situated in a climate possessing all the properties we have described, as the natural, or rather providential, result of the same principles.

SECOND WEEK—FRIDAY.

PRACTICAL EFFECT OF THE COMMERCIAL SPIRIT PRODUCED BY A VARIETY OF CLIMATES.

It would be very interesting to trace the progress of a mercantile spirit, arising from the wants of one climate, and the superabundance of another; but this is a speculation which I cannot at present stop to pursue in its various bearings; and I must confine myself to a rapid view of the practical effects actually produced by it in European countries, and especially in our own.

The desire to possess, when once thoroughly awakened, becomes insatiable; and this, again, gives a proportionate stimulus to the spirit of enterprise, which induces the traveller to urge his discoveries, and the trader to compass sea and land in the transport of produce from country to country; while the artificer, the manufacturer, and the agriculturist, each in his own department, exert

their industry, skill, and ingenuity, in turning to account the knowledge and the materials which thus flow in upon them. It is because neither the climate nor the soil of any one country is naturally suited to the production of all the luxuries and conveniences which man covets, and because, even where these objects of desire might be produced by human industry, they are not naturally to be found, that the intercourse between distant countries takes place, on which so much of the civilization of the world depends. The ingenuity of man being thus stimulated, produces the most surprising changes, and promotes, in an astonishing degree, the means of human subsistence and enjoyment. It is not merely that the varied riches of other lands are imported, but that an essential alteration is effected in the actual produce of the soil.

It is a remarkable fact, noticed by Mr Whewell, that where man is an active cultivator, he scarcely ever bestows much of his care on those vegetables which the land would produce in a state of nature. He improves the soil, he even improves the climate, by his skilful labours, and he thus renders both fit for sustaining and nourishing more useful plants. He, therefore, does not generally select some of the natural productions, and improve them by careful culture, but, for the most part, he expels the native possessors of the land, and introduces colonies of strangers. This remark he proceeds to exemplify in the condition of our own part of the globe.

"Scarcely one of the plants," he says, "which occupy our fields and gardens, is indigenous to the country. The walnut and the peach come to us from Persia; the apricot from Armenia. From Asia Minor and Syria, we have the cherry-tree, the fig, the pear, the pomegranate, the olive, the plum, and the mulberry. The vine which is now cultivated, is not a native of Europe; it is found wild on the shores of the Caspian, in Armenia, and Caramania. The most useful species of plants, the *cereal* vegetables, are certainly strangers, though their birth-

place seems to be an impenetrable secret. Some have fancied that barley is found wild on the banks of the Semara, in Tartary; rye in Crete; wheat at Baschkiros, in Asia; but this is held by the best botanists to be very doubtful. The potato, which has been so widely diffused over the world, in modern times, and has added so much to the resources of life in many countries, has been found equally difficult to trace back to its wild condition."*

"In our own country," Mr Whewell goes on to observe, "a higher state of the arts of life is marked by a more ready and extensive adoption of foreign productions. Our fields are covered with herbs from Holland, and roots from Germany; with Flemish farming, and Swedish turnips; our hills with forests of the firs of Norway. The chesnut and the poplar of the south of Europe adorn our lawns, and below them flourish shrubs and flowers, from every clime, in profusion. In the meantime, Arabia improves our horses, China our pigs, North America our poultry, Spain our sheep, and almost every country sends its dog. The products which are ingredients in our luxuries, and which we cannot naturalize at home, we raise in our colonies; the cotton, coffee, and sugar of the East, are thus transplanted to the farthest West; and man lives in the middle of a rich and varied abundance, which depends on the facility with which plants and animals, and modes of culture can be transferred into lands far removed from those in which nature had placed them. And this plenty and variety of material comforts is the companion and the mark of advantages and improvements in social life, of progress in art and science, of activity of thought, of energy of purpose, and of ascendancy of character."

This splendid display of the effects of commercial and agricultural intercourse, which might easily be enlarged,

* Whewell's Bridgewater Treatise, p. 71.—He observes in a note, that it appears now to be ascertained that the edible potato is found wild in the neighbourhood of Valparaiso.

depending, as that intercourse mainly does, on the influence, direct and indirect, of varieties of climate on the surface of the earth, serves to show a wise and beneficent intention in so unequal a distribution of temperature, and brings us back to the conclusion, that whatever partial inconveniences may accompany such arrangement, these are vastly counterbalanced by the advantages of which it is productive. If it be true, as it undoubtedly is, that much of the activity, ingenuity, and intelligence, which exist in the world, had their first development in the circumstances attending the differences in question; and if the very wants and privations of a less genial climate have eventually, not merely, improved the intellectual character of men, but bound them together by new and intimate ties, from the equator to the vicinity of the poles, how can we avoid the inference, that such extensive and important results were contemplated and provided for by the Divine Mind, in establishing the relations between the natural and moral worlds?

SECOND WEEK—SATURDAY.

ADAPTATION OF ORGANIZED EXISTENCES TO SEASONS AND CLIMATES.

THE adaptation of plants and animals to the changes of the seasons, which, taken even in the broad and general view, is so clear an indication of an intelligent Designing Cause, is no where more conspicuous than in the season of winter. Were but a strong and continuous blast of the breath of winter to pass over our forests, fields, and gardens, in any of those months when vegetation is in its glory, and when animated nature luxuriates in universal plenty, the effect would be most disastrous. All organized existences would feel the fatal shock. Leaves, and fruits, and flowers, would shrink, wither, and decay; insects on the wing would fall life-

less to the earth; the various species of caterpillars would drop stiff and dying from the frozen vegetables on which they fed; even the larger animals would be stricken with the general blight; birds and beasts, if they did not instantly perish, would droop and shiver; and man himself, adapted as his constitution is to sustain the rigours of all climates, would find himself invaded by deadly diseases. Nor would the evil end here. Not only would individuals die, but whole species would become extinct. The seeds, and eggs, and larvæ, which propagate the various races of plants and insects, would be unproduced. The progress of reproduction would be arrested at its source; and, were the untimely blast to be universal, various links would be broken for ever in the chain of existence.

This consideration brings us, at once, to a clear perception of the kind of adaptation to which I allude. It is evident that some peculiar provision has been made, in temperate climates, for the preservation of organized existences during winter. In that season they are not in the same condition as in other seasons of the year. It is not merely that the change from heat to cold has been gradual. It is true that the hurtful effects of a violent alteration of temperature are thus avoided; and this is something which ought not to be overlooked in the wise provisions of the Author of Nature. But much more than this was necessary; and, as we shall afterwards have ample means of observing, has actually been effected. It was requisite, for the preservation both of plants and animals, that, during winter, their habits and functions should be altered, or even suspended, and that peculiar contrivances should be resorted to for protecting them from the rigours of the season.

But there is another consideration which must not be overlooked. Not only are their peculiar provisions for preserving animal and vegetable life, in our temperate climates, during the cold of winter, but the whole classes of organized beings which exist in any climate, are

adapted to all the ordinary changes of their peculiar locality; so that the fact I have mentioned, is only a single instance of a principle of adaptation which runs through the whole system. The tropical plants, for example, are peculiarly formed, for the express purpose of living and flourishing under vertical suns, long droughts, and periodical rains; the vegetable productions of the polar regions, on the other hand, have been remarkably contrived for resisting the chilly influences occasioned by the long absence of the sun, and for starting suddenly into life, and running their short but rapid race, during the few weeks which comprise their spring, summer, and autumn. And so it is also with our temperate climates. It is not in winter, alone, that an adaptation to the season is conspicuous, but throughout every month of the year. Every parallel of latitude has it peculiarities of weather,—its longer or shorter duration of mildness and of rigour,—of rain and of drought,—of light and of darkness; and to all these varieties, the plants indigenous to the soil are adapted.

But, what is more, under the very same parallel, there are localities which differ materially from the general average of the climate, on account of the elevation of mountain ranges, or other accidental circumstances. Here, again, we find very striking indications of the provident care we have noticed. By whatever mysterious means the distribution has been made, there we find productions suited to the situation. Some extraordinary instances of this have been noticed on the Himalaya mountains, on the Andes, on the Peak of Teneriffe, and, indeed, in all the quarters of the globe where lofty mountain ranges are to be found. Humboldt has shown that there is upon the earth a geographical distribution of plants, according to its various climates, which he distinguishes into so many zones of vegetation, from the pole to the equator. In the Island of Teneriffe, he observed that its various heights, which, as in all mountains are colder as the elevation increases, exhibited differences of

plants, corresponding with the temperature; and he divided the various heights into five zones, each clearly marked by their respective vegetations. It has been a matter of curious investigation among philosophers, by what means the earth was at first supplied with productions suited to its respective climates and peculiarities; and it has been ingeniously attempted to be shown, that a single mountain, of sufficient elevation, placed in a favourable situation, and furnished, by the Creative Power, with the various vegetable productions which its different altitudes and consequent varieties of temperature required, might suffice, in the course of ages, for the dissemination of these productions over the whole face of the globe, according as its various localities might be adapted to receive them. Such an inquiry, however, is more curious than useful. It is enough for us to perceive the designing hand of a wise Creator in the adaptation of the vegetable creation to the very diversified circumstances of soil and climate, as it is found actually to exist in the different countries and regions of the world.

I shall only add, at present, that what has just been said of the vegetable, is equally applicable to the animal kingdom, as will be seen when we enter into the particulars to which these preliminary remarks refer.

THIRD WEEK—SUNDAY.

THE OMNIPRESENCE OF GOD.

THE doctrine of an Eternal Self-existent Being, involves in its very idea, that He is every where present throughout His immeasurable creation, and that, if there be any region of infinite space where He has not exerted His creative power, He is there also; and this doctrine receives a more distinct and definite character, from the discoveries of astronomy. The idea of infinity, indeed, is too vast to be fully comprehended, as any one will be forced to confess who makes the attempt. We can conceive an immense extent, but it is an extent circumscribed by some boundary, however distant; and, if we only attend to what passes in our own minds, when we endeavour to extend our conceptions so as to arrive at the idea of infinite space, we shall find that we do this by figuring to ourselves, first, one immense extent, and then, beyond that, another, and another still, in a constant and indefinite series. This shows the limited nature of our mental powers, which cannot form conceptions, but by the aid of things that are the object of the senses; and it serves at the same time, to exhibit the importance of astronomical studies, in assisting the mind to form a more exalted view of the Divine attributes. Even though deprived of the discoveries of astronomy, indeed, we could still speak of infinity; but our conceptions of that divine attribute would necessarily be far less vivid and definite. It is by the help of this most interesting and astonishing science, that we raise our comprehension from the contracted bounds of our own planet, to the vast extent of the planetary system with which we are connected, and thence to the amazing distances of the fixed stars, and thence again to those little spaces in the heavens called nebulæ, full of thousands and tens of thousands of worlds, in new systems,

at distances beyond the power of numbers to compute. Thus, step by step, we extend our views; and, although long before we have reached the nearest star, we find our mental powers begin to flag, and, in tracing these discoveries to their farthest limit, are forced to confess that even imagination is bewildered and lost, yet in such an exercise we certainly do gain much to aid our conceptions of unbounded space.

The practical conclusion to which we come is, that, if nature be so unspeakably and inconceivably immense, the God of Nature must be absolutely infinite; and although, after all, we can form no distinct idea of this attribute, we comprehend enough to affect the mind with highly exalted and salutary impressions.

Infinity implies omnipresence. The Almighty is an infinitely extended Mind. Wherever He exists, He is conscious. His knowledge is, therefore, as infinite as His existence. The universe lies open to his inspection. The earth, with all its productions, animate and inanimate,—the rocks and minerals in its bowels,—the plants, so varied in their form and qualities, from the microscopic parasite to the mighty oak of the forest, which are spread profusely over its surface,—the insects, the reptiles, the birds and beasts with which it teems,—and man, the lord of them all, every one of them, individually, is continually in His view. He pervades every atom of matter, and surveys every movement of the living principle, and of the mental powers, with which He has respectively endowed the various orders of organic beings. Let this view be extended to other worlds. Whatever exists, either of matter, of vegetable and animal life, or of rational powers, in the sun and in the planets, and, beyond their wide orbit, in the suns, and systems, and interminable groups of suns and systems of which the universe is composed, is penetrated, beheld, recognized, and individually distinguished, by the All-pervading Mind.

How beautifully and feelingly does the Psalmist express the sentiment to which this view of the Divine Being gives rise in the devout heart:—"Whither shall I go from thy Spirit? or whither shall I flee from thy presence? If I ascend up into heaven, thou art there; if I make my bed in hell, behold thou art there. If I take the wings of the morning, and dwell in the uttermost parts of the sea, even there shall thy hand lead me, and thy right hand shall hold me. If I say, surely the darkness shall cover me; even the night shall be light about me." This sense of the Divine presence, if deeply and habitually cherished, must produce a salutary effect on the character. When we know and feel that the eye of the holy God is upon us, our mind is struck with solemn awe; and should unhallowed thoughts intrude, we are sensible that they are unworthy of the presence in which we stand, and inconsistent with those aspirations after the Divine favour, which our relation to him inspires. Should the temptation become, notwithstanding, so strong as to incline us to some action of moral turpitude, the half-formed design is checked, by the conviction, that the All-seeing eye is upon us, and with just indignation we cast the thought away from us, inwardly exclaiming, "How can I do this great wickedness, and sin against God."

This salutary effect of a belief in the Divine omnipresence, is but too seldom realized in actual practice. It is held, almost universally, as a speculative doctrine; but how few really adopt it as a rule of life. Melancholy experience assures us, that the heart does not often receive very deep impressions from abstract views, and is not easily awakened and animated by the speculations of the closet. It will be our wisdom to make use of the various means, which Providence has bestowed on us, for counteracting this unhappy propensity to separate speculation from practice; and among these there is none so effectual as frequent and fervent prayer. An apostle exhorts us to "pray without ceasing;" by which he doubtless means, not that we should be constantly on

our knees, but that we should cultivate a continual sense of the presence of our heavenly Father in the ordinary affairs of life,—and begin, carry on, and end every thing, by casting ourselves on His protection and blessing. By this prayerful spirit, we shall learn to see God in every thing. If we walk abroad, whether in the full blaze of day, or when, through the curtain of night, we behold the hosts of heaven shining in their brightness, we shall turn our thoughts to that Eternal Being who clothed the earth in beauty, and "ever busy, wheels the rolling spheres." If we retire to the bosom of our families, and in the kind attentions and soothing endearments of domestic life, feel our hearts overflowing with a tender delight, we shall not fail to remember from whose hand we derived the blessing, and to whose paternal care we are indebted for its continuance. If, in the duties of active life, we find our labours of love crowned with success, and our bosom expand with the glow of gratified benevolence, we shall not forget that it is the hand of our unseen Father which has directed and blessed our efforts; and a Father's smile which cheers and elevates our soul. And when the rod of affliction is upon us,—when the loss of worldly possessions oppresses our spirits, or a more cruel calamity has visited us, in the death of some beloved relative or friend; or when we ourselves are stretched upon our death-bed, with our weeping family around us, even then the consolations of religion will lend their balm; and casting our care on Him who careth for us, and finding refuge in the Rock of Ages, we shall learn to bless the hand which inflicts the wound.

THIRD WEEK—MONDAY.

ADAPTATION OF ORGANIZED EXISTENCES TO THE TROPICAL REGIONS.

Almost every country has its winter, as well as the other seasons of the year, differing materially, however,

in different parts, and influenced not merely by its position in respect of latitude, but by various other circumstances which affect the climate generally,—such as elevation above the level of the sea, the neighbourhood of mountains, of forests, or of the ocean, the prevalence of periodical or constant winds, and other topical causes. Now, the observation which applies to climate, taken on the average, applies with equal truth to this uninviting season, namely, that there is, even during its rigours, a remarkable adaptation of the weather to the condition of animal and vegetable life; and, on the other hand, of animal and vegetable life to the weather. The temperature is admirably modified, and the various meteorological changes are wisely regulated, so as to correspond with the other seasons, and to be suited to the kind of organized existences which are to be found within the range of these natural operations; or, what comes to the same thing, these organized existences have been so framed, as to correspond in their nature and habits with the qualities of the weather.

In tropical climates, there can scarcely be said to be any winter, in the sense in which that word is understood, with reference to the other divisions of the earth; yet, even here, there is a period which possesses some of its distinctive characteristics. Under the equator, indeed, and in the adjoining regions, there may be said to be, in respect of temperature, two winters in the year,—the one, when the sun visits the tropic of Capricorn; and the other, when he looks down on our temperate climes with the smiles of summer, from the tropic of Cancer. Within the vast zone, bounded by the tropics, the climate is peculiar, not only on account of the extreme heat, but on account of the trade-winds, the monsoons, and periodical droughts by which it is distinguished. These phenomena, which are very various in their periods and extent, being much affected by the particular circumstances of their geographical position, wonderfully harmonize during the various seasons of the year, so as to render them,

in each region, speaking generally, conducive to the salubrity of the climate; and the plants and animals which exist in these regions, are, at the same time, with surprising nicety, adapted to their respective peculiarities. This, would our space admit, might be interestingly exemplified by a detail of particulars; but, at present, I must be content to state, in general, that there are contrivances and adaptations which secure both plants and animals from the hurtful effects of the changes of temperature, of moisture, of violent and incessant rain, and of the direct rays of the sun,—so striking and obvious, as to challenge attention from the most careless observer. In this fervid climate, the soil requires no lengthened rest to recruit its powers; nor do its vegetable products need to sleep for months in the bud or in the root. Under a long drought, indeed, they languish and decay; and this may, in fact, be considered as their period of winter, although it does not correspond with ours as regards the season of the year, or various other particulars; but no sooner does the equinoctial monsoon or the solstitial rain pour its refreshing streams on the surface of the parched earth, than all nature revives. Mr Elphinstone, in his account of Cabul, after graphically describing the appearances at the commencement of the monsoon in India, consisting of an incessant pouring of rain, amidst constant peals of thunder, and the most vivid flashes of lightning, attended with violent blasts of wind, proceeds to say,—"This lasts for some days, after which the sky clears, and discovers the face of nature changed as by enchantment. Before the storm, the fields were parched up; and, except in the beds of the rivers, scarce a blade of vegetation was to be seen; the clearness of the sky was not interrupted by a single cloud, but the atmosphere was loaded with dust, which was sufficient to render distant objects dim as in a mist, and to make the sun appear dull and discoloured till he attained a considerable elevation; a parching wind blew like a blast from a furnace, and heated wood, iron, and

every solid material, even in the shade; and immediately before the monsoon, this wind had been succeeded by still more sultry calms. But when the first violence of the storm is over, the whole earth is covered with a sudden but luxuriant verdure; the rivers are full and tranquil; the air is pure and delicious; the sky is varied, and embellished with clouds."

This change, from what may be termed a tropical winter, though arising from an excess of heat instead of cold, to all the beauty and luxuriance of spring, proves, without any detail, that a constitution has been given to tropical plants, adapted to their situation and circumstances, and sufficiently marks the peculiar wisdom of the arrangement as regards the vegetable kingdom. Let it be remarked, too, that the monsoon takes place precisely at the very time when, but for this change, the heat would have become excessive and intolerable. It occurs at the period when the sun is approaching his zenith in that parallel, and would have darted his vertical rays on the earth with unmitigated fierceness, were not a providential hand to interpose a veil of clouds, and cause them to pour forth their refreshing stores. This change is not the less admirable, that it is produced by the operation of known and uniform laws; and, assuredly, the wise adjustment and balancing of the great mechanical powers of nature is no unequivocal proof of Divine agency.

On turning to the animal productions within the tropics, we discover similar marks of beneficent design in the adaptation of their natures to the circumstances of the climate. M. Lacordaire,* as quoted by Mr Kirby, gives a striking account of the state of animated nature in Brazil. The great rains begin to fall in that country about the middle of September, when all nature seems to awake from its periodical repose; vegetation resumes a more lively tint; the greater part of plants renew their leaves; and the insects begin to appear. In October the rains are rather more frequent, and with them the in-

* Annales des Sciences Naturelles, 20 Juin 1830, p. 193.

sects; but it is not till towards the middle of November, when the rainy season is definitely set in, that all the families seem suddenly to develope themselves; and this general impulse, which all nature seems to receive, continues augmenting till the middle of January, when it attains its acmè. The forests present, then, an aspect of movement and life, of which our woods in Europe can give no idea. During part of the day we hear a vast and uninterrupted hum, in which the deafening cry of the treehopper prevails, and you cannot take a step, or touch a leaf, without putting insects to flight. At eleven in the forenoon, the heat has become almost insupportable, and all animated nature becomes torpid; the noise diminishes; the insects and other animals disappear, and are seen no more till the evening. Then, when the atmosphere is again cool, to the morning species succeed others, whose office it is to embellish the nights of the torrid zone. I am speaking of the glow-worms and fireflies; whilst the former, issuing by myriads from their retreats, overspread the plants and shrubs,—the latter, crossing each other in all directions, weave in the air, as it were, a luminous web, the light of which they diminish or augment at pleasure. This brilliant illumination only ceases when the night gives place to the day.*

These observations as to the effects of climate within the tropics, harmonizing as they do with what occurs in other regions of the earth, tend to show what surprising attention has been paid by the great Creator, in the adaptation of organized existences, both vegetable and animal, and more especially the latter, with its instincts and habits, to their geographical position, and what skill has been employed in diffusing life and enjoyment throughout the world. Facts of a similar kind will meet us every where in the course of our inquiry.

* Kirby's Bridgewater Treatise, vol. ii. pp. 250, 251.

THIRD WEEK—TUESDAY.

ADAPTATION OF ORGANIZED EXISTENCES TO TEMPERATE AND POLAR CLIMATES.

Our attention was yesterday directed to those beneficent arrangements by which organized existences, within the tropics, are adapted to their geographical position. The same observation may be extended to all the other regions of the earth, and the further the subject is investigated, the more shall we find reason to admire and adore the Divine wisdom, so variously, and every where so beneficently displayed.

Among a vast profusion of instances which might be selected, I will take the history of the camel, which recommends itself to our notice at present, as being peculiarly appropriate, in our descent to climates of a lower temperature, because the range of this animal is extended from the tropical into the temperate regions; and, because, within that range, its conformation and habits are curiously and exclusively suited to a peculiar locality. The camel, including, of course, the dromedary, which is only a variety of the species, is an animal distinctly formed by the Author of Nature, to subsist, and to contribute to the comfort of man, in the parched and sandy wildernesses, which, in the vast regions of the East, stretch from the tropics far into the temperate zone. A description, abridged from Goldsmith, may suffice for our purpose.

The camel is the most temperate of all animals, and it can continue to travel for several days without drinking. In those vast deserts, where the earth is very dry and sandy; where there are neither birds nor beasts, neither insects nor vegetables; where nothing is to be seen but hills of sand, and heaps of stones; there the camel travels, posting forward, without requiring either drink or pasture, and is often found six or seven days without any

sustenance whatever. Its feet are formed for travelling on sand, and are utterly unfit for moist or marshy places.

In Arabia, and those countries where the camel is turned to useful purposes, it is considered as a sacred animal, without whose help the natives could neither subsist, traffic, nor travel. Its milk makes a part of their nourishment; they feed upon its flesh, particularly when young; they clothe themselves with its hair; and, if they fear an invading enemy, their camels serve them in flight; and, in a single day, they are known to travel a hundred miles. Thus, by means of the camel, an Arabian finds safety in his deserts. All the armies on earth might be lost in pursuit of a flying squadron of this country, mounted on their camels, and taking refuge in solitudes, where nothing interposes to stop their flight, or to force them to await the invader. There are here and there, in the dreary wastes inhabited by the Arabian, found spots of verdure which, though remote from each other, are, in a manner, approximated by the labour and industry of the camel. Thus the Arab lives independent and tranquil amidst his solitudes; and, instead of considering the vast wilds spread around him as a restraint upon his happiness, he is, by experience, taught to regard them as the ramparts of his freedom. Who does not admire in this remarkable instance, the beneficent intentions of Providence, in the structure and habits of an animal so exclusively adapted to regions of heat, sterility, and drought?

In the temperate regions, similar adaptations to the season of scarcity are familiar to the student of nature; but, as it is in this zone of moderate climate that we dwell, and from it, therefore, that our illustrations will, in the following pages, be chiefly taken, I shall pass to its extreme verge, towards the polar circles, where the countries, although they still bear the geographical title of temperate, have ceased, in reality, to deserve it, and are rapidly tending to an extreme, in which organized beings are no longer to be found. The Laplander, the Greenlander, the inhabitants of Nova Zembla and Labrador, although, in winter, they suffer many privations, greater than are experienced in our more favoured climate, are yet furnished with many alleviations, which prove that their comfort and enjoyments have not been forgotten by Him who appointed the bounds of their habitation.

Some inhabitants of these severe regions have received from a bountiful Providence the gift of the rein-deer, which is not less adapted to their wants than the camel is to those of the Arab. It furnishes them with the means of rapid and easy conveyance from place to place; while its skin supplies them with clothing for their bodies, and covering for their tents, its flesh is their necessary food, and its milk their delicious drink. Their long winter night, for it is one uninterrupted night during several months, is cheered by a bright twilight, and the brilliant and busy coruscations of that wonderful meteor, the aurora borealis; and, when they retire to their humble dwellings, they find at once light and heat in the blaze of the oil abundantly extracted from the fish which their industry has drawn from the neighbouring seas.

In Greenland, and the countries bordering on Baffin's Bay, where the rein-deer is but seldom, if at all, domesticated, the inhabitants have other means of supplying, though less comfortably, the necessaries of life which this useful animal provides to the northern inhabitants, of Europe. They build their winter huts of *snow*, within which they light their fires, without danger of its melting, so long as the intensity of the cold prevails; and, within these apparently miserable habitations, they experience more enjoyment than the natives of genial climes can easily conceive possible. The frost preserves from corruption the animal food they have stored; and, so long as their provisions remain, they seem to have no great care for the future. Having few wants, and little forethought, they spend, from day to day, a contented, though a degraded life; and the goodness of the great Creator towards them, appears in this, that if their cir-

cumstances preclude them from the enjoyment of many luxuries, or even conveniences, they are happily insensible of the privation; and, if they are destitute of high intellectual pleasures, they are at least not subjected to the miseries arising from that acute sensibility, with which the cultivation of the mental powers is frequently attended.

Were we to inquire into the condition and habits of the lower animals which inhabit these frozen regions, we should be struck with similar wise adaptations. Of the thick and shaggy fur which covers their bodies, so admirably adapted both to preserve the animal heat, and exclude the external cold, increasing in warmth with the increasing rigour of the season; of the instinct which induces some to migrate to more genial regions, and others to retire to caves and burrows, where they spend the long and dreary winter months in a state of insensibility, or of partial lethargy; and of other matters connected with the season of winter in that inhospitable climate, which afford, even in apparently neglected corners of the world, unequivocal proofs of beneficent design, we shall afterwards have occasion to speak. Meanwhile, this slight sketch seems sufficient to show, that, in every climate, even the dreariest season of the year has its uses, its adaptations, and its enjoyments.

THIRD WEEK—WEDNESDAY.

THE BALANCE PRESERVED IN THE ANIMAL AND VEGETABLE CREATION.

EVERY naturalist must have observed, that there is a tendency in the reproductive powers bestowed by the Creator, to overstock the world, so that, if any one species of animals were permitted to produce its kind without check, the whole earth would, in process of time, be entirely over-run by that species alone, to such an extent, that, by-and-by, there would not be room for the

vegetable to spread, or the animal to move. Among living creatures, a remarkable example of this power may be taken from the rabbit. This animal breeds seven times in a year, and produces from four to eight young at a time. On the supposition, therefore, that this happens regularly, at the end of four years, a couple of rabbits would have peopled the land with a progeny of nearly a million and a half. The common grass is an example of a similar kind among vegetables, a single plant of which would, in a very few years, under favourable circumstances, clothe a whole island such as ours. These are extreme cases; but, if any person would take the trouble of estimating the productive powers of any one kind of plant or animal, even the least remarkable for fecundity, he would soon satisfy himself, that the fact is not overstated.

This excessive power of reproduction, as in one sense it may be called, seems to be a necessary part of the wise economy of Nature; because it always enables organized existences to propagate their species, up to the extent in which provision is made for their subsistence; but then it would have occasioned the most injurious consequences, were not checks provided, by which each kind might be kept within its proper bounds. These checks are numerous and effectual. The most remarkable of them, among the living tribes, is the existence of predacious animals. One creature preys upon another, and thus provision is made, by a remarkable contrivance, which, at first sight, appears cruel, for the existence of more numerous species, and for the more easy death of individuals, which would otherwise so press upon the means of subsistence, as to drag out a lingering and miserable life, till they perish by famine; while another instance of providential care in this provision is, that dead bodies are consumed and removed, which would otherwise infest the air with noisome and pestilential effluvia, in the process of decomposition.

But what has led me at present to advert to this sub-

ject, is the effect which winter also produces in checking an over production of organized beings. To what extent its severity, and the scanty subsistence it affords, are destructive of animal and vegetable life, I shall not attempt to estimate; but that it is considerable, cannot be denied. Notwithstanding the various and astonishing means made use of by a wise Creator, for the preservation of organized beings during the inclemency of winter, it is certainly true, that this season does not pass without a great expense of life. Violent storms, severe frosts, sudden inundations, deep snows, scarcity of food, the tracks of animals in the new-fallen snow, which guide the hunter to their lair,—all these are so many means of destruction to numerous individuals of various tribes of animals, and some of them means of destruction to different kinds of vegetables also.

Now, that the checks we have mentioned, combined with others, are most wisely adapted for promoting the benevolent intentions of Providence, in preserving a due balance in Nature, may be inferred from various considerations. Of these, I shall mention one, which is sufficiently striking. Man has frequently attempted, for his own purposes, to interfere with the balance which Providence has thus established, often wisely and successfully, the higher species being destined to supplant the lower; but when injudiciously, not with impunity. The following examples of the latter, which I extract from a note in Mr Sharon Turner's History of the Creation, may suffice as an illustration. "Farmers destroy moles, because the hillocks they make break the level surface; but they have found worms increase so much, when the moles were gone, as to wish they had not molested them. Moles live on worms, insects, snails, frogs, and larvæ. The farmers on a nobleman's estate in France, found the moles' disturbances of the earth such a good husbandry to it, as to solicit their landlords not to have them killed.—(*Bull, Un.*, 1829, p. 334.) So toads are found to keep down the ants. Mice have increased in

barns where owls have been shot. The blue jay was destroyed in America for eating the pease; but the pea-grub, which it fed on, became more destructive afterwards. A gentleman shot a magpie, to save his cherries, but found its craw as full as it could be crammed with the large blue-bottle flies, that lay their eggs in meat. The fox renders considerable service to man, by the quantity of rats, field-mice, frogs, toads, lizards, and snakes, which he destroys."*

These are instances of the kind of balance which is preserved in the animal world, by means of predacious animals, and prove that, by removing one cause of annoyance, we may sometimes only give room to another of a more grievous nature; and that we ought, therefore, to be cautious how we do violence to Nature. There can be no doubt, however, that the judicious interference of man was taken into account in the establishment of the order of Nature; and that his employing his rational powers for this purpose, is one of the exercises by which Providence intended to call forth his ingenuity, and reward his industry. It is not merely as a curse, that, in the field of the sluggard, "thistles grow instead of wheat, and cockle instead of barley;"—it is also as a warning against sloth, and as a stimulus to exertion. So it is with regard to industrious, intelligent, and virtuous habits of every kind; and, with reference to the agriculturalist, while the neglect of such habits is punished by an accumulation of noxious weeds and vermin, and a deficiency of useful produce, the very reverse is the case when these habits are cultivated;—and, *mutatis mutandis*, the same observation may be made in relation to every other profession.

Of the salutary effect of a judicious use of the power which Providence has entrusted us with, of extirpating noxious animals, we have a remarkable instance in the total extinction of the wolf from Great Britain, chiefly through the energetic measures adopted by two of our

* Turner, note, p. 350, quoting from Howit's Brit. Preserv.

kings, Edgar I. and Edward I. The importance which we ought to attach to the removal of this nuisance, will be better estimated on reading the official account which was given in the public papers, of the devastations committed by wolves, in the year 1823, in the province of Livonia alone. They are stated to have devoured 1841 horses, 1243 foals, 1807 horned cattle, 733 calves, 15,182 sheep, 726 lambs, 2545 goats, 183 kids, 4190 swine, 312 sucking pigs, 703 dogs, 673 geese.

This destruction is remarkable, and it is only a single example of the immense extent of the power by which the excess of the reproductive principle is restrained, in all the various races of living beings, from the microscopic insect to the huge elephant. The proof thus afforded of the wisdom of the great Creator, is conspicuous and pre-eminent; the balance of Nature is preserved; one species, taken on the average, does not unduly encroach upon another; a greater quantity of living beings have the means of being nourished, and are therefore produced; and the good of the whole is most strikingly consulted.

One condition, which the due balance of the reproductive powers involves, is, that the most useful species shall be able not only to maintain their ground, but to preponderate over all the rest. This is instanced in the case of vegetables, in the prolific power already noticed, as bestowed upon the common grasses on which so many animals, and especially those destined for the use of man, are formed to feed. It is in virtue of this quality, with which man, for his own purposes, finds it necessary frequently to war, that the soft green carpet is so universally spread over hill and valley, on which our herds and flocks graze so luxuriously by day, and repose so comfortably by night. But then, it was the wise intention of Providence, that this mastery, gained by the prolific power, should not be of such extent as to annihilate any of the species of plants formed by His creative wisdom. There are, therefore, most surprising and ingenious contrivances, by which this power is so far counteracted as

to serve the end in view. These will fall more properly to be considered in another season, and it is enough at present merely to advert to them.

In saying, however, that the most useful vegetable productions are usually the most prolific, I must not forget to make an exception, which embraces a great variety of those plants that are cultivated by the farmer and the gardener, for the use of man. All the cereal, leguminous, potato, and cabbage tribes are of this kind, and seem to be intended, along with many other means in the economy of Providence, to verify the sentence so early pronounced on our fallen race, that in the sweat of their brow they must eat bread. It is, indeed, in this view, a most remarkable provision, that while the means of subsistence are so amply provided for the lower animals, man is left to procure his food by the exercise of his own mental and bodily powers, in the labours of cultivation; and, for this purpose, finds it necessary to counteract the natural tendencies of vegetation, as well as to control the habits, and subdue the propensities of the brute creation.

Among animals, the balance which we have been considering is kept up in a way different from that which takes place in the vegetable kingdom, though in some respects analogous to it. Here, too, the powers of reproduction are with obvious design unequally distributed, being most copiously bestowed on those species which are either most useful to man, or most harmless in their own nature, or least capable of defending themselves. Were not this the case, animals of prey, whose species are numerous, and are to be found in all the classes of animated nature, from the lowest to the highest, would soon destroy the more helpless kinds, and reduce the various orders of beings to a few of nearly equal strength and prowess in the various genera. Among beasts, the lion and tiger, for example, would desolate the tropical regions; the wolf would reign paramount in the temperate zone; and the arctic bear would over-run the re-

gions bordering on the poles, till nothing would be left for them to devour but creatures of their own species. Among birds, the eagle, the vulture, and the condor, would each assert the terrible powers of its nature, till the other feathered tribes, in their respective localities, had been exterminated; and as to fishes, the enormous whale,* and the rapacious shark, each of which devour the inferior tribes by hundreds at a mouthful, would quickly divide the desolated ocean between them.

The very fact, therefore, that, notwithstanding the existence of such formidable enemies, the other tribes of animated beings not only survive but abound, is a proof that the Author of Nature has provided sufficient checks to their power and rapacity. Of quadrupeds alone, from 800 to 1000 species are known to exist; and, as we descend in the scale to the lower genera, their species proportionally increase, till among the insect and microscopic tribes, they become almost innumerable. If this be the case with regard to species, how would the mind be overwhelmed with the immensity of the subject, were it to attempt to estimate the number of individual existences in the animal and vegetable kingdoms. Let us recognize and admire the designing mind which has with such wonderful skill adjusted the balance of nature, and fitted it to the condition of man in his fallen state. It is impossible not to be struck with the analogy which runs through all the departments of organized existence, from the highest to the lowest, in this as well as in other instances. We see every where a superabundant power of reproduction counteracted and balanced by what may be justly called antagonist powers. Among these opposing forces we find voracity and famine every where, excessive heat and periodical storms in tropical countries, excessive cold during the winter of the temperate and frigid regions, each in its own manner and its own place, doing the necessary work of destruction.

* The Greenland whale is supposed to live only on medusæ or shrimps, but the catchalot, and its varieties, are exceedingly voracious.

THIRD WEEK—THURSDAY.

ALTERNATION OF DAY AND NIGHT.

With us the sun now remains little more than eight hours above the horizon; and, even during that short period, the comparative intensity of his light and heat is much decreased. He is daily taking a less extensive circuit in the heavens; and in another month the length of the day will be diminished by more than another hour. Were the influence of the sun, and the length of the day to continue in this state, the whole organized world, in the climate which we inhabit, would quickly be destroyed. But the year will soon recommence its annual round; and nature is even now preparing for its coming labours.

The repose of plants, and even of many animals, in this dreary season, reminds us of the salutary provision, of a similar description, which is made for the diurnal recruiting of exhausted strength by the alternation of night with day. That this arrangement is adapted to the constitution of animal and vegetable existences, will be readily admitted; and, on examining particulars, we shall be confirmed in our general conclusion. It is not merely true that nature requires a frequently recurring period of rest, but that the actual period of twenty-four hours, divided between activity and repose, is the best suited for this end. If this be so, it implies a Designing Cause; for such a period is *arbitrary;* that is to say, no reason can be assigned, in the nature of things, either why the earth should complete her daily revolution in twenty-four hours, or why animals and vegetables should require a season of rest in that precise interval. As to the former, no mechanical or physical necessity requires that our earth should complete three hundred and sixty-five revolutions in a year. It might, apparently, move either faster or slower, without the slightest inconvenience to the system with which it is connected. Ju-

piter and Saturn revolve on their axes each in ten hours, which, considering their bulk, must carry their equators round with a velocity immensely greater than that of the earth, while Mercury, which is so much nearer the sun, and so much smaller, has its day and night nearly of the same length as our own.

Now, if we look at the vegetable world, we shall find, as already observed, a remarkable adaptation of this arbitrary period of twenty-four hours to the constitution of its various productions. In some plants, indeed, this is not so obvious; but there are others which clearly show that they are endowed with a periodical character, corresponding with the average length of our day. Linnæus classified a number of plants according to their time of opening and shutting, with reference to the hour of the day, and found that there are some which change their hour of opening and shutting as the day becomes longer and shorter, while there are others which do not seem to be affected by the actual state of the light and heat, but have a daily period of their own, independent of these influences, expanding their leaves, and closing them, at a particular hour, whatever be the state of the weather, or the length of the day. Both of these instances prove an adaptation to the diurnal revolution of the earth, which could not be the effect of chance, and must, therefore, have been the work of an Intelligent Cause.

This adjustment is still more remarkable in the animal world. A period of sleep is necessary for the health and vigour of living beings; and the alternation of day and night, which actually takes place, seems, from various considerations, to be that which is best fitted for them; or, at all events, any very great deviation from the arrangement actually established, would be prejudicial. When a workman retires from his twelve hours' labour, he is sufficiently inclined to take rest; and, although it is possible for him to encroach on the night, without much inconvenience, and to extend his exertions, if not

immoderate, to fifteen or sixteen hours, a longer period, without an interval of repose, would incur the risk of undermining the constitution. It is certain, at least, that a considerable proportion of time, spent in sleep during the four and twenty hours, is of importance to the health both of body and mind; and that, if our day were extended, for example, to the length of two, the human powers would droop under the prolonged period which would thus occur between the intervals of rest.*

To the lower animals, also, the alternation of day and night, as it actually exists, is wisely adapted. To some of these, the day is the season of collecting their food; to others, the night: but, whatever be the instincts which guide them in this respect, we cannot but perceive that the adjustment between their constitution and habits, on the one hand, and the period of light and darkness on the other, is such as to show that the one bears reference to the other, and to indicate benevolent contrivance.

It is no valid objection to this view, that the relative length of the days and nights vary very considerably in our climate, and still more in higher latitudes; because, where this is the case, we find adaptations and adjustments of a different kind, which, in some degree, compensate for these variations; and because, except in regions approaching very near the poles, the revolution of day and night is uniformly comprised in twenty-four hours; and the only difference consists in a longer or shorter time during which the curtains of night are drawn,—an inconvenience which the ingenuity of man removes by artificial means, and to which the habits and wants of the lower animals, and of plants, are wonderfully accommodated.

On the whole, we have here another proof of an Intelligent Creator, who has suited the organized beings he has called into existence, to the circumstances of the

* George III. is said to have been fond of using the somewhat caustic proverb,—"Six hours of sleep for a man, seven for a woman, and eight for a fool."

material world, in which he has been pleased to place them. The observations of Mr Whewell on this subject, to whose judicious statements we have so frequently had occasion to refer, are entirely to the purpose. "The hours of food and repose," says he, "are capable of such wide modifications, in animals, and, above all, in man, by the influence of external stimulants and internal emotions, that it is not easy to distinguish what portion of the tendency to such alternations depends on original constitution. Yet no one can doubt that the inclination of food and sleep is periodical, or can maintain with any plausibility, that the period may be lengthened or shortened without limit. We may be tolerably certain that a constantly recurring period of forty-eight hours, would be too long for one day of employment, and one period of sleep, with our present faculties; and all, whose bodies and minds are tolerably active, will probably agree, that, independently of habit, a perpetual alternation of eight hours up, and four in bed, would employ the human powers less advantageously and agreeably, than an alternation of sixteen and eight. A creature which could employ the full energies of his body and mind uninterruptedly for nine months, and then take a single sleep of three months, would not be a man."

"This view," he afterwards adds, "agrees with the opinion of some of the most eminent physiologists. Thus Cabanis notices the periodical and isochronous character of the desire to sleep, as well as of other appetites. He states, also, that sleep is more easy and more salutary, in proportion as we go to rest, and rise every day at the same hour; and observes, that this periodicity seems to have a reference to the motions of the solar system."

All this leads to the conclusion, that the correspondence thus obvious between the laws of the material world, and the constitution of man, and other animals, is not fortuitous, but is the appointment of a Wise Contriver, and manifests a designing First Cause.

THIRD WEEK—FRIDAY.

SLEEP.

The remarkable manner in which the constitution of plants and animals is adapted to the length of the day, was yesterday commented on; and one of the most striking of these adaptations is the provision by which man, and many of the lower animals, drop into a state of inactivity and sweet oblivion during the night.

The presence of light is necessary to enable creatures, constituted as we are, to prosecute useful labours; but constant toil wears out the frame, and a period of rest is necessary. There is, therefore, an arrangement of our ever-provident Creator, by which light shall be, for a time, withdrawn from us, that we may be compelled, by a natural necessity, to refrain, at regulated and short intervals, from the prosecution of labours in which we might otherwise be too eagerly engaged. This is the point of view in which the subject has been already considered. Let us now attend to the subject in another light. Looking at the fact, that the earth is made to revolve on its axis once every twenty-four hours, and that thus its inhabitants are deprived of its light, and other genial influences, for nearly the half of that time, on an average, each day, What is the contrivance by which this natural occurrence is rendered agreeable and salutary? The reply is, that a provision is made by which the active powers both of body and mind are suspended, and sleep is induced.

And what is sleep? There is something very mysterious in this state, considered as a physiological phenomenon; but this inquiry does not fall under our present plan; and, if it did, we should probably find it difficult to come to any satisfactory conclusion as to its efficient cause, or the nature of the physical change in the nervous system, by which it is produced. We know it is a

fact in the constitution of living beings; and this is all that it seems necessary, at present, to say on the subject. To define sleep, according to its actual appearances, is sufficiently easy. In attending to our own experience, in regard to its approach and actual occurrence, we discover that the will seems gradually to become enfeebled in its power over both the bodily and mental operations; that the body becomes as it were benumbed, and ceases to receive impressions of external objects; and that the faculty of thought seems to wander without control. In the functions which serve for the support of life, on the contrary, there is no material interruption. All of them remain unsuspended, and some of them are maintained in full vigour and activity. The natural actions of respiration, circulation, and digestion, are little affected. The powers, which are merely mechanical or chemical, seem to proceed in the usual manner; and, whatever internal *stimuli* are necessary for keeping them in action, retain their sensibility.* It is otherwise with the different senses. These fall into a state of obtuseness and relaxation, from which they are not easily roused, though the possibility of affecting them, even without putting an end to the state of sleep, is a matter of daily experience; and, indeed, the fact that a sleeper can be awaked at all, through the medium of his sense of hearing, or of touch, or of sight, or even of taste or smell, is a sufficient proof that these faculties are not completely suspended. Neither is there a suspension of the mental powers. Our thoughts succeed each other with inconceivable rapidity, and the imagination appears

* It seems that this should be taken with some limitation. "Sleep," says Mr Macnish, "produces rather important changes in the system. The rapidity of the circulation is diminished, and, as a natural consequence, that of respiration: the force of neither function, however, is impaired; but, on the contrary, rather increased. Vascular action is diminished in the brain and organs of volition; while digestion and absorption all proceed with increased energy." "Sleep lessens all the secretions, with one exception,—that of the skin. "Sleep produces peculiar effects on the organs of vision. On opening the eyelids cautiously, the pupil is seen to be contracted; it then quivers with an irregular motion, as if disposed to dilate; but at length ceases to move, and remains in a contracted state till the person awakes."

often to be peculiarly awake and brilliant. It is the power of volition alone, so far as the mind is concerned, which has ceased to be exerted. This is usually attended with a relaxation of the voluntary muscles, which occasions a total want of power in all the parts of the body over which these muscles have control. I mention this, however, only as the *usual* condition of persons in a state of somnolency; for it is one of the remarkable phenomena of dreaming, to which we shall have occasion afterwards to advert, that the mind does then frequently exert an influence, of a very extraordinary nature, over the bodily functions.

There is something at once interesting and strange in this state, which its familiar occurrence causes us often to lose sight of; but I must at present confine myself to a single observation. It is an essential characteristic of sleep, that, so far from being able to induce it when we please, the anxiety to obtain this refreshment only drives it away from us; and it is not till we cease to think about it, that it steals on us. This is doubtless a wise provision; but then, were it to invade our body and mind not only unsolicited, but unexpected, and were we unable, to any extent, to counteract its approaches, very distressing effects might be produced. Attend to this for a moment. If we were to drop asleep, without warning, in the midst of some active operation, it is easy to see how many daily occurrences, of the most disastrous nature, would ensue. Struck by the unexpected visitant, the seaman, as he ascended the top-mast, or clung on the yard-arm, would relax his grasp, and be plunged into the sea, or dashed to pieces on the deck. The coachman, in the middle of his stage, would drop his reins, and fall senseless from his box. The builder would tumble with his trowel from the wall. The porter would fall paralyzed under his burden. The orator in the senate, at the bar, or in the pulpit, would falter, and sink with the unfinished sentence on his lips; and, in one, the fire of his patriotism; in another, the acuteness of his reason-

ing, or adroitness of his statement; and, in a third, an exhibition of the high and holy doctrines of the Gospel, or of impassioned eloquence in a heart full of zeal, or of the tender touches of Christian love, would ludicrously expire in a sudden drawl, a closing eye, and a countenance in an instant relaxed into an expression of drowsy insensibility. Or rather, almost all these active and useful operations, and indeed most of the important business of life, would be prevented by the anticipation of so inconvenient and dangerous a catastrophe.

It is, therefore, no slight proof of the wisdom of the Divine Contriver, that, while he has rendered sleep a necessary function, superior to the human will, he has, at the same time, afforded such indications of its approach, as to allow man time and opportunity decently to compose his limbs, and has even bestowed upon him such power of temporary counteraction, especially in seasons of active exertion, as to enable him to carry on his operations for a considerable period, without serious inconvenience, or fear of interruption, by the unwelcome and death-like intruder.

THIRD WEEK—SATURDAY.

DREAMING.

The phenomena of dreaming, which are so remarkable, and in some respects so inexplicable, seem to have been afforded by Providence, as a kind of agreeable relaxation to the ever active powers of the mind, while the bodily functions are in a state of necessary repose.

The subject has attracted deep attention from the earliest times, and has given rise to views and theories of very different kinds, corresponding either with the prepossessions of a particular age, or with the speculative views of the individuals by whom it has been treated. In early times, when a miraculous intercourse was kept

up between heaven and earth, in preparing the world for the reception of the Saviour, dreams were frequently employed as the medium of that intercourse; and it was perhaps owing to these *real* events, that a superstitious veneration for dreams was cherished, even in the most polished ages of the ancient world. The Greeks and Romans divided the action of the mind, in sleep, into five sorts,—the dream, the vision, the oracle, the *insomnium*, and the phantasm, of which the three first were supposed to be divinely inspired. To such height had the superstitious feeling with regard to dreams arisen in Rome, in the age of Augustus Cæsar, that this monarch procured the passing of a law, obliging all who had dreamed any thing respecting the state, to make it publicly known; and he himself, in consequence of a nocturnal vision, submitted to the degrading act of begging in the streets.

More rational views have of late been entertained on this curious subject, though the philosophical theories which have been entertained regarding it, are still far from being either very satisfactory in themselves, or consistent with each other. On these I shall not enter;* but some facts present themselves to our notice, which seem worthy of remark.

What I have chiefly to observe is, that, whatever may have been the design of Providence in appointing the existence of this mysterious state of mind, its functions

* Should the reader wish to prosecute this subject, he may be referred to the interesting observations of Dr Abercrombie, in his "Inquiries concerning the Intellectual Powers," and to the elaborate work of the late Mr Robert Macnish of Glasgow, on "The Philosophy of Sleep," where the phenomena of sleep and dreaming are investigated with much ingenuity, and in a manner which has deservedly gained the author considerable celebrity. Dr Abercrombie states, that there is a strange analogy between dreaming and insanity; and he defines the difference between the two states to be, that, in the latter, the erroneous impression being permanent, affects the conduct; whereas, in dreaming, no influence on the conduct is produced, because the vision is dissipated on awaking. "This definition," says Mr Macnish, "is nearly, but not wholly, correct; for, in somnambulism and sleep-talking, the conduct is influenced by the prevailing dream. Dr Rush has, with great shrewdness remarked, that a dream may be considered as a transient paroxysm of delirium, and delirium as a permanent dream."

are so guarded and qualified, as, speaking generally, to prevent injurious consequences, and often to afford an exhilarating play to the imagination. The dreamer is introduced into a kind of fairy land, where, as Addison, with his usual elegance and felicity, expresses it, "the soul converses with numberless beings of her own creation, and is transported into ten thousand scenes of her own raising: she is herself the theatre, the actor, and the beholder." In this state, when reason appears, for a time, to have given up the reins to fancy, it seems as if a very slight variation in the intensity of the feeling, or in the duration of the delusion, might be attended with fatal effects. Sometimes a deed of horror is supposed to be done, or the most overwhelming calamity is believed to have happened. The event is depicted in the strongest colours; it is actually seen, as it were, to take place before our eyes; the impression made on the mind is that of assured conviction of its truth, accompanied with the most intense agony; a moment longer, and the brain would be set on fire. That boundary, however, is never passed. A provision is made by which the very violence of the agitation effects the remedy, and the dreamer awakes with a heart ready to burst indeed, or with nerves strung and shaken to the very verge of their utmost endurance; but the phantoms disappear,—the anguish subsides; and, in a few minutes, the mind is as calm and serene as before.

The same observations will apply, with still greater force, to the phenomena of somnambulism, the most frightful and dangerous condition of persons in sleep. This is evidently not a natural and healthy, but a diseased state of the bodily and mental powers, and therefore forms such an exception to the general rule as we would make in any other case of morbid action. It is worthy of remark, however, that while this irregular affection shows the distressing consequences which might ensue, were it to be the usual accompaniment of the dormant state, and thus very strikingly proves the wisdom

of the natural provision, the law of which is, that the body shall not obey the dictates of the soul in sleep, it is at the same time kept within such bounds, that fatal, or even distressing accidents, seldom take place from the vagaries of the somnambulist. We hear of such persons climbing to the tops of houses, or walking along precipices, and performing other perilous feats, which in their waking hours they would have shuddered even to think of, yet, when left undisturbed, with astonishing dexterity surmounting every danger, and returning in safety to their beds, thus affording a pleasing conviction that He who permits the occasional irregularity, has condescended with paternal care to mitigate its unhappy effects. But we must further remark, that even these are extreme and very rare instances, and that, in by far the greatest variety of cases, in which there is a tendency to this disease, the body only very partially and very harmlessly yields to the suggestions of the mind. A few muttered sentences, or a restless turning in bed, or at most, perhaps, a habit of occasionally rising and walking about the floor, are in general the only indications that the body has a tendency, under the excitement of dreaming, to obey the suggestions of the imagination.

Having mentioned the subject of somnambulism, I am reminded of a remarkable instance of it, recorded in the Edinburgh Encyclopedia, in its memoir of my venerable relative, Dr Blacklock, whose accomplishments as a poet and a clergyman, though struggling from his early infancy with all the privations of blindness, are so well known to the literary world. This excellent man had received a presentation to the living of Kirkcudbright, and his settlement was violently opposed. He was deeply agitated with the hostility which was manifested against him, and after dining with some friends on the day of his ordination, finding rest necessary to recruit his harassed and exhausted spirits, he left the table and retired to bed, when the following extraordinary circumstance occurred:—"One of his companions, uneasy

at his absence from the company, went into his bedroom a few hours afterwards, and finding him, as he supposed, awake, prevailed on him to return again into the dining-room. When he entered the room, two of his acquaintances were engaged in singing, and he joined in the concert, modulating his voice as usual with taste and elegance, without missing a note or a syllable; and, after the words of the song were ended, he continued to sing, adding an *extempore* verse, which appeared to the company full of beauty, and quite in the spirit of the original. He then went to supper, and drank a glass or two wine. His friends, however, observed him to be occasionally absent and inattentive. By-and-by he was heard speaking to himself, but in so low and confused a manner as to be unintelligible. At last, being pretty forcibly roused by Mrs Blacklock, who began to be alarmed for his intellects, he awoke with a sudden start, unconscious of all that had happened, having been the whole time fast asleep."*

Lord Brougham, in his preliminary discourse to the edition of Paley's Natural Philosophy, lately published,† makes use of the phenomena of dreaming, as an argument for the mind's independence of matter, and capacity of existence without it. His argument, in a few words is this:—In the state of dreaming, all the bodily functions which depend upon volition are suspended; and the bodily senses, though not entirely in a state of abeyance, become very obtuse. But this does not interrupt the activity of the mind; on the contrary, the power of imagination, and the celerity with which ideas pass through the mind, are increased by this cessation of communication through the senses. The mind, therefore, acts vigorously, when the powers of the body are unstrung; and it is only advancing another step to suppose, that it can act altogether independently of its material instrument, and survive it. To prove the extreme agility of the mental powers, and their total diversity

* Edinburgh Encyclopedia,—Article, Blacklock. † Published in 1835.

from any material substances and actions, his lordship enters into some curious details of the phenomena of dreaming, which incontestably prove that it sometimes requires but an exceedingly short period to suggest and complete a long train of incidents. "A puncture made," says he, in one of his illustrations, "will immediately produce a long dream, which seems to terminate in some such accident, as that the sleeper has been wandering through a wood, and received a severe wound from a spear, or the tooth of a wild animal, which at the same instant awakens him. A gun fired in one instance, during the alarm of invasion, made a military man at once dream the enemy had landed, so that he ran to his post, and repairing to the scene of action, was present when the first discharge took place, which also at the same moment awakened him."

From these facts, Lord Brougham infers, "the infinite rapidity of thought." "Mark," he says, "what was done in an instant,—in a mere point of time. The sensation of the pain or noise beginning, is conveyed to the mind, and sets it a thinking of many things connected with such sensations. But that sensation is lost or forgotten, for a portion of the short instant during which the impression lasts; for the conclusion of the same impression gives rise to a new set of ideas. The walk in the wood, and the hurrying to the post, are suggested by the sensation beginning. Then follow many things unconnected with that sensation, except that they grew out of it; and lastly comes the wound, and the broadside, suggested by the continuance of the sensation; while, all the time, this continuance has been producing an effect on the mind wholly different from the train of ideas the dream consists of, nay, destructive of that train; namely, the effect of rousing it from the state of sleep, and restoring its dominion over the body. Nay, there may be said to be a third operation of the mind going on at the same time with these two,—a looking forward to the *denouement* of the plot,—for the fancy is all along so contriving

as to fit, by terminating in some event, some result consistent with the impression made on the senses, and which has given rise to the whole train of ideas."*

Whether we entirely agree with this reasoning or not there can be no doubt that the rapidity of thought, evinced in dreaming, is amazing; nor is it easy to elude the ingenious argument for the immateriality of the soul, which the author has founded on it; though, if we were to rely on this argument, it might land us in the belief, that the souls of the lower animals, many of which are known also to dream, must be immaterial too.

* I cannot, without diffidence, differ from such an authority; but I am by no means sure that the view the noble author has taken of these phenomena is perfectly correct. I should rather be inclined to think that the whole series of incidents in dreams were suggested after the shock which at last put an end to sleep, had been received; and, during the period, somewhat more than an instant, though exceedingly short, which elapsed before the process of awaking had been accomplished; and that the wound and discharge of musketry, imagined in the dream, were not the same as the puncture and the shot which actually took place, but were afterwards conceived, like the other parts of the dream. This view disembarrasses the matter of some of its difficulties; but, on any supposition, the dream must have been nearly instantaneous, and the rapidity of the succession of ideas is wonderful. I am compelled also to doubt the validity of the conclusion to which his Lordship comes, that "we only dream during the instant of transition into and out of sleep." Several facts contradict this view; and, in particular, the phenomena of somnambulism, and of speaking during sleep, are conclusive against it. The case of Dr Blacklock, for example, cannot possibly be explained on his Lordship's hypothesis.

FOURTH WEEK—SUNDAY.

THIS WORLD A STATE OF DISCIPLINE.

The peculiar condition of sublunary things, as imperfect and transitory, is forced on our notice by the circumstances of the external world during the period of winter. The beauty of the year is gone,—the cheerful notes of the lark, of the blackbird, of the thrush, and of the whole choir which poured the voice of love and enjoyment from earth and sky, have ceased in our land, and a brooding ominous melancholy reigns around. This is but one instance of a character impressed, as we have seen, on every thing under the sun. All are full of change and decay; and the state of the natural world is only an emblem of that which subsists in the moral world, where temptation, and sin, and sorrow, have shed their fatal blight over the once glorious prospects of rational and immortal beings.

This condition would be totally inexplicable, were it not for the light thrown on the subject by Revelation. When we are told that we are at present only in the infancy of our existence, placed here in a state of discipline, to prepare us for a higher and more perfect residence, the mystery is unravelled, and we are made to understand, in some degree at least, why it has pleased the All-wise disposer of events to place us in a world where He only displays the brightness of His perfections as it were by glimpses, and casts clouds and darkness over the rest of the scene.

It is true that evil exists; but the Christian knows that it is over-ruled for good. Our Divine Master does not, indeed, remove calamity, but He changes its nature, and gives us power cheerfully to endure it. As His religion shows us the hand of a God of love in every thing, it causes us to regard distress, from whatever earthly source it arises, as "the chastisement of a Father, who

chastens us for our profit, that we may become partakers of his holiness." Hence the Christian is in a condition to feel a constant and delightful dependance on Providence. Thus instructed, he may grieve, but he cannot repine; he may be humbled and afflicted, but he cannot despair. Shall a child, who knows that a Father corrects him in love, murmur under the rod? Shall he not rather bend with humble resignation, and look up with affectionate joy, to the hand which wounds that it may heal?

This would be the effect of faith in the promises of the Gospel, even although the operations of Providence were surrounded with such mysterious darkness, that our limited faculties could perceive in them no traces of Divine wisdom and goodness. But it is no trifling addition to the satisfaction with which we rest in these promises, that God frequently condescends to make bare His holy arm in our sight, that we may follow His hand, as it over-rules earthly events, and controls human passions and affections, so as to render both moral and physical evil an instrument of good.

In reference to our condition as moral agents, and with a view to the powers and faculties, which, as fallen but rational creatures, we possess, it is not difficult to perceive in what manner the afflictive vicissitudes of life operate in elevating and ameliorating our character. If life were free from evil, there would be little to employ the judgment, or call into action the latent faculties,—little to rouse, to affect, and to invigorate the human soul. The heroic virtues of fortitude and courage, for example, would be without an object, were there no perils to encounter, and no enemies to subdue. What self-abasement could there be where there was no infirmity? What meekness, what patience, what forbearance, if there were no injustice to sustain, no calamities to suffer, and no injuries to forgive? Where were the exercise of resignation in a paradise of bliss? Where the trial of faith in a land of righteousness?

The social virtues, too, as well as the personal, could,

under such circumstances, only be called into partial action. How could there be any pity, where there was no distress?—any sympathetic joy, where there was no escape from danger?—any compassionate charity, where there were no sins to cover, and no wants to relieve?

Were there no evils, then, either in the circumstances of the external world, or in the moral and physical condition of the society in which we dwell, we should be placed in a state to which our fallen nature is not suited; and some of our noblest faculties would remain unexercised and unimproved. But it is not so. Under the discipline of Providence, the Christian is tutored in the school of adversity; and is rendered prudent by disappointment, humble by error, and magnanimous by endurance. Baffled, afflicted, persecuted, but rising superior to calamity, he unfolds his patience, his meekness, his resignation. Experiencing the hatred and contempt of those whom his heart desires to benefit, he learns the divine duty of forgiveness, and is taught to persevere in offices of kindness to the ungrateful. While engaged in these severe but exalted exercises, he becomes sensible of his own inability, and is forced to exclaim, "Who is sufficient for these things?" Thus, he is led to apply to Him who has said, "My grace is sufficient for thee, my strength is made perfect in weakness." Weeping for his sins at the foot of the cross, he feels the virtue of humility taking deep root and growing in his soul; and the graces of faith, of hope, and of joy in the Saviour of sinners, rising to maturity.

In a word, the disciple of the Man of Sorrows is exposed to temptation, that he may guard against it; to difficulties, that he may overcome them; to dangers, that he may rise above them. He is taught, by experience, the unprofitableness of sin, and he hates it,—the emptiness of human honours, and he despises them,—the worthlessness of earthly pleasures, and he looks beyond them.

Contemplate the servant of Jesus, as, under the guidance of Heaven, he advances through this vale of tears,

gradually throwing off the load of his sins,—mixing with the world, that he may learn to despise its follies,—gaining strength by moral discipline, and improving in virtues and graces at every step. In this character, you witness the highest glory of human nature in its state of sin and suffering on earth,—a being worthy of the approbation of angels. You see a soldier taught to fight the good fight of faith, and trained to victory amidst hardships, dangers, and death,—a pilgrim travelling through the wilderness, with steady eye fixed on the Holy Land,—a pupil of God, instructed in the school of His providence,—an heir of immortality, rendered meet for the inheritance of the saints in light.

In this noble, this admirable being, you no longer recognize the fallen descendant of Adam, but the adopted child of God. Amazing change! How superior is this once degraded and wretched outcast to his former self! Clothed now in the armour of God, he goes forth "conquering and to conquer,"—surrounded with danger, but trusting in an unseen arm;—struggling with sorrow, yet kissing the hand which inflicts the wound,—"troubled on every side but not distressed, perplexed but not in despair, persecuted but not forsaken, cast down but not destroyed,"—eluding the snares of the world, and even successfully contending with "principalities and powers, the rulers of the darkness of this world, and spiritual wickedness in high places."

What striking instances of the efficacy of Christian principles, exercised amidst vicissitudes and suffering, do we discover in the Apostles of our Lord, who rejoiced when they were counted worthy of stripes for the sake of their beloved Master, in whom "tribulation wrought patience, and patience experience, and experience hope;" and whom "hope made not ashamed, because the love of God was shed abroad in their hearts." And, above all, what a dignified and lovely example of the same principle do we behold in Christ himself, whose whole life was an illustration of the power of Divine grace, in

calling the noblest faculties into exercise, and thus rendering the character of man "perfect through suffering; and who could,—at the close of his earthly career, when He saw the time immediately at hand, so full of unutterable horrors to His human nature, in which the whole world was to be combined against Him, in which His very disciples were basely to forsake their Master, and allow Him to tread the wine-press alone, and in which, during the agony of mysterious sufferings, such as the Son of God alone could endure, the blood-drops of anguish were to burst from every pore of His sacred body,—who could, I say, even in this most appalling hour of the power of darkness, preserve unshaken His confidence in an unseen God, and feeling that he was not alone, for the Father was with Him, could in pious resignation exclaim, "Father, not as I will, but as thou wilt!"

But there is a far higher consideration which gives a peculiar character to the troubles of life, and stamps on them an inestimable value. They prepare mortal man for immortality. Here is the true source of Christian consolation. What are a few fleeting years of imperfect enjoyment, or even of positive calamity, when, through that very condition, we shall be rendered meet to enter the kingdom of God, and dwell with Him for ever? Who would not go on a pilgrimage through this dark and howling wilderness, when he sees rising before him, in all their grandeur and beauty, the everlasting mansions of the promised land? Who would not cheerfully bear the light affliction of the present moment, when he knows that it is "working out for him a far more exceeding, even an eternal weight of glory?"

FOURTH WEEK—MONDAY.

I. THE STARRY HEAVENS.—GENERAL REMARKS.

Nothing is better calculated to raise the contemplative mind to the great Author of all things, than a view

of the starry heavens, when night has cast its deep shade over the face of Nature, and the frost of winter has not only converted the earth into stone, and the waters into crystal, but has charmed the exhalations from the air, and endowed it with such a beautiful transparency, that each little star shoots its radiance on the eye, and the whole sublime hemisphere seems like an immense and gorgeous dome, studded with diamonds; a fit temple for the worship of the Creator. The untutored savage, though he regards the stars only as so many lamps suspended from the azure vault, to enlighten and cheer his abode, is struck with admiration of the gift; and, with a heart overflowing with gratitude, falls down to bless the Great Spirit who bestowed it. Ignorance and astonishment have gone still further; and, in almost all nations, traces are to be found of the worship of the heavenly bodies,—a rude, but not altogether unnatural form of religion to the uninstructed mind. The "Hosts of Heaven," are assuredly the most striking and appropriate visible emblems of the glory of the Almighty Unseen; and, where the mind has been unaccustomed to reflect on any objects but those which strike the senses, the mistake may, without difficulty, be accounted for. Certainly such a belief is neither so strange nor so revolting, as the worship of cows and serpents, or even of men and devils, with examples of which the history of heathen mythology abounds.

Science, however, even in its earliest efforts, easily shook off this superstition; and, as it advanced, opened up new wonders in the sky, which extended the views, while they intensely excited the curiosity, of man, and gave deep exercise to his intellectual faculties. Hence have resulted discoveries which have overwhelmed the mind with astonishment. It does appear little less than miraculous, that a worm of earth, like man, who is bound to a little spot of this remote planet; whose abode upon it is but threescore and ten years; whose bodily strength is inferior to that of many other animals; whose powers

of vision are more limited; whose intellect, in ordinary circumstances, rises but little beyond a mere provision for daily subsistence; that this being, with faculties and means apparently so inadequate, should have been enabled, by dint of an insatiable desire of knowledge, and an unwearied perseverance, to overcome so many difficulties, and to forge a key, by which the mysteries of the universe have been unlocked, and a near view has been obtained of the secret springs, which, under the fiat of the Creator, move the amazing machinery of the material world. Little did the rude inhabitants of the earth think, when they gazed, in stupid surprise, on the tiny sparks which bespangled the heavens, that each of these was a globe of fire, compared with which the earth they inhabited, was but as a ball, which a child tosses in his hand; or that the distance at which they were situated, was so amazing, that a hundred millions of miles was but as the length of an infant's step. Yet these are truths now familiar to every mind, and established by demonstrations, on which scepticism itself dare not breathe a doubt.

The world of wonders into which astronomy introduces us, is calculated at once to enlarge and to depress the mind; to depress it with a sense of its own insignificance; to enlarge it with views and exercises so immense, that, as it expands, it perceives more and more clearly the immeasurable vastness of the grasp it is required to take; and, though constantly enlarging, in proportion to its efforts, feels itself, at every step, left hopelessly behind, till at last it is lost in infinitude.

When a man confines himself to his own little locality, and looks around him on the subject earth, which his plastic hand converts from a wilderness into a garden; or on the lower animals, whom he subdues to his will, and causes, by the superiority of his mental powers, to supply his wants, and administer to his comforts; or, even on the waters of the far-spread ocean, whose proud waves he conquers, and over whose trackless wastes he makes

his way; or on the free and capricious air, whose fury he controls, and whose blandness he renders subservient to his pleasures or his profit,—in such contemplations, he may find much to foster self-complacency, and to persuade him that he is, in reality, that lordly being which pride and vanity delight to portray. But the scenes which astronomy unfolds, are altogether of a different tendency, and ought to repress those swellings of self-love, which a more partial and contracted view of his situation may excite. The voyager who has compassed the earth, when he returns to his native village, is surprised to find that every thing has, to his view, contracted in its dimensions, and become comparatively mean and sordid in its appearance. The houses have shrunk into hovels; the village-green, from a broad-spread lawn, has dwindled into a miserable court-yard; miles have diminished into furlongs; and magnificent estates into sorry farms. This effect has been produced by a contrast with the expansion of his own views, and a similar result arises from the contemplations of the astronomer. Expatiating in the infinity of the universe, the things of earth seem to lessen while he regards them. As he pursues his inquiries, the contrast becomes daily more apparent and more humbling. He begins to perceive an emptiness in those things that formerly engaged his attention, and interested his affections, which he did not previously suspect. He finds himself placed on a little planet, whose comparative insignificance is such, that, were it struck from the face of creation, its fate would be but like that of a falling star, which loses itself in the heavens, and is remembered no more. And, as to himself, what an atom is he? How humiliating is the thought!

But the mind cannot rest here. If the creation be so inconceivably extensive, what is the Creator? This is the most interesting and elevating of all inquiries. When the mind has dwelt upon it, till its importance is appreciated, and its various bearings perceived, and then turns back upon itself, the reflection naturally occurs, "Am

not I a child of this Almighty Parent?" Is it not in His universe that I exist? Has he not constituted me a part of the system which His Infinite Wisdom has established? And what, then, is that system with reference to me, and the race with which I am connected?

Such views open up, to the inquiring mind, the whole field of Natural and Revealed Religion, and lead irresistibly to the conclusion, that there is no satisfactory account of man's nature and destiny, but in the inspired word, and no resting-place for his hopes, but in the life and immortality which have been brought to light in the Gospel of Jesus?

FOURTH WEEK—TUESDAY.

II. THE STARRY HEAVENS.—GRAVITATION AND INERTIA.

If it be true, as there is every reason to believe, that the fixed stars, which sparkle in the heavens, are suns like our own, shining, as they certainly do, by their own light, and shedding their radiance on other worlds, a view of creation is opened up to us, which it is both delightful and overwhelming to contemplate; and to this view we shall afterwards turn. At present let us take a rapid survey of the system of which we ourselves form a part.

Our star (for the sun, considered with reference to the universe, deserves no higher name) appears larger than other stars to us, only on account of its nearness; but when we call it near, we speak relatively; for it is known to be separated from us by the amazing distance of 95,000,000 of miles. It is the centre of our planetary system; that is to say, there are certain bodies similar to our own globe, which bear to the sun the same relation, being, like the earth, attracted to it by the all-pervading law of gravitation, and only kept from falling

into it,—as a stone when thrown falls to the ground,—by the velocity with which they move in a different direction. The two well-known laws, so simple in their nature, and yet so vast in their effects, by which the whole creation is moulded and regulated, have, ever since their discovery as universal agents, been most justly regarded with the highest admiration; and it is not easy to conceive any thing capable of impressing on the mind a more exalted view of the power and wisdom of the Creator. It would be inconsistent with our plan to enter deeply into this subject; but some cursory observations on a matter of such intense interest, and so directly illustrative of the perfections of God, cannot be considered out of place. Every one is familiar with the law of gravity or weight,—that mysterious power, which, acting uniformly, draws all things downwards, towards the centre of the earth. It is in virtue of this law, that, were I to open my fingers, the pen with which I write would fall flat upon the paper. It is the same law which causes the ink to flow upon the paper from my pen, the paper to lie steadily on my desk, and the desk itself to stand firmly on the floor. Nay, it is this very law which gives solidity to the ground on which I tread, which has formed it into a globe, and which prevents it from breaking up into shapeless and unconnected masses. The properties of this unseen agent are too palpable, in relation to our own sphere, to have escaped the attention of the earliest inquirers into nature. But it was reserved to a far later period to demonstrate, or even to conjecture, that the very same power, which produces such salutary effects in the earth, is not only an essential property of all matter, but acts at the greatest distances, and preserves the balance of the universe.

The other property, which, combined with gravitation, is employed in regulating the machinery of creation on the great scale, is also familiar to the most ignorant, in regard to some of its qualities. Every child knows, that a stone thrown forcibly from the hand, or an arrow shot

from a bow, will continue for some time to move forward in the direction in which it has been projected; but, then, this power of continued motion, as it comes under ordinary observation, is only very limited in its operation, because it is counteracted both by the attraction of the earth and the resistance of the air, and no force which human skill can apply, is sufficiently powerful to give an impetus to any body, capable of overcoming, for a length of time, these opposing forces. In the principle itself, however, there is no limit; and the law is simply this, that while a body at rest will, if not disturbed, remain for ever in that state,—a body once set in motion, will, when not acted on by some modifying or counteracting force, move on continually without deviation or intermission, in a straight line. This is the law of *inertia*,—a law which is not less universal than that of gravitation.

Now, to understand the operation of these two laws in relation to each other,—first, suppose a small body, placed at rest, in the neighbourhood of a large one, also at rest, both of them in empty space. The mutual attraction would immediately begin to operate, and they would move toward each other till they met, and that with a rapidity proportioned to the quantity of matter contained in each, the larger most powerfully attracting the smaller. Suppose, again, that the smaller body, instead of being placed at rest, was projected with a certain velocity in a direction different from that in which the other was situated. That velocity might be very great; and then, after a mutual disturbance, arising from the reciprocal attraction, the moving body would disengage itself from the other, and fly off into boundless space; or it might be very small, and then the *vis inertia* would be overcome, and the two bodies would fall towards each other, and unite; but, if the projecting force were, within certain limits, proportioned to the gravitating force, the consequence would be, that there would be a certain point in the progress of the moving body, in which the two powers would balance each other, and

no other than bodies partaking of the conditions of our own globe, and moving, like the earth, in a constant orbit round the sun. These are called planets.

To the ancients only five planets were known,—Mercury, Venus, Mars, Jupiter, and Saturn. To this list, modern science has added the Earth,—which takes its place, with relation to its distance from the sun, between Venus and Mars,—and Uranus, or Georgium Sidus, which is the most distant of them all. Besides these, a still later discovery has been made, of four other planetary bodies, which move in orbits considerably more eccentric than the rest, and are of much smaller dimensions, whose situation has been found to be between Mars and Jupiter. All these planets are nearly globular, and each moves round its own axis, as well as round the sun. Some of them have attendant bodies, called satellites, of which our moon is an example, moving round their primary planets, nearly in the same plane in which the latter revolve round the sun, and nearly also in a similar orbit. Now, of the orbit of these bodies, the sun, as has been observed, is the centre; and the first observation which may be made in reference to this arrangement, as indicating wise design, is, that this central body is the source of light and heat. Had the world been, as the atheist contends, a mere fortuitous concourse of atoms,—granting, for the present, that other arrangements might be accounted for, on causes entirely mechanical inherent in the constitution of matter,—there seems to be no reason deducible from such causes, why the great body, whose enormously superior size constituted it the centre of motion to the smaller globes, should, at the same time, be endowed with those peculiar properties so essential to the very existence of vegetable and animal life. How comes it that any of the bodies belonging to our system should shed light and warmth over the rest, and that of these, only one should be endowed with such properties? If this can be accounted for, then why does that body occupy the position at the centre,—the only position, be

it observed, which could render these life-sustaining properties available for the purpose? There seems to be no possible reason, except that of Creative Intelligence, why the illuminating body should not be one of the planets; and, if that had been the case, how irregular, and how totally inefficient would have been the operation.

This proof of contrivance, which is strikingly and convincingly illustrated by Whewell, attracted the attention of Sir Isaac Newton himself. In his correspondence with Bentley, he concedes that the sun and fixed stars might be formed by the mere force of attraction, and might exhibit their present appearances, provided the matter were of a lucid nature; "But," adds he, "how the matter should divide itself into two sorts, and that part of it which is fit to compose a shining body, should fall down into one mass, and make a sun; and the rest, which is fit to compose an opake body, should coalesce, not into one great body, like the shining matter, but into many little ones; or, if the sun were at first an opake body, like the planets, or the planets lucid bodies, like the sun, how he alone should be changed into a shining body, whilst all they continue opake; or all they be changed into opake ones, whilst he continued unchanged, I do not think explicable by mere natural causes, but am forced to ascribe it to the counsel and contrivance of a Voluntary Agent."

It seems impossible that any unbiassed mind should hesitate to acquiesce in the conclusion of this great man; and thus, from the very existence of a sun in the centre of our system, a satisfactory proof is drawn of the being of a God.

FOURTH WEEK—THURSDAY.

IV. THE STARRY HEAVENS.—THE SUN AS THE SOURCE OF LIGHT AND HEAT.

In considering the advantages derived from that obviously intentional and most wise arrangement, by which

the sun has been made the centre of our system, reference was necessarily made to that body, as the source of light and heat. A cursory view of some circumstances connected with these properties, seems, therefore, to suggest itself as an appropriate subject for this day's consideration.

The sun is a body of such immense magnitude, that it fills a space nearly twice as large as is comprehended within the orbit of the moon in its motion round the earth,—being in diameter no less than 882,000 miles, and in bulk considerably more than a million of times larger than the earth. From this amazing orb, light and heat are in some manner communicated to our planet, and to all the other planetary bodies, with a velocity which surpasses conception, the influence, whatever it is, travelling at the rate of 12,000,000 of miles in a minute, and reaching our globe in something less than eight minutes. It was supposed by Sir Isaac Newton, and has, till lately, been assumed as a fact, that the properties in question were transmitted from the sun by *emanation;* that is, that he was continually throwing off from his surface, a material substance, of extreme tenuity, possessing these properties. Late discoveries, however, of certain peculiarities in the nature of light, have given currency and probability to another opinion, namely, that the sun is no more than the spring which communicates activity to qualities or substances residing in our own atmosphere, from which the phenomena of light and heat are derived. This is called the theory of vibrations; and it has been aptly illustrated by the manner in which sound is caused and propagated. It supposes an ethereal fluid diffused through the universe, of inconceivable rarity and elasticity, to which the luminiferous vibrations are communicated, and through which they are transmitted.

It is not the province of this work to enter into any discussion on this curious subject; and it is enough for our present purpose to know, that the Creator has caused

the most salutary effects to depend on the presence and influence of this central body. Whether by vibration or by emanation, the properties of heat and light, indispensable to the existence of organized beings, in all their different grades, are, by means of the sun, adequately conveyed to the earth, otherwise dark and dead. We shall by-and-by have occasion to notice some of the qualities of heat, the partial absence of which, in our climate, at this season of the year, indicates how necessary this subtle agent is to life and enjoyment. Let us, at present, look at the kindred element of light, and we shall see that its operation is scarcely less indispensable in a world constituted as ours.

It is necessary to vegetable life. Without light, indeed, vegetables might grow. Some of the most important powers of vegetation are carried on under ground and in darkness, and the energies residing in the roots are sufficient to cause the plant to shoot forth its stem, and even to expand its leaves; but then, light is essential to the health, and, as it would seem, to the productive powers of plants, so that, without this genial influence, they could not survive beyond one generation. Colour, and to a considerable extent, strength of fibre also, are bestowed on vegetables by the influence of light, a circumstance which is familiar to gardeners, who *blanche* their celery, and other productions, by causing them to grow in the dark; and which is known to every one who has observed the colourless and feeble shoots of potatoes, for example, which happen to grow in a cellar or a pit, and the wonderful instinct which leads these shoots eagerly to extend in the direction of the slightest chink through which light is introduced. The manner in which light operates in bestowing a wholesome state on plants, appears to be by a chemical action, by which they are enabled to imbibe carbon, and disengage oxygen. In the absence of light, this action is reversed; and it is worthy of remark, that the operation of this agent, in the process of vegetation, is not only healthful to the

plant, but also useful to animal life, in freeing the atmosphere from some noxious qualities, and restoring it to a salubrious condition. It seems unnecessary to remark, that there is here the unequivocal impress of designing Intelligence.

It is further obvious, that the influence of light on vegetables, is extended likewise to animal life, which derives its support from these productions. But this is not all: for, on living creatures, its more direct effects are not less necessary. This agent is essential to sight, a faculty of such paramount importance; and the eye, an organ of most curious and peculiar construction, is, beyond all doubt, framed for the express purpose of receiving its impressions. Nothing can be more worthy of observation, than the manner in which the instrument of vision is adapted to the properties of the agent. Light is reflected, in all directions, from every object on which it falls; and, by the construction of a *camera obscura* most skilfully contrived, these reflected rays convey form, colour, light, and shade,—a perfect representation, in short, of external objects,—into the interior of the head; thus, by a mysterious connexion between mind and matter, giving rise, in living beings, to the faculty of sight, with all its well known properties and advantages. Who can doubt that there is here a proof of skill and adaptation,—that light was made for the eye, and the eye for light?

FOURTH WEEK—FRIDAY.

V. THE STARRY HEAVENS.—MOTIONS OF THE PLANETS.

As the fountain of light and heat is placed, by the great Creator, for obviously wise reasons, in the centre of our planetary system, it is natural to expect, that all the arrangements connected with this appointment, should be found so contrived, as to correspond with the

beneficent intention; and the more deeply we inquire into the subject, the more distinctly do we observe such an expectation realized. The object of the present paper will be to illustrate this position, with reference to the motions of the planetary bodies.

And first, with regard to their orbits. We have already stated, that a planet, in its path round the sun, may, according to the laws of motion, describe either an oval or a perfect circle. I have now to observe, that the oval might either be very long or very short, there being, so far as appears, nothing in the mechanical law tending to restrict the elliptical form. But it is obvious, that, if the circuit should prove very eccentric, the greatest inconveniences would take place, in a world constituted like ours; and, indeed, a total destruction of animal life would be the necessary consequence; because, at the point of the orbit nearest the sun, the fervour of his rays would be destructive; and, at its greatest distance, his apparent size, and his illuminating and warming power, would diminish together, till the land and the sea would yield equally to the ungenial influence, and be converted into one frozen and lifeless mass. Among the almost numberless forms, therefore, which the orbits of the planets might assume, the production and maintenance of organized existences, such, at least, as those with which we are familiar, required that a selection should be made within narrow limits; and that selection has been made. Every one of the planets, with the exception only of three of the smallest of these bodies, viz. Mercury, Juno, and Pallas, which their peculiar circumstances may account for, move in an orbit nearly approaching to a circle. The earth's orbit, for example, only deviates from an exact circle, by the thirteenth part of its distance from the centre; and, though the deviation of all the other planets, except Venus, is somewhat more than this, that deviation is so small, unless in the instances already alluded to, that it need scarcely be mentioned as a source of inconvenience. "Taking

the solar system altogether," says Whewell, "the regularity of its structure is very remarkable. The diagram, which represents the orbits of the planets, might have consisted of a number of ovals, narrow and wide in all degrees, intersecting and interfering with each other, in all directions. The diagram does consist, as all who have opened a book of astronomy know, of a set of figures, which appear, at first sight, concentric circles, and which are very nearly so; no where approaching to any crossing or interfering, except in the case of the small planets, already noticed as irregular. No one, looking at this common diagram, can believe that the orbits were made to be so nearly circles by chance, any more than he can believe that a target, such as archers are accustomed to shoot at, was painted in concentric circles by the accidental dashes of a brush in the hands of a blind man."*

Another peculiarity in the motions of the planets, is, that they are all in the same direction, and nearly in the same plane. It is quite evident, that, had chance originated these motions, they might, and probably would, have moved round the sun, both as to direction, and as to the plane of their orbit, in very different ways. Now, to those who are acquainted with the properties of the law of attraction, it will appear evident, that a most important object is served by the arrangement which actually subsists. Let it be observed, that such is the extraordinary nature of this law, that every particle of matter attracts, and is attracted by every other particle, the power, of course, being greater, in proportion to the quantity of each mass, and its nearness. The consequence of this is, that not only does the great central mass attract the smaller bodies, so as to cause them to revolve round it, but each of these smaller bodies also attracts the others; and this mutual attraction, which, it is easy to perceive, must be of a very complicated nature, and may produce the most extensive effects, re-

* Whewell's Bridgewater Treatise, p. 156.

quires to be nicely adjusted, in order to preserve the stability of the system. If the numerous globes, of which our system is composed, were to move in their respective orbits, without any such adjustment, our system would be far indeed from being stable. The disturbing forces, which might only be trifling, when a year, or even an age, was considered, might, in a long series of ages, accumulate to such an amount, as totally to disorganize and subvert the whole frame.

Nor is this a mere gratuitous hypothesis. Astronomers have actually discovered, in our solar system, an apparent tendency to derangement. Changes have been taking place, owing to the cause just mentioned, which, at first sight, appear to be of an alarming nature. The eccentricity of the earth's orbit has been gradually diminishing; the moon has been approaching nearer the earth, and accelerating her motion; and the obliquity of the ecliptic has been diminishing. These changes have been going on, from the period of the first scientific observations, to the present day, and are still in progress. Are they to continue without end? If so, the present system of things is tending to destruction.

This question has, by an amazing effort of calculation, been satisfactorily answered. Aided by the mathematical investigations of ages, two celebrated French philosophers, Lagrange and Laplace, have solved the problem, and have demonstrated, that "the planetary system will only oscillate about a mean state, and will never deviate from it, except by a very small quantity."* This remarkable result depends on these three conditions,—that the orbits of the planets are nearly circular; that these orbits are nearly in the same plane; and that they all move in the same direction.

Had any one of these conditions been different, the equilibrium of the system would not have been maintained; the tendencies to derangement would not have been counteracted, but, on the contrary, year after year,

* Laplace, Expos. du Syst. du Monde, p. 441.

would have been accelerated by accumulation; and, sooner or later, the whole fabric would have broken up, and been dissolved by its own inherent defect.

It is unnecessary to enter into any argument, to show that the combination of the various arrangements alluded to, could not have occurred without design;—that the adjustment is that of an Intelligent Cause; and that it affords the clearest proof of consummate and adorable wisdom.

FOURTH WEEK—SATURDAY.

VI. THE STARRY HEAVENS.—RESISTING MEDIUM.

We have seen, in the case of the planets, including also their satellites, that Supreme Wisdom has so balanced our system, that the disturbing forces, to which it is subjected by the mutual attraction of the heavenly bodies, will, in consequence of simple but selected arrangements, in the course of ages, correct themselves, so as never to threaten any violent change from such mechanical causes, so far, at least, as the power of attraction is concerned. This is highly satisfactory, as a demonstration against the atheistical doctrine, which would exclude from the universe the operation of a Designing Cause. It does not, however, prove the absolute permanency of the system, and we know, from the "more sure word of prophecy," that it is not destined to last for ever.

There is, indeed, another element to be taken into consideration, which the French philosophers, already alluded to, have overlooked or rejected, but which bears directly upon the question of inherent stability,—I mean the question regarding a resisting medium. All their calculations have been founded on the two simple powers of attraction and inertia, under the supposition that these powers acted in empty space, without the existence of

any impeding force. If it be found, therefore, that a resisting medium actually exists in the system; that is, that there is some fluid matter, however rare, in which the celestial bodies move, then this one fact will overturn the conclusion as to the absolute and inherent permanency of the present system of things, so far as mechanical powers are concerned. Nor will this discovery invalidate the reasoning in the preceding paper; for it will still remain a truth, worthy of the deepest admiration, that the plan was adopted, which, of all others, is best calculated to balance and counteract disturbing forces, even although other considerations should prove that the system was not intended to be eternal. It is this principle which secures the equal and salutary working of the system, while it lasts, and which bestows upon it properties suited for the habitation of organized existences, during that period; and this is the whole extent of the view for which we have been contending.

Is there, then, a resisting medium,—a fluid in which our system floats? or are our planetary spheres wheeled in empty space? The diffusion of light throughout the universe, might, of itself, form a powerful argument for the existence of such a medium, on whatever theory its properties are accounted for. Light is either an emanation from the great central body, and then that emanation must be something material; or it is an exciting cause of vibratory motion; and, in that case, the vibrations must apparently be conveyed through some material substance. In either case, the theory of an absolute vacuum seems to be untenable. But, independent of this view, some facts have been very recently discovered, which cannot well be accounted for, but on the supposition of a resisting medium. I allude to certain circumstances occurring in the motion of one of the comets belonging to our solar system, to which the importance of *Encke's* observations have justly caused that astronomer's name to be attached. The revolution of this body round the sun, is found to be completed in a period of about

three years and four months, while its orbit is so eccentric and elongated, that it is more than ten times nearer the sun in one part of its course, than in another. The materials of which it is composed, seem to be exceedingly thin and transparent, so much so, indeed, that the stars may be seen through the most condensed part of its nucleus, without any apparent diminution of their brilliancy. In 1786, this comet was first observed; but it was not till 1822, that its periods were accurately determined; and then Encke, on comparing the calculated with the observed places, perceived a difference, which he attributed to the effect of a resisting medium. It was again the subject of conversation in 1825, in 1828, and still more recently; and the conclusion has become general, that the obvious and constant disturbance of its course, arises from no other cause than that of its being affected by its motion in an etherial fluid.

This fluid, however, must be of inconceivable rarity, and would probably not produce any apparent effect in its velocity, were it not from the small quantity of matter contained in the vapoury sphere, which, as will easily be perceived, must increase the power of resistance of the medium through which it moves. Light and loose, however, as the body is, it has been found to be acted on by the solar and planetary attraction, in the same manner with the other heavenly bodies; and the result having been accurately calculated, what Sir J. Herschel calls a *residual phenomenon*, has been discovered, which has given rise to the inference of a resisting medium.

The effect, however, though something very discernible, is yet but trifling; and, what may appear strange, this retardation of the motion, causes the body to perform its revolutions round the sun more quickly. The reason is, that the increasing slowness of the motion has the effect of augmenting the relative power of the sun's attraction, thus drawing the comet nearer to himself, and shortening its orbit. Within the last fifty years, in which its course has been observed, it has been found,

that, while it has advanced about ten days farther in its path, than would otherwise have been the case, the time of its revolution has been diminished by about two days.

Now, the very same power of resistance, which acts so perceptibly on this unsubstantial body, must act also on every other body which passes through the same medium; and, however small the effect produced may be, it must be something, which, though not, perhaps, sufficient to produce any sensible effect on those more solid bodies, for many centuries, must yet, in reference to a period of eternal duration, be sufficient to derange, and finally to destroy, the whole system. As yet, no retardation of the planetary bodies has been observed, which could be referred to the existence of a resisting medium, because our observations extend to a period too limited; but this may only prove the extreme remoteness of the final catastrophe. "It may be millions of millions of years," says the distinguished author, whom we chiefly follow in this part of our work, "before the earth's retardation may perceptibly affect the apparent motion of the sun; but still the day will come (if the same Providence which formed the system, should permit it to continue so long), when this cause will entirely change the length of the year, and the course of our seasons, and finally stop the earth's motion round the sun altogether. The smallness of the resistance, however small we choose to suppose it, does not allow us to escape this certainty. There is a resisting medium; and therefore the movements of the solar system cannot go on for ever. The moment such a fluid is known to exist, the eternity of the movements of the planets becomes as impossible as a perpetual motion on the earth."*

The obvious use to be made of the fact now stated is, that our present system of things, which must have an end, must also have had a beginning. There must have been a period in which the impulse, now proceeding, originated. A period of commencement implies a cause;

* Whewell's Bridgewater Treatise, p. 200.

the order and regularity of the system implies an *Intelligent* Cause; and thus the idea of a Creator is forced upon us; and, instead of an eternal operation of mechanical powers, and an eternal succession of organized existences, which is the dream of the atheist, we see a system, glorious with the impress of a Divine hand, and rejoicing in the smile of a present Deity.

An ingenious living writer, after attributing the resisting medium to the remains of the nebulous matter out of which, according to Laplace's theory, the whole universe has originally been formed, concludes his account of the disturbing effects of that medium with the following striking observations:

"The idea of the ultimate dissolution of the solar system has usually been felt as painful, and forcibly resisted by philosophers. When Newton saw no end to the deranging effect of the common planetary perturbations, he called for the special interference of the Almighty to avert the catastrophe; and great was the rejoicing when a recent analyst descried a memorable power of conservation in our system's constituent phenomena. But, after all, why should it be painful? Absolute permanence is visible nowhere around us; and the fact of change merely intimates, that, in the exhaustless womb of the future, unevolved wonders are in store. The phenomena referred to would simply point to the close of one mighty cycle in the history of the solar orb,—the passing away of arrangements which have fulfilled their objects, that they might be changed into new. Thus is the periodic death of a plant perhaps the essential to its prolonged life, and when the individual dies and disappears, fresh and vigorous forms spring from the elements which composed it. Mark the chrysalis! It is the grave of the worm, but the cradle of the sunborn insect. The broken bowl will yet be healed and beautified by the potter; and a voice of joyful note will awaken one day, even the silence of the urn.

"Nay, what though all should pass? What though

the close of this epoch in the history of the solar orb, should be accompanied, as some, by a strange fondness, have imagined, by the dissolution and disappearing of all these shining spheres? Then would our universe not have failed in its functions, but only been gathered up and rolled away, these functions being complete. That gorgeous material framework wherewith the Eternal hath adorned and varied the abysses of space, is only an instrument by which the myriads of spirits borne upon its orbs, may be told of their origin, and educated for more exalted being; and a time may come, when the veil can be drawn aside,—when spirit shall converse *directly* with spirit, and the creature gaze without hinderance on the effulgent face of the Creator."*

* Dr Nichol "On the Architecture of the Heavens," p. 189-192,—a work containing a beautiful popular view of the recent discoveries of the two Herschels, and other modern astronomers, published in June, 1837.

FIFTH WEEK—SUNDAY.

DIVINE AND HUMAN KNOWLEDGE COMPARED.

When the philosopher compares his knowledge of external nature with that of his fellow-men not conversant with such high studies, there is danger of his becoming vain of his attainments. He has unbarred the gate of science, and penetrated the mysteries of creation. He follows the course of the sun, and measures the stars, and unravels the mystic changes of the planets, and discovers new worlds in distant space, and puts his finger on the law which sustains, impels, and guides the immense machine of the universe. This sounds proudly; and if we only consider the limited faculties of man, his attainments are undoubtedly worthy of admiration; but when viewed in the light of the Divine perfections, they dwindle and disappear. With reference to these, the capacity of man to acquire knowledge is extremely limited. As he advances but a few steps beyond the ordinary train of his ideas, he is lost in the immensity of his own conceptions. He has not faculties to grasp the wonders even with which he is more immediately surrounded, and how much less to form any adequate idea of the nature and character of the *Self-existent*. Let any man reflect, for an instant, on the divine attributes of Eternity, Infinity, Unchangeableness, and he will at once perceive how imperfectly he comprehends them. Who can do this without being awed, confounded, and bewildered? "Such knowledge is too wonderful for me; it is high, I cannot attain unto it!"

But even supposing we were capable of comprehending all mysteries, and all knowledge, how extremely limited is our sphere of observation. We are placed in a remote corner of creation. What a mere atom is the world which we inhabit, compared with the universe! Even if we knew every thing under the sun,—nay, if all

the powers of nature within our planetary system, with all the transactions of the whole animated creation which it contains, lay naked and open before us, how ignorant, even then, would we be! Worlds on worlds, and systems on systems, would still be entirely unknown to us.

But how little do we know even of the earth which we inhabit! We are confined to a little spot of this little world. How small are the British islands compared to the broad expanse of sea and land! And yet, of this diminutive region, how insignificant is the space with which we are acquainted! And even of the objects within our view, how ignorant are we! Nay, of the things with which we are most familiar, what do we know! We observe their outward appearance,—we can tell what they are to the eye, to the ear, and to the touch; but what they are in their own nature, the greatest philosopher cannot so much as conjecture. Indeed, the very production of organized existences, is an impenetrable mystery. Who can define the secret power by which a single blossom of the spring germinates and grows, opening its beauties to the sun, and embalming the air with its perfume?

Compared with this stinted portion of knowledge, how amazing is the knowledge of God! As He made all things, He must be intimately acquainted, not only with their properties, but with their very essence. His eye, at the same instant, surveys all the works of His immeasurable creation;—He observes, not only the complicated system of the universe, but the slightest motion of the most minute microscopic insect;—not only the sublimest conceptions of angels, but the meanest propensity of the most worthless of His creatures. At this moment, He is listening to the praises breathed by grateful hearts in distant worlds, and reading every grovelling thought which passes through the polluted minds of the fallen race of Adam.

Another difference between Divine and human knowledge, arises from the limited term of man's existence,

and the limited extent of his memory. Threescore and ten years sum up the days of his earthly career. In that short period, how little can he learn! How much of that little does he lose by inattention, or by defect of memory and judgment! From books, indeed, he may acquire some knowledge of the past; and from Revelation, still more, not only of the past, but of the present and future. But of what we learn from the works of fallible men, if we were to deduct all that is false or doubtful, how little would remain! And even of the unerring oracles of God, how much is there that we cannot fully comprehend!

To this, also, what a contrast do we find in the knowledge of God! At one view, He surveys the past, the present, and the future. No inattention prevents Him from observing; no defect of memory or of judgment obscures His comprehension. In His remembrance, are stored not only the transactions of this world, but of all the worlds in the universe;—not only the events of the six thousand years which have passed since the earth was created, but of a duration without beginning. Nay, things to come, extending to a duration without end, are also before Him. An eternity past, and an eternity to come, are, at the same moment, in His eye; and with that eternal eye He surveys infinity. How amazing! How inconceivable!

But while we thus do homage to the perfections of the Eternal, let us not undervalue the studies by which these perfections are elucidated. Though, when compared with the Divine mind, the mind even of a Newton must sink into utter insignificance; yet, to feeble man, it is great,—it is admirable,—to have removed the veil which lay on the face of nature,—to have pierced, with keen glance, to the suns of other systems, and to have known the law, so simple and so sublime, by which the beauty, order, and harmony of the universe, are sustained. By enlarging our views of nature, the philosopher enlarges our conceptions of Nature's God. He throws new light

on the power, the wisdom, and the infinity of the Creator;—and this is well, but it is not enough. Without a higher principle, his knowledge is ignorance; his wisdom is folly; his light is darkness. Every discovery which extends our conceptions of the Divine power, while it hides from our view the beauty and grace of his paternal character, only places man at a more awful distance from his Maker, and surrounds the throne of the Eternal with new terrors, till, in the full blaze of the Godhead, the corrupted child of earth shrinks,—is consumed,—is annihilated!

O! how unspeakably more cheering and glorious,—how infinitely better adapted to our condition and our wants, would be a simple message from the unseen world, intimating favour to the sinful and perishing race of Adam. And that message has been sent. The Almighty has broken the silence of nature, and sent that message by his own Son.

FIFTH WEEK—MONDAY.

VII. THE STARRY HEAVENS.—THE SATELLITES.

We have considered the arrangements of the planetary system, in reference to its stability, and to the diffusion of light and heat; but there is a contrivance of a different kind, which seems to require a slight notice. The existence of satellites, or secondary planets, as they are called, is a striking concomitant of the system. These smaller bodies attend the primary planets in their course round the sun, partaking of their motion, and at the same time wheeling round them, in an orbit of their own, at greater or less distances. Now, it has been remarked, that, speaking generally, these moons are bestowed as attendants on the planets, in some relation to their distance from the sun, increasing in number in pro-

portion as we recede from that luminary. The inferior planets, that is, those that are nearer the sun than our earth, have none. The Earth has one; Jupiter, which is five times more distant from the sun than our planet, has four; Saturn, which nearly doubles the distance of Jupiter, has seven, besides the curious anomaly of a ring; Uranus is known to have five, and may, in all probability, have many more, which the extreme remoteness of his situation, at the distance of one billion eighteen hundred and thirteen millions of miles, may well render invisible, even with the use of our best instruments. Supposing, however, that this is the case, there are still exceptions to the rule of increase. Mars, and the four other planetary bodies which are stationed between the Earth and Jupiter, have no attendants. As to the ultra-zodiacal planets, the peculiarity of their condition might lead us to expect this deviation; and though it may be more difficult to account for the want of an attendant in the case of Mars, there are few who, on this account, will withhold their assent to the truth of the general observation.

What purpose, then, do these secondary planets serve? This question has been well answered by Mr Whewell, in reference to our own moon, and in refutation of the sceptical doubts of Laplace. "A person of ordinary feelings," observes this sound philosopher, "who, on a fine moonlight night, sees our satellite pouring her mild radiance on field and town, path and moor, will, probably, not only be disposed to 'bless the useful light,' but also to believe that it was ordained for that purpose; that the lesser light was made to rule the night, as certainly as the greater light was made to rule the day.

"Laplace, however, does not assent to this belief. He observes, that 'some partizans of final causes have imagined, that the moon was given to the earth to afford light during the night;' but he remarks that this cannot be so, for that we are often deprived at the same time of the light of the sun and of the moon, and he points out

how the moon might have been placed so as to be always 'full.'

"That the light of the moon affords, *to a certain extent*, a supplement to the light of the sun, will hardly be denied. If we take man in a condition in which he uses artificial light scantily only, or not at all, there can be no doubt that the moonlight nights are for him a very important addition to the time of daylight. And, as a small proportion, only, of the whole number of nights are without some portion of moonlight, the fact, that sometimes both luminaries are invisible, very little diminishes the value of this advantage. Why we have not more moonlight, either in duration or in quantity, is an inquiry, which a philosopher could hardly be tempted to enter upon, by any success which has attended previous speculations of a similar nature. Why should not the moon be ten times as large as she is? Why should not the pupil of a man's eye be ten times as large as it is, so as to receive more of the light which does arrive? We do not conceive, that our inability to answer the latter question, prevents our knowing that the eye was made for seeing; nor does our inability to answer the former, disturb our persuasion, that the moon was made to give light upon the earth."*

To show that the light derived from the moon exhibits no proof of an Intelligent Cause, Laplace undertakes to suggest a better arrangement himself, and points out a position of that luminary, which would always cause her to appear full to the inhabitants of the earth. Mr Whewell answers this suggestion by proving, that such a position could only be found by placing the moon four times farther from us than she is at present, which would diminish her apparent size no less than *sixteen* times, and, of course, proportionally diminish her light. Whether or not this arrangement would be preferable to the present, may well be doubted; but even if its superiority could be demonstrated, it seems doubtful if the

* Whewell's Bridgewater Treatise, p. 174.

influence of the disturbing forces, which, on such a supposition, would certainly act more powerfully, would suffer the arrangement to be stable.

But, even allowing the full force to Laplace's objection, which the validity of his suggestion could with any show of reason afford, it amounts, after all, just to this, that the provision thus made for the comfort and happiness of living creatures, and especially of man, is mingled with imperfection and privation. Is not this, however, the precise character which is inscribed on all sublunary things? and does not the analogy which we here discover, serve to confirm the very view of the Divine perfections, as exhibited in his works, with reference to the moral government of the human race, which I have been endeavouring all along to establish? This is a chequered scene of brightness and gloom, of sunshine and shade, of enjoyment and depression; and such is the discipline best suited to our fallen condition.

In turning from our own satellite to those of the other planets, a similar train of reasoning may be applied. These nightly luminaries, attached to Jupiter, Saturn, and Uranus, certainly compensate, in some degree, by their numbers, for the increased deficiency of light arising from the remoteness of their primaries from the sun. This view will not be successfully redargued by the fact already stated, that Mars, and the four small planets, still more distant than he from the source of light, are destitute of these useful appendages. The answer to such an objection just is, that, according to the analogy of creation, we may expect exceptions for which we may be altogether incapable of assigning an adequate cause; but the ignorance inherent in our limited views, can never invalidate the evidence of facts and principles clearly established.

FIFTH WEEK—TUESDAY.

VIII. THE STARRY HEAVENS.—RELATIVE PROPORTIONS OF THE PLANETARY SYSTEM.

Before concluding our remarks on the system with which we are more immediately connected, it may be useful to take a general survey of the whole, in its relative proportions, that we may be enabled to form to ourselves some idea of the enormous scale on which even our comparatively diminutive department of the universe is constructed. It is exceedingly difficult for the mind to compare very great things with each other; because, beyond a certain point, all proportions seem to be lost in a kind of undefined immensity. We are commonly conversant with things on so minute a scale, being ourselves mere atoms, as it were, of a little planet, that it requires an effort to raise our thoughts to so vast a subject; and, in contemplating it, we are, at every step, forced to feel the inadequacy of our own powers of comprehension. It is reported of some savages, that the scantiness and trifling nature of the objects which occupy their attention, have so contracted their faculty of estimating quantities, that they have no means of enumeration beyond the number of their fingers; and all groups of objects above ten are expressed, in their language, by a word which implies what is innumerable, on account of its immensity. We are surprised at the want of comprehension which this indicates; but it is, in reality, only a greater degree of a defect which belongs to the condition of our nature and circumstances as human beings; and the astronomer himself, familiar as he is with numbers and quantities, the very statement of which startles a less practised mind, comes quickly to a point, at which, though his mechanical power of calculation may continue, his imagination flags, his judgment is confounded,

and he finds himself much in the state of the untutored savage.

The author from whom we yesterday made an interesting quotation, adverting to this difficulty, has taken an ingenious method of bringing the relative proportions and distances of the bodies connected with our system, nearer to a level with a common apprehension, by reducing their dimensions. "If we suppose the earth," says he, "to be represented by a globe, a foot in diameter, the distance of the sun from the earth will be about two miles; the diameter of the sun, on the same supposition, will be something above a hundred feet; and, consequently, his bulk such as might be made up of two hemispheres, each about the size of the dome of St Paul's. The moon will be thirty feet from us, and her diameter three inches,—about that of a cricket ball. Thus, the sun would much more than occupy all the space within the moon's orbit. On the same scale, Jupiter would be above ten miles from the sun, and Uranus forty. We see, then, how thinly scattered through space are the heavenly bodies. The fixed stars would be at an unknown distance; but, probably, if all distances were thus diminished, no star would be nearer to such a one-foot earth, than the moon now is to us. On such a terrestrial globe, the highest mountains would be about one eightieth of an inch high, and, consequently, only just distinguishable. We may imagine, therefore, how imperceptible would be the largest animals. The whole organized covering of such an earth would be quite undiscoverable by the eye, except perhaps by colour, like the bloom on a plum.*

* Sir John Herschel's illustration of the relative magnitudes and orbits of the planets is not less striking:—"Choose any well levelled field or bowling-green: on it place a globe two feet diameter, this will represent the SUN; *Mercury* will be represented by a grain of mustard-seed, on the circumference of a circle 164 feet in diameter from its orbit; *Venus*, a pea, on a circle 284 feet in diameter; the *Earth* also a pea, on a circle of 430 feet; *Mars*, a rather large pin's head, on a circle of 654 feet; *Juno*, *Ceres*, *Vesta*, and *Pallas*, grains of sand, in orbits of from 1000 to 1200 feet: *Jupiter*, a moderate sized orange, on a circle nearly half a mile across: *Saturn*, a small orange on a circle of four-fifths of a mile; and *Uranus*, a full-sized cherry or small plum, upon the circumference of a circle more than a mile and a half in diameter."

* Whewell's Bridgewater Treatise, pp. 273, 274.

"In order to restore the earth and its inhabitants to their true dimensions, we must magnify the length, breadth, and thickness, of every part of our supposed models, forty millions of times; and, to preserve the proportions, we must increase equally the distances of the sun and of the stars from us. They seem thus to pass off into infinity; yet each of them, thus removed, has its system of mechanical, and perhaps of organic, processes, going on upon its surface."*

While, by the process of diminution, we are enabled to form a clearer estimate of the relations of those vast bodies which exist in our system, we may accomplish a similar object by magnifying those which, from their minuteness, strain our imagination on the other side. By far the greater part of organized beings are so small, that the human eye in its naked state, formed only for the discernment of objects of practical utility, cannot detect them. These the microscope discloses; and, while they thus become apparent to the sight, it requires a similar process of the mind to bring their amazing minuteness within the scope of the understanding. "We know," says our author, "that we may magnify objects thousands of times, and still discover fresh complexities of structure. If we suppose, therefore, that we thus magnify every member of the universe, and every particle of matter of which it consists, we may imagine that we make perceptible to our senses the vast multitude of organized adaptations which lie hid on every side of us; and, in this manner, we approach toward an estimate of the extent through which we may trace the power and skill of the Creator, by scrutinizing his work with the utmost subtlety of our faculties."

These views are calculated to impress the mind with very elevated and interesting conceptions of the stupendous nature of those Divine perfections, by which our

system was originally called into existence, and is still upheld and governed; but it is, after all, but the entrance to a survey of the universe. The planetary system to which we belong, is but that of a single star; and, when we cast our eye over the heavens, and endeavour to rouse our faculties to the comprehension of the fact, that every one of those little twinkling lights with which the blue vault is bespangled, with the exception only of those few which are known to change their relative positions, is a sun like our own, and that each of them has, in all probability, a planetary system analogous to ours, we want words to express the sublimity of the conception, and receive a more vivid impression of the feelings of the poet of the Seasons, when, overpowered by the vastness of his subject, he exclaims,

> ——————— "I lose
> Myself in HIM—in light ineffable!
> Come, then, expressive silence—muse HIS praise."

FIFTH WEEK—WEDNESDAY.

IX. THE STARRY HEAVENS.—DISTANCE OF THE FIXED STARS.

THE precise distance of any of the fixed stars cannot be ascertained by such means as have hitherto been employed by astronomers, although it may be considered as certain, that the nearest of them does not approach our sun so near as *nineteen billions* of miles! The calculation by which this inconceivable distance is established, is entirely satisfactory, and may readily be understood. I shall state it in as popular a manner as I can. As the earth moves round the sun at the average distance of about 95,000,000 of miles, it follows that she must be nearer those fixed stars that lie in the plane of her orbit, at one period of the year than at another, by double that distance, or 190,000,000 of miles; but it has been found that an approach of this immense amount makes not

the very slightest perceptible alteration in the apparent size of these bodies; and hence we justly conclude, that 190,000,000 of miles is but as a point in comparison of the space which still intervenes between us and them. On this fact, we may form a loose estimate of a distance within which the stars, situated as I have mentioned, cannot be stationed. But we must take another and somewhat more scientific method of judging with regard to the distance of those stars which are otherwise situated. It might be expected, that the vast diameter of the earth's orbit would produce some perceptible amount of annual parallax in the stars; that is to say, that, in moving over this immense space, some change would be effected in their relative position, just as a lateral movement of a few miles along a road produces a change in the outline even of the most distant hills. Were this the case, the distance of the stars might be ascertained with some degree of accuracy. But it is not so: "After exhausting every refinement," says Sir John Herschel, "astronomers have been unable to come to any positive or coincident conclusion upon this head; and it seems, therefore, demonstrated, that the amount of such parallax, even for the nearest fixed star which has hitherto been examined with the requisite attention, remains still mixed up with, and concealed among, the errors incidental to all astronomical demonstrations. Now, such is the nicety to which these have been carried, that, did the quantity in question amount to a single second (that is, did the radius of the earth's orbit subtend, at the nearest fixed star, that minute angle), it could not possibly have escaped detection and universal recognition." Hence, by a simple mathematical process, he is led to the conclusion, that the distance of the stars cannot be so small as 4,800,000,000 radii of the earth, or 19,200,000,000,000 miles! But, for any thing we can tell, the very nearest of them may be much farther removed from us than even this inconceivable distance.

Now, with regard to the size of these bodies, remote

as they are, science has invented a way of forming some comparative estimate. Dr Wollaston, by experiments on the light of Sirius, the brightest of the fixed stars, has ascertained that his splendour, when it reaches our earth, is twenty billions of times inferior in intensity to that of the sun. That the sun, therefore, might be made to appear no brighter than Sirius, he would require to be removed from us 141,400 times his actual distance; but this is scarcely two-thirds of the distance beyond which we know the nearest fixed star to be actually placed. It follows, therefore, that the light of Sirius, and probably also his bulk is much greater than that of our sun. Dr Wollaston, on data that cannot easily be disputed, has assumed the distance of Sirius to be so great, that his intrinsic light must be nearly equal to *fourteen* suns. Sir John Herschel, taking a more modest and cautious, but perhaps not truer, estimate of his distance, concludes that, "upon the lowest possible computation, the light really thrown out by Sirius, cannot be so little as double that emitted by the sun; or that Sirius must, in point of intrinsic splendour, be at least equal to two suns, and is, in all probability, vastly greater."

I cannot better conclude this paper, than by the judicious remarks with which the eminent philosopher, above quoted, follows up his statements on the size and distances of the fixed stars. "For what purpose," says he, "are we to suppose such magnificent bodies scattered over the abyss of space? Surely not to illuminate *our* nights, which an additional moon, of the thousandth part of the size of our own, would do much better; nor to sparkle as a pageant, void of meaning and reality, and bewilder us among vain conjectures. Useful, it is true, they are to man, as points of exact and permanent reference; but he must have studied astronomy to little purpose, who can suppose man to be the only object of his Creator's care, or who does not see, in the vast and wonderful apparatus around us, provision for other races of animated beings. The planets, as we have seen, derive their light from the sun; but that cannot be the case with the stars. These, doubtless, then, are themselves suns, and may, perhaps, each in its sphere, be the presiding centre, round which other planets, or bodies of which we can form no conception, from any analogy offered by our own system, may be circulating."*

FIFTH WEEK—THURSDAY.

X. THE STARRY HEAVENS.—IMMENSITY OF THE UNIVERSE.

On casting the eye across the heavens, it is arrested by a streak of faint light, which passes athwart the whole sky, in the direction, speaking loosely, of east and west. This streak is called the milky way, in allusion to a well known childish fancy of heathen mythology. When we regard the stars, with reference to this permanent band, we find that, in proportion as they recede from it on either side, they gradually become less and less numerous, till, towards the extreme north and south, there is an obvious deficiency in the comparative richness of the garniture with which the mighty dome is adorned. On applying the telescope to the diffused light of this remarkable part of the heavens, the astronomer is lost in admiration to find that this appearance is occasioned by an amazing multitude of stars, too minute to be detected by the naked eye, and too numerous to be accurately calculated, "scattered by millions, like glittering dust, on the black ground of the general heavens." Sir William Herschel informs us, that, on calculating a portion of the milky way, about ten degrees long, and two and a half broad, he found it to contain 258,000 stars, a quantity so great, in so small a space, that the moon would eclipse 2000 of them at once! Now, all these are suns probably at as great a distance from each other, as

* Herschel's Astronomy, p. 380.

our sun is from Sirius,—a distance so incomprehensible, when stated in miles, that the best way of forming some clear idea of it, is to compare it with the velocity of some moving body with which we are acquainted. We know of nothing so swift as light, which moves at the rate of 12,000,000 miles in a minute; and yet light would be at least three years in passing between the sun and Sirius. Let any one, then, comprehend, if he is able, the distances implied in the conception, that the minute and thickly-studded sparks of the milky way, are suns, each so far separated from each other, that it would require three years for the light of the one to reach the other! And yet this astonishing view is not a mere gratuitous imagination, but a calm philosophical deduction from observed facts and obvious analogies.

But this stretch of the mental powers is little, compared with what is required for comprehending the conclusions we are led to form, from other celestial phenomena. In various parts of the heavens, and in all quarters, there are discovered either small groups of stars, or certain dusky spots, called nebulæ, which the power of the telescope has multiplied to thousands of greater or less distinctness and magnitude.* Now, these nebulæ, when subjected to a very strong magnifying power, generally resolve themselves into vast assemblages of minute stars, "crowded together," as Sir John Herschel expresses it, "so as to occupy almost a definite outline, and to run up to a blaze of light in the centre, where their condensation is usually the greatest." "Many of them," adds this astronomer, "are of an exactly round figure, and convey the complete idea of a globular space, filled full of stars, insulated in the heavens, and constituting in itself, a family or society apart from the rest, and subject

* "In the northern hemisphere, after making all allowances, those whose places are fixed cannot be fewer than between one and two thousand; and you will have a good idea how plentifully they are distributed, by remarking that this is at least equal to the whole number of stars which the naked eye perceives on any ordinary night."—*Nichol's Architecture of the Heavens, p.* 47.

only to its own internal laws. It would be a vain task to count the stars in one of these *globular clusters*. They are not to be reckoned by hundreds; and, on a rough calculation, grounded on the apparent intervals between them at the borders (where they are seen not projected on each other), and the angular diameter of the whole group, it would appear that many clusters of this description must contain at least 10,000 or 20,000 stars, compacted and wedged together in a round space, whose angular diameter does not exceed eight or ten minutes; that is to say, in an area not more than a tenth part of that covered by the moon."

Are these numerous spangles, suns like our own, separated from each other by distances similar to those by which our solar star is separated from the other stars of the group to which he belongs? And are we, then, to believe that the system of stars to which our sun belongs, is nothing else than a nebula? Immense as are the bodies which that system embraces, and extensive, beyond all human conception, as is the space which it occupies, must we conclude, that, if viewed from the distance of the other nebulæ of which we have been speaking, it would appear but as a little cloud, no bigger than a man's hand? Such is, in truth, the astonishing conclusion to which the study of celestial appearances seems almost inevitably to conduct us.

Now, if we are permitted, on such a subject, to argue from analogy, we may fancy to ourselves some such idea as this,—that each nebula or group of stars, bears the same reference to other groups which our planetary system does to the globes of which it is composed; and that, while they may be impressed with a rotatory motion round each other, like our satellites round their primaries, there is some central point of unknown position, and immeasurable dimensions, round which the whole groups of the universe revolve, like our little worlds round their sun. There are not wanting reasons for such a supposition, extravagant as it may appear.

The two great laws of gravitation and inertia, by which our own system is regulated and maintained, have been proved to exist with precisely the same powers, at least in some of the fixed stars. The probability, therefore, is, that these are universal qualities inherent in all material objects. This, being granted, seems to imply the necessity of a balanced rotatory motion in every system of worlds, for preserving the general equilibrium of the whole; because universal attraction must prevent any body from remaining absolutely stationary. Now, the same principle appears to apply to groups of systems which applies to systems themselves. Hence, we may infer a complication of movements of the most wonderful and extensive kind, combining not merely worlds with worlds, and systems with systems, but nebulæ with nebulæ, embracing the whole material creation, and extending to infinity. What a magnificent view does this afford of the works of the Eternal; and what a beautiful unity does it give to His operations! Could we but stretch our faculties to the conception, we might figure to ourselves the Almighty present, in some peculiar sense, in the centre of His works, and thence surveying the infinite machine which His hand has formed—groups upon groups, each containing tens of thousands of worlds, moving in constant succession before Him, without confusion, and without interference,—rolling in an ethereal fluid, which bears light and heat in the waves of its never-failing tide, and which communicates life, and intelligence, and joy, to organized existences over the whole,—reflecting, wherever they move, the perfections of an Eternal Mind, and experiencing, throughout all their members, and in all their revolutions, the blessings of a Father's smile.

FIFTH WEEK—FRIDAY.

XI. THE STARRY HEAVENS.—NEBULÆ.

Sir William Herschel, by the use of his powerful telescopes, has made other most interesting discoveries in the starry heavens, some of which it will be the object of this paper briefly to detail, as throwing light on the condition of the universe, and demonstrating that the same mighty hand, which "wheels the rolling spheres" in our own system, is equally employing its amazing powers in the most distant regions, and regulating the material world every where, so far as we are able to discern, by the same laws, under some remarkable varieties of application.

We have already noticed the wonderful discovery of the apparently general arrangement, whereby the innumerable suns, of which the universe is composed, are thrown into groups, each containing vast numbers of these splendid bodies, and comprehending systems of their own. Of these nebulæ, as they are called, our own seems to be of a singular figure, forming a stratum of which the thickness is small in comparison with its length and breadth, and which is divided into two branches, inclined at a small angle to each other, near the point in which our sun, with its planetary system, is situated. This figure seems, at least, to account for the appearances of the heavens, with their milky way, studded with innumerable stars, which branch off in one place in a remarkable manner from the main body, and which, as we have observed, decrease rapidly in numbers, in proportion to their distance from that singular belt. The other nebulæ are of various forms, and even seem to differ from each other in their nature. Sir William Herschel divides them into six classes, of which the two first appear to be distinguished merely by their relative distance from us, but the rest to be in a state altogether

different from any thing of which we have experience. These latter, he describes under the four heads of nebulæ, in which there is no appearance whatever of stars, planetary nebulæ, stellar nebulæ, and nebulous stars. Of these the variety is very great, some being formed of little flaky masses, like "wisps of cloud," adhering to small stars; others being of a round or oval form, increasing more or less in density and brightness towards the central point; others offering "the singularly beautiful and striking phenomenon, of a sharp and brilliant star, surrounded by a perfectly circular disc or atmosphere;" others, again, of more rare occurrence, are annular, exhibiting, in the central opening, a faint hazy light; and last of all, come nebulæ, which have "exactly the appearance of planets,—round, or slightly oval discs, in some instances quite sharply terminated, in others a little hazy at the borders, and of a light exactly equable, or only a very little mottled, which, in some of them, approaches in vividness to that of actual planets." These last are bodies of enormous magnitude,—so large, indeed, that they would include the whole of our planetary system within their diameter, forming masses of solid matter, if they are solid, such as the greatest stretch of imagination cannot grasp.

"The nebulæ," says the younger Herschel, "furnish, in every point of view, an inexhaustible field of speculation and conjecture. That by far the larger share of them consists of stars, there can be little doubt; and in the interminable range of system upon system, and firmament upon firmament, which we thus catch a glimpse of, the imagination is bewildered and lost. On the other hand, if it be true, as, to say the least, seems extremely probable, that a phosphorescent, or self-luminous matter also exists, disseminated through extensive regions of space, in the manner of a cloud or fog,—now assuming capricious shapes, like actual clouds, drifted by the wind, and now concentrating itself, like a cometic atmosphere, around particular stars;—what, we naturally

ask, is the nature and destination of this nebulous matter? Is it absorbed by the stars, in whose neighbourhood it is found, to furnish, by its condensation, their supply of light and heat? Or is it progressively concentrating itself, by the effort of its own gravity, into masses, and so laying the foundation of new sidereal systems, or of insulated stars?"*

The author naively remarks, that it is easier to propound such questions, than to offer any probable reply to them; and it would be well if other astronomers were to imitate the modesty and philosophical forbearance of this eminent man. But there are, unfortunately, philosophers, who feel pleasure in every conjecture by which an intelligent First Cause may be excluded from the universe; and the obscure and doubtful phenomena afforded by these nebulous appearances, have furnished one of the most profound mathematicians of his class† with a theory, by which he attempts to show, that the whole construction of nature depends on mere unintelligent mechanical powers. He supposes, for example, that our own sun, with his planetary system, was originally nothing else than a part of a universally diffused phosphorescent vapour, which, condensing into a nucleus, gave rise to a revolving sun, of excessive heat; that as the heat diminished, the solar atmosphere contracted, leaving portions of itself detached by the centrifugal motion, which became gradually condensed into solid planets and satellites; and these he, with much ingenuity, attempts to show, from mechanical considerations, would assume the form and motions which we find actually impressed on them. Mr Whewell mentions this "nebular hypothesis," as he calls it, and triumphantly shows, that even granting it could account for the phenomena, it could not be held, in the most remote degree, to prove the sufficiency of mechanical causes without intelligence and design. On this highly satisfactory reasoning I cannot enter, but must refer the reader to the work itself; and

* Herschel's Astronomy. † Laplace.

I am quite sure that no candid mind can resist the conclusion to which he comes, that, whatever may be the scientific merits of this hypothesis, they cannot, in sound reason, affect at all the view of the universe as the work of a wise and great Creator. "Let it be supposed," observes he in conclusion, "that the point to which this hypothesis leads us, is the ultimate point of physical science; that the farthest glimpse we can obtain of the material universe by our natural faculties, shows it to be occupied by a boundless abyss of luminous matter; still, we ask, how space came to be thus occupied,—how matter came to be thus luminous? If we establish, by physical proofs, that the first fact which can be traced in the history of the world is, that 'there was light,' we shall still be led, even by our natural reason, to suppose that, before this could occur, 'God said, let there be light.'"

Dr Nichol, who adopts the hypothesis of Laplace, as to the gradual conversion of nebulæ into stellar and planetary systems, and illustrates it in a very striking manner, deduces from it the following pleasing and sublime views:—"The ideas I have presented to you—august and strange though they are—should not appear in contradistinction to what every moment is passing around us. Supposing these phenomena did unfold the long growth of worlds, where is the intrinsic difference between that growth and the progress of the humblest leaf, from its seed to its intricate and most beautiful organization? The thought that one grand and single law of attraction, operating upon diffused matter, may have produced all those stars which gild the heavens, and, in fact, that the spangling material universe is, as we see it, nothing other than one phase of a mighty progress, is indeed truly surprising; but I appeal to you again, in what essential it were different from the growth of the evanescent plant? There, too, rude matter puts on new forms, in outward shape most beauteous, and in mechanism most admirable: and there *cannot* be a more astonishing process, or a mightier power, even in the growth of a world!—The thing which bewilders us is not any intrinsic difficulty or disparity, but a consideration springing from our own fleeting condition. We are not rendered incredulous by the nature, but overwhelmed by the magnitude, of the works;—our minds will not stretch out to embrace the periods of this stupendous change. But time, as we conceive it, has nothing to do with the question,—we are speaking of the operations, and tracing the footsteps, of one who is above all time,—we are speaking of the energies of that Almighty Mind, with regard to whose infinite capacity a day is as a thousand years, and the lifetime of the entire human race but as the moment which dies with the tick of the clock which marks it—which is heard and passes."*

FIFTH WEEK—SATURDAY.

XII. THE STARRY HEAVENS.—BINARY STARS.

THERE is yet another singular phenomenon in the starry heavens, which shall form the subject of this day's paper,—I allude to the curious fact of the existence of binary revolving stars. These are very numerous. Sir William Herschel has enumerated upwards of 500, and Professor Strave, of Dorpat, has recently added to this number between 2000 and 3000. When these combinations were first observed, it was thought probable, that their extreme apparent proximity would enable astronomers to ascertain their distance from the earth, by the discovery of an annual parallax; for supposing, as might naturally be expected, that one of the combined stars should be nearer the earth than the other, and that both should prove to be stationary in relation to each other, the motion of the earth in her orbit would cause these stars to alter their apparent position; and, if that should

* Architecture of the Heavens, pp. 143, 144.

be the case, even in the slightest appreciable degree, this circumstance would furnish data, on which calculations of the greatest importance might be founded.* This consideration induced Sir William Herschel to turn his attention to the double stars, and to subject them to careful and minute measurements; but he had scarcely begun this task, when he was arrested by phenomena of a very unexpected character. Instead of the effect which might be produced by the earth's annual motion, he observed, in many instances, a regular progressive change, "in some cases bearing chiefly on their distance; in others, on their position, and advancing steadily in one direction, so as clearly to indicate either a real motion of the stars themselves, or a general rectilinear motion of the sun and the whole solar system, producing a parallax of a higher order than would arise from the earth's orbitual motion, and which might be called systematic parallax."

* We may perhaps despair of fixing the distance of any but the very nearest of the fixed stars, by means of noting their parallax, *i. e.* the variation which takes place in their relative position in different parts of the earth's orbit; but there is another and highly ingenious method of determining the distances of the binary stars, which has been pointed out by M. Arago. This method depends on the progressive motion of light. If the orbit of a revolving star presents nearly its edge to the observer's eye, it is evident that during one half of its revolution it is constantly receding from the observer, and, during the other half, constantly approaching him. Supposing the light of that star to take thirty days in travelling to the earth from the nearest point of its orbit, it will require *more* than thirty days to reach the earth from the farthest point. Hence it will appear to spend more time in one part of its orbit than in the other; and the difference between the calculated and the apparent time of its transit through the nearest and farthest halves of its orbit, though it should be but a few seconds, will supply the astronomer with the data he requires. The two observed semi-revolutions differ from each other by the double of the time which the light takes to pass across the star's orbit. Hence half the difference of time expressed in seconds, and multiplied by 200,000, the number of miles which light traverses in a second, will give the diameter of the orbit. This element known, the distance from the earth is easily found. What a new accession to our knowledge will be acquired, when, by a long and careful observance of these double stars, this discovery is made. "The day in which the distance of a double star is determined," says M. Arago, "will be the day in which it may be weighed, in which we shall know how many millions of times it contains more matter than our globe. We shall thus penetrate into its internal constitution, though it may be removed from us more than 120,000,000,000,000 of leagues."

After a patient investigation of twenty-five years, the elder Herschel ascertained, what has been further established by subsequent observations, "that there exist siderial systems, composed of two stars, revolving about each other in regular orbits."* Between fifty and sixty instances of changes in the position of double stars, were adduced by this astronomer, in communications published in the Transactions of the Royal Society for 1803 and 1804. The revolutions of these combinations of stars round each other, are of extremely different periods, one in the Crown being completed in little more than forty years, while that which is found in the Lion, extends to a cycle of no less than 1200 years. Many of the double stars exhibit the curious and beautiful phenomenon of contrasted or complimentary colours. In such instances, the larger star is usually of a ruddy or orange hue, while the smaller one appears blue or green. The complimentary colour of the smaller star may, in some instances, be considered as an optical illusion; but the contrast cannot be thus accounted for in others. The double star in Cassiopeia, for instance, exhibits the beautiful combination of a large white star, and a small one of a rich ruddy purple. Sir John Herschel, in mentioning these combinations, indulges his fancy in the following somewhat amusing remarks:—"It may be easier suggested in words, than conceived in imagination, what variety of illumination *two suns*,—a red and a green, or a yellow and a blue one,—must afford a planet circulating about either; and what charming contrasts and 'grateful vicissitudes,'—a red and a green day, for instance, alternating with a white one, and with darkness,—might arise from the presence or absence of one or other, or both, above the horizon."†

Without entering into this speculation, which, of course, is taken from the views and tastes of human be-

* In some instances the combination consists of three stars, in others of four, and even of more, with very complex motions.

† Herschel's Astronomy, p. 356.

ings, and may or may not bear reference to the feelings of the animated creation in these distant worlds, I cannot dismiss this curious subject without a single remark on the beautiful variety which appears in the works of the Creator, combined with a sameness which gives evidence of the architecture of One creating hand. The revolving motions of these binary stars have been found to be governed by the same centripetal and centrifugal forces as regulate and preserve the order and harmony of our own planetary system. M. Savary, Professor Encke, and the younger Herschel, having each applied the Newtonian law of gravitation to the calculation of the elliptic orbits of binary stars, have thus elicited their periods, and the forms of their ellipses: and the correspondence between their calculated and observed places, has satisfactorily proved the existence of the law in these remote regions of the universe. Here, then, a new element is added to our knowledge of creation. The identity of the light emitted by the fixed stars, and by our own sun, had been previously ascertained, as well as various other particulars which seemed to mark these distant luminaries as belonging to the same universal system; but although, united with these considerations, the phenomena of comets seemed to intimate some connexion between the great laws which govern our own planetary worlds, and those of other suns, and although analogy certainly rendered the extension of these laws to all things created more than probable, it was not till the revolution of these binary stars was observed, and subjected to calculation, that the fact was demonstrated.

It is most curious and instructive to trace the same character in the operations of the Eternal, throughout every corner of His universe, which science unfolds to our view. It is true, that even now, after all the insight which astronomy has afforded of more distant worlds, it is but a faint glimpse that we obtain; but still that glimpse, while it opens up a profusion of wonders, establishes principles which connect system with system, and

group with group; and the gradation and variety which it displays, correspond so remarkably with what we perceive around us, both on the large and the minute scale, that we seem warranted in feeling confidence in our reasonings founded on these analogies, and while we trace every where the exercise of the same power and wisdom, may legitimately infer also, every where, the exercise of the same moral qualities.

SIXTH WEEK—SUNDAY.

DISCOVERIES OF THE TELESCOPE AND MICROSCOPE COMPARED.

The inconceivable space, and innumerable quantities, with which we become conversant in contemplating the phenomena of the heavens, while they stretch the human mind, till it is lost in infinity, are calculated to produce a peculiar effect on our religious views and feelings. They elevate our conceptions of the Creator, and fill us with the utmost astonishment and awe. But there is something so incomprehensible in the attributes of that Self-existent Being, by whose power these wonders were created, and by whose wisdom they are governed, as to overpower and confound the mind. In the presence of such a God, we appear to become as nothing; and, were we only to dwell on the immensities of nature, it seems as if we should scarcely be in a fit state for receiving the truths of Revealed Religion, or for cherishing those pious and filial affections, which the doctrines of the Gospel are so admirably adapted to excite. After wandering through the boundless realms of space, and observing worlds on worlds, and systems on systems, and even groups of systems on groups, in interminable succession, all glorious with the perfections of the Eternal, it is not easy to conceive, that the dreadful and stupendous Power, who created and sustains this infinite universe, should condescend to care for such worms of earth as we are,—much less that He should extend to us the tender affections of a Father. To think of such a Being as providing food for the ravens, and sustaining the sparrow in its flight, or even looking regardfully on man, and numbering the hairs of the hoary head, or counting the beatings of the infant's heart, seems, to the mind thus exclusively prepossessed, as little better than a fond and idle dream. A general Providence, such a mind will readily admit; but,

that the Creator and Sustainer of the universe should occupy Himself with the little affairs of such an insignificant and worthless creature as man, is a doctrine, to say the least, by no means so congenial to the habits of thinking which astronomy induces.

It is not, however, only in the large and magnificent scale of operations, to which the view of the starry heavens introduces us, that the perfections of the Creator are visible. We have seen, that the hand of the Almighty may be equally perceived to be at work in little things as in great. "The cattle on a thousand hills are His."—He not only created them, and endowed them with most wonderful instincts for self-preservation, and faculties for enjoyment; but adapts these instincts and faculties to the revolution of the seasons, and the revolution of the seasons to them. The deeper we examine this subject, the more powerfully are we struck with proofs of the minute and tender care of a Parent in making provision for the wants of His offspring. Descending from the larger to the smaller animals, we find no point in the scale where this parental character stops, or is even diminished. The same wise and most wonderful provision is made for the worm and the mite, as for the lion and the elephant,—their bodies are equally formed with consummate art, and equally contrived with amazing care, for the circumstances in which they are placed, and the means of subsistence and happiness within their reach.

Nor is this all: Science applies its skill to aid nature in investigating the little as well as the great. If, by means of the telescope, the astronomer has been enabled to lay open a thousand wonders of the starry heavens, hid from our unaided sight, and taught us to believe, that, after all, we are only on the threshold of discovery in this department; that we still see, "as through a glass darkly;" and that it is but a faint and feeble glimpse of creation which our most approved instruments can exhibit;—the microscope has directed our attention to wonders no less worthy of admiration on our own earth, and

I see strewed around me, with a profusion which baffles my every attempt to comprehend it, the evidence that there is no one portion of the universe of God too minute for his notice, nor too humble for the visitation of his care."

It gives me pleasure to conclude this quotation with the following well-known and highly-impassioned passage :—" I do not enter at all into the positive evidence for the truth of the Christian Revelation, my single aim, at present, being to dispose of one of the objections which is conceived to stand in the way of it. Let me suppose, then, that this is done to the satisfaction of a philosophical inquirer; and that the evidence is sustained; and that the same mind that is familiarized to all the sublimities of natural science, and has been in the habit of contemplating God in association with all the magnificence which is around him, shall be brought to submit its thoughts to the captivity of the doctrine of Christ. Oh! with what veneration, and gratitude, and wonder, should we look on the descent of Him into this lower world, who made all things, and without whom was not any thing made that was made. What a grandeur does it throw over every step, in the redemption of a fallen world, to think of its being done by Him who unrobed Himself of the glories of so wide a monarchy; and came to this humblest of its provinces, in the disguise of a servant; and took upon Him the form of our degraded species; and let Himself down to sorrows, and to sufferings, and to death, for us. In this love of a dying Saviour to those for whom in agony he poured out his soul, there is a height, and a depth, and a length, and a breadth, more than I can comprehend; and let me never, never, from this moment, neglect so great a salvation, or lose my hold of an atonement made sure by Him who cried, that it was finished, and brought in an everlasting righteousness."*

* Chalmers' Astronomical Sermons, pp. 115-120.

SIXTH WEEK—MONDAY.

WONDERS OF THE MICROSCOPE.—INFUSORY ANIMALCULES.

HAVING spoken of the wonders of the microscopic world, as a proof that there is nothing too little to be beneath the care of the universal Father, it seems desirable to follow out this statement by an induction of particulars; and I shall devote this paper to that department of animated nature which, on account of its extreme minuteness, escapes the human vision, unless assisted by the resources of art.

The microscope has revealed to human observation new races, and indeed new systems, of organized and living beings, whose existence, had it not been for the invention of that instrument, could have scarcely been suspected, and whose functions must have been entirely unknown. These are the most numerous of all terrestrial creatures, and exhibit properties which fill the mind with a kind of wonder, different from, but scarcely inferior to, that which is excited by the view of nature on the largest scale. Although they are so extremely minute, that a single drop of water may contain hundreds of them, and yet appear to the naked eye as pellucid as if it were a pure and simple globule of newly distilled dew, they are discovered, by the magnifying power of the solar microscope, not only to be animated beings, but to possess members, some of them formed in the most delicate symmetry, and all of them framed with consummate art. Their species are incalculably numerous, each adapted to the element which it occupies, and the peculiar sphere in which it is destined to move. They have obviously volitions, feelings, and preferences, like the superior animals; and, like them, they display symptoms of hatred and affection, of rapacity and contentment, of enjoyment and suffering. Here, then, is a new world of living beings, sufficiently resembling that in which we are ourselves destined to exist, to prove that

it is the work of the very same Creator; yet, as we shall presently see, so different in many respects, besides its extreme minuteness, as to show, still more distinctly, the inexhaustible resources of the Divine Mind, in the endless variety of created existences. The most minute of those animalcules which have been studied and delineated, are the *infusory*, that is, those which are found in liquids; and to these we shall at present confine ourselves. They have been divided into two classes, those with external organs, and those in which such organs are wanting. Of the former, seven genera have been enumerated, and 254 species; of the latter, ten genera, and 123 species. These, it is not to be doubted, form a very small part of the actual existences, many of which are so minute, that they elude the action of the most powerful magnifiers,—as may be safely inferred from the fact, that new species, descending in minuteness, have constantly been discovered, in proportion as the power of the microscope has been increased.

The wonderful diversity of shape in these animalcules has been thus described:—"Let one suppose himself transported to a region, where the appearance, figure, and motion, of every animal is unknown, and he will form some idea of the variety presented by a drop of an infusion, observed by means of the microscope. One animalcule is a long slender line; another is coiled up like an eel or a serpent; some are circular, elliptical, or globular; others a triangle or a cylinder; some resemble thin flat plates; and some may be compared to a number of articulated reeds; one is like a funnel, and another like a bell; and the structure of many cannot be compared to any object familiar to our senses. Certain animalcula, such as the *Proteus diffluens*, can change their figure at pleasure, being sometimes extended to immoderate length, and then contracted to a point; one moment they are inflated into a sphere, the next completely flaccid, and then various eminences will project from the surface, altering them apparently into animals entirely

different. Neither is the peculiar motion of animalcula less remarkable; in several species, it consists of incessant gyration on the head as a centre, or around a particular point, as if one of the foci of an ellipse; the progression of others is by means of leaps or undulations; some swim with the velocity of an arrow, and the eye can scarcely follow them; some drag their unwieldy bodies along with painful exertion; and others, again, seem to persist in perpetual rest."*

In turning to the organs of these microscopic animals, we shall find equal subject for admiration. Some take their food by absorption, being destitute of a mouth; others have a mouth, and several stomachs, amounting, sometimes, to the remarkable number of forty or fifty; some are without eyes, others have several; some have mandibles, and others have processes resembling eggs; while many have their mouths fringed with ray-like bristles. In many the internal structure is quite peculiar, in others it bears a remarkable analogy to that of higher species. Each class has its own particular food; some live on vegetable substances, others are predaceous, and others again seem to derive their nourishment entirely from absorbing the liquid in which they exist.

Let it not be forgotten, that all this minute organization, and these various appetites, habits, and motions, belong to existences too minute, in most instances, to be even discernible by the human eye; and we shall find it almost as difficult to stretch our imagination downwards, to the infinitely little among created objects, as it was to rise to the contemplation of the infinitely great. To the minute subdivision of matter there seems to be no conceivable bounds. This is not very hard to admit; but, to be compelled to believe that the most minute particle which our fancy can frame is an organized and living being,—that it has a complex system of members, each of which is most skilfully fitted for its pecu-

* Edinburgh Encyclopedia—article Animalcule, written by Dalzell, the Translator of Spallanzani.

liar functions,—that the processes of digestion, of nutrition, and of reproduction, are carried on in these invisible particles with equal perfection as in our own bodies,—that they have instincts, and habits, and powers of choice and of enjoyment,—all this appears so amazing, that the mind can scarcely yield itself to the belief. And, yet, why should it not? All magnitude and quantity are relative. We judge of them merely by the measure of our own experience; and, if we could but sufficiently disengage our minds to take an abstract view, we would perceive that there is, in reality, nothing more incredible in the subdivision and organization of what appears to us infinitely minute, than in the construction of the animals with which our senses are conversant.

Yet what an amazing view is opened up to us, of the Creator, and his infinitely diversified works! The exclamation of Pliny, with regard to insects, may, with peculiar emphasis, be applied to the wonders of the microscopic world:—*In his tam parvis, atque tam nullis, quæ ratio, quanta vis, quam inextricabilis perfectio!* It may be difficult to determine to what extent, or even in what manner, these innumerable myriads of invisible beings produce a salutary effect on the visible world; but we may be sure that it was not without a benevolent object that they were every where scattered over the world. Like the larvæ of certain insects, they probably act the important part of *scavengers*, in removing nuisances from the liquids in which they live, and preserving in them a healthy action. At all events, besides enjoying, as they doubtless do, a kind of happiness in themselves, they furnish food to animals of a somewhat higher species, while these, again, afford support to animals still higher in the scale, and so on, through all the gradations of animated beings,—one species preying upon another, and thus, by a mysterious arrangement, increasing the quantity of living creatures, by an increase of their means of subsistence. It is truly wonderful to observe the wise contrivances by which life is sustained, in all

its forms. First, from the crude earth springs the vegetable by which food is elaborated for living creatures; and then follow the countless hosts of invisibles, which prey on these, or their infusions, and on one another; and then, rising through numerous grades, in a thousand different forms, and with continually varying faculties and habits, come the various orders of sentient beings, which fill and adorn the visible creation, deriving their food, like their microscopic fellow-creatures, some directly from the vegetable kingdom, others from the bodies of animals which have died a natural death, and others again by the destruction of living creatures. Such is the law of existence, exhibiting the clearest evidence of wise contrivance, but yet marked in this, as well as in other particulars, with the peculiar character belonging to a world blighted with a curse.

SIXTH WEEK—TUESDAY.

I. PLANTS AND ANIMALS COMPARED.

It is my intention now to devote some papers to the consideration of what has been called the *hybernation* of plants and animals; but, before entering on this subject, I shall make a few observations on some of the general characters in which vegetables and animals resemble each other, and of others in which they differ. Such an examination is not only curious in itself, and satisfactory, as illustrating the remarkable unity of design which exists in creation, but useful to our purpose, as forming a proper introduction to the various particulars which I shall afterwards have to investigate.

The first and most important resemblance between plants and animals, is in their possessing what has been called a living principle. This constitutes the chief difference between organized and unorganized existences;

and it is only while it exists in the former, that these exhibit the other qualities by which they are distinguished from brute matter. What this living principle is, it may be impossible to say; but that it is something which possesses distinct properties, and performs peculiar functions, the most ignorant are aware. An animal breathes, and moves, and feels, and performs certain actions for a time: This is animal life. It then ceases to show any of these properties; it lies motionless and insensible; it undergoes rapid decomposition, and is resolved into its original elements: This is death. And something analogous to this takes place in plants. The living principle appears, indeed, under a different and less perfect modification; but still it is there. Although vegetable existences have no voluntary motion, they yet possess certain vital functions; they select and secrete their food; they grow; they expand and flourish: This is vegetable life. After a time, these functions cease; they droop, decay, and are decomposed: Their life is fled.

Both in animals and vegetables, the principle of life is endowed, or at least connected, with a power of repairing injuries to a certain extent, so as to reproduce decayed or destroyed parts. In both, also, there exists a power of reproducing the species. Nor is the similarity less remarkable in regard to a property, the existence of which, in vegetables, was, till lately, but little known,—I mean the circulation of a fluid through every part of the body. That the blood circulated through the veins of animals, was a fact which could never escape observation, although the principle on which this remarkable function depended, was but lately discovered; but it does not seem to have been suspected, till within these few years, that there was an analogous circulation through vegetable substances. That sap existed in plants, indeed, was a familiar fact, and even that it was to be found in greater profusion at one season than at another; but it now appears to be satisfactorily ascertained, that

there is a regular and periodical circulation of the sap from the root, through the stem of the plant, to the branches, buds, and leaves; and back again through the bark to the root; and that this circulation is as essentially necessary to the life and growth of vegetables, as the circulation of the blood is to the life and growth of animals.

In the manner of propagating the species, too, there are some curious resemblances between the vegetable and animal creation. Besides that the whole classes of plants, like animals, with few exceptions, are divided into male and female, there is another resemblance, which will scarcely be considered fanciful. All the winged tribes, and most of the inhabitants of the sea, as well as amphibious animals, reproduce the species by means of eggs. In like manner, the whole races of plants, from the moss to the tree, with scarcely any exception, propagate their species by means of seeds, which, in many remarkable particulars, deserve the name of vegetable eggs.

Animals seem to differ essentially from the vegetable kingdom, in the possession of sensibility,—a property which the Author of Nature has apparently denied to the latter. This quality forms the first step in the scale, by which the former rises above the latter; but, as it has pleased the Almighty to cause the various grades of existences to run, as it were, into each other, we see here, also, a connecting link of the chain, in the wonderful properties of the sensitive plant, with which most of my readers are probably familiar, which, as it were, simulates sensibility, and approaches so near this vital principle, that authors who delight in those theories which aim at confounding the distinctions that subsist among organized existences, have plausibly maintained the identity of the one with the other.

I have said that plants as well as animals select and secrete their food; but there is a marked difference both in the nature of the food, and in the process by which

this nourishment is conveyed and appropriated. The vegetable, adhering to the soil, draws its food from thence, through the medium of roots, by mechanical action, without volition, without feeling, and without locomotion; and that food is inorganic matter. The animal, on the contrary, seeks for its food by a voluntary action, receives it into its system by a mouth, digests it in a stomach, and rejects crudities by an intestinal canal. Its food is organized matter, either animal or vegetable; the Creator having appointed the nourishment of this superior class to be elaborated from crude and indigestible materials by the organized, indeed, but insentient creation below them. This is one of the wonders of that astonishing gradation of beings with which the world is stored, and cannot but be contemplated with admiration and gratitude.

The view which is presented to us, even on the most cursory contemplation of organized matter, as may be perceived from these remarks, is that of a comprehensive whole, united together with the most consummate wisdom, and beautifully harmonizing in all its parts; and this impression will be found to be mightily confirmed and strengthened, when we come to consider the details.

SIXTH WEEK—WEDNESDAY.

II. HYBERNATION OF PLANTS.—ADJUSTMENT OF THE CONSTITUTION OF PLANTS TO THE ANNUAL CYCLE.

From what has been already said, it appears that the chilly nature of the season is not the only cause of the changes in the vegetable kingdom, which begin in autumn, and are consummated in winter. The disappearance of flowers and fruits, the fall of the leaf, and the general sterility which prevails, are evidently the indications of a cycle, belonging to the constitution of this

department of nature, which corresponds with the cycle of the year, and affords, by its existence, a new proof of wise adaptation. The effects produced by the sudden occurrence of a tract of frosty and tempestuous weather in summer, compared with a similar occurrence in winter, has been elsewhere alluded to, as illustrative of this principle. But a thousand other illustrations might be given. There is something exceedingly interesting and instructive in this view of the subject. The nice adjustment of organic substances to climate, has already been slightly noticed; and, were this inquiry to be followed out in detail, it could not fail to afford conclusive evidence of the same kind of contrivance with that to which we are now adverting. Every where we should find the productions of the soil admirably adapted to their localities, as to nourishment and climate; and, in the physical distribution of plants, we should discover new grounds for adoring the perfections of the Creator. The most superficial comparison of the plants of tropical regions with those of the polar circle, would be sufficient for this purpose. In the diminutive *Empetrum nigrum*, with its well-flavoured berries, which forms probably the last link of the descending chain of fruits in our progress to the poles, we observe the same careful adaptation of vegetation to the circumstances of external nature, which forces itself on our view in the majestic and luxuriant productions of the equator.

In the extremes of climate, taken on the average, we have, as it were, permanent summer, on the one hand, and permanent winter on the other; but, in the temperate regions, we have a regular alternation of modified heat and cold, which requires a different constitution of the vegetable creation; and that constitution has been bestowed. We here find the gradual development of seeds, and shooting forth of buds and leaves, in spring; the vigour and prime of vegetation in summer; its maturity and commencing decay in autumn; its temporary death in winter. Now, what deserves to be peculiarly

remarked in this, is the adjusted correspondence of this annual revolution in plants, to the precise circumstances of the character and duration of the seasons.

That the stimulants of heat and cold exercise a considerable influence in promoting or retarding the periodical changes in the vegetable world, there can be no doubt; and this indeed is just one of those wise contrivances which indicate design, as, without this modifying power, a slight variation in the temperature of the season, such as frequently takes place in all countries, and especially in a changeable climate like ours, might be productive of fatal effects; but the influence of heat and cold does not extend beyond a certain range, and is undoubtedly controlled, as we have said, by another principle, which we have called the natural constitution of plants. If proof of this were wanting, we should find it in the fact, that fruit trees, for example, when transplanted from our northern temperate zone to that of the south, where the seasons are reversed, continue to flourish for several years in the winter months of these regions; and, for the same reason, plants from the Cape of Good Hope, and from Australia, transplanted to our climate, preserve their accustomed period of blooming, notwithstanding the influence of an altered climate. Of this the heaths of those countries which bloom in the most rigorous season of our year, may be taken as a familiar example.

It appears, then, that the functions of plants have a periodical character, entirely independent of heat and cold. Such stimulants could not produce the effects which actually take place, were not the plants formed by the Author of Nature to run their annual cycle. Now, let it be observed, that a year might, by possibility, be of any length. Instead of extending to twelve months, it might be completed in six, and all the seasons might be comprised in that period, or its revolution might be lengthened to double, or fourfold its present period. In either case, the adjustment which now takes place between the seasons and the constitution of plants, would be entirely destroyed, and an utter derangement of the vegetable world would take place. "The processes of the rising of the sap," says Mr Whewell, "of the formation of proper juices, the unfolding of leaves, the opening of flowers, the fecundation of the fruit, the ripening of the seed, its proper deposition in order for the reproduction of a new plant,—all these operations require a certain portion of time, which could not be compressed into a less space than a year, or at least could not be abbreviated in any very great degree. And, on the other hand, if the winter were greatly longer than it now is, many seeds would not germinate at the return of spring."

"Now, such an adjustment," adds this author, "must surely be accepted as a proof of design exercised in the formation of the world. Why should the solar year be so long, and no longer? Or, this being of such a length, why should the vegetable cycle be exactly of the same length? Can this be chance? And this occurs, be it observed, not in one, or in a few species of plants, but in thousands. Take a small portion only of known species, as the most obviously endowed with this adjustment, and say ten thousand. How should all these organized bodies be constructed for the same period of the year? How should all these machines be wound up, so as to go for the same time? Even allowing that they could bear a year of a month longer or shorter, how do they all come within such limits? No chance could produce such a result; and, if not by chance, how otherwise could such a coincidence occur, than by an intentional adjustment of these two things to one another?—by a selection of such an organization in plants, as would fit them to the earth on which they were to grow; by an adaptation of construction to conditions; of the scale of the construction to the scale of conditions."*

The concluding paragraph of the chapter from which

* Whewell's Bridgewater Treatise, pp. 28, 29.

we have just quoted, which carries the view of adjustment between organized existences and the annual cycle still farther, is also well worthy of being quoted:—"The same kind of argument might be applied to the animal creation. The pairing, nesting, hatching, fledging, and flight of birds, for instance, occupy each its peculiar time of the year; and, together with a proper period of rest, fill up the twelve months. The transformations of most insects have a similar reference to the seasons, their progress and duration. 'In every species, except man,' says a writer* on animals, 'there is a particular period of the year, in which the reproductive system exercises its energies. And the season of love, and the period of gestation are so arranged, that the young ones are produced at the time wherein the conditions of temperature are most suited to the commencement of life.' It is not our business here to settle the details of such provisions, beautiful and striking as they are. But the prevalence of the great law of periodicity in the vital functions of organized beings, will be allowed to have a claim to be considered in its reference to astronomy, when it is seen that their periodical constitution derives its use from the periodical motions of the planets round the sun; and that the duration of such cycles in the existence of plants and animals, has a reference to the arbitrary elements of the solar system,—a reference which we maintain is inexplicable and unintelligible, except by admitting into our conceptions an Intelligent Author alike of the organic and inorganic universe."

SIXTH WEEK—THURSDAY.

III.—HYBERNATION OF PLANTS.—PHYSIOLOGICAL CONDITION OF PLANTS DURING WINTER.

THE beautiful variety of shades in our woods and groves, towards the close of autumn, which the most in-

* Fleming's Zool. i. 400.

attentive observer must have admired, arises from the preparation which nature is making for the winter state of our shrubs and trees. The functions of the productive seasons are ended; the forest trees have completed their annual growth; the fruit-bearing trees have yielded their stores; and the leaves, which performed such an important part in these processes, being no longer useful, are to be dropped, that they may, by mingling with their parent earth, supply the waste of the vegetable soil, and repair its exhaustion from the efforts of the preceding year. The sap which had risen profusely in the beginning of autumn, to aid nature in giving maturity to the fruits, and vigour to the young branches, and thus to crown the labours of the year, having performed this important office, has begun to flow downwards through the inner integuments of the bark, thus completing its periodical circulation. The leaf and flower-bud, destined to be developed in the ensuing spring, have been already formed, and are carefully shut up in their winter cerements. The tree exposed naked to the wintry blast, is rendered, by a wonderful provision of the All-wise Creator, proof against the injurious effects of frost. It is in its state of hybernation, like many beasts and insects; for here, too, the analogy of nature is striking:—it has fallen into its winter sleep.

The proofs of this state of torpidity are numerous and interesting. Among these, the most familiar is that of the capability of removal, without material injury, to another place. There is no size or age of a tree which would prevent it from enduring transportation, at this season, with perfect safety, provided only it could be effected without greatly injuring the root; and it is only in winter that such an experiment can be performed with any chance of success. Why? Because the powers of nature are then suspended. The plant has ceased to draw nourishment from the earth, and its vital principle, though by no means extinguished, is in a state of temporary lethargy.

Now, the importance of this state of plants, in winter, will be obvious, if we consider the condition of the soil and climate of temperate regions, during that period. The genial warmth which caused the juices to flow is gone; the ground is frequently rendered, by frost, rigid and almost impenetrable; tempestuous weather would threaten the destruction even of firmly-rooted trees, did not the removal of the leaves admit a free passage to the wind through the branches; the cold would blast the delicate fibre of the growing shoot. All these dangers are either entirely provided against, or at least rendered by no means formidable, by the torpidity which invades the vegetable creation. The plant still lives, but its food is gone; its active operations would expose it to be the sport of the angry elements, and therefore it has retired within itself, like the coiled hedgehog, to sleep out the ungenial season, and to prepare, with new vigour, for the exercise of its renovated powers, in the coming spring.

Much less is known of the physiology of plants, than the interesting nature of the subject would lead us to desire; but there is one circumstance connected with their state in winter, which is too curious to be overlooked. The vital principle, whatever it may be, exerts a peculiar energy in defending them from the influence of frost. A very simple experiment, within the power of every person, will show this. Let a bud be cut off from the parent tree, and suspended, during a strong frost, either by a string, or even within a glass vessel, upon one of the branches, and it will be found that this severed bud will be completely frozen through, while all the buds still attached to the tree, are entirely unaffected by the cold. There is, then, a living power in plants which, of itself, resists, to a considerable extent, the effects of cold. But the Author of Nature does not rest the security of vegetable productions on this principle;—on the contrary, the safety of the bud, on which the future existence of the plant so materially depends, is

provided for by its careful envelopment in plies of scales, or within a downy substance, besides being often united together by a coat of resinous matter, of which latter state the horse-chestnut furnishes a familiar example. The intention of this kind of protection is distinctly indicated by the fact, that it occurs only in northern countries, the buds of trees in milder regions being destitute of the scaly covering. The security from injury, which the resinous coat affords, may be proved by a simple experiment. Let a bud of this kind be taken from the tree, and, sealing up the cut end, let it be plunged into water; and in this state it may be kept uninjured for several years. In tropical regions, the leaf or flower not requiring any such means of safety, starts into existence at once, without the intervention of buds,—another proof of the designing hand of Nature in this provision.

We have mentioned the power possessed by plants, in a living state, of resisting the effects of cold; and this fact has led some physiologists to conceive, that an internal heat is generated in plants, as it is in the animal frame. The experiments, however, which have been made to test this opinion, have been of somewhat doubtful result, though some curious facts have been adduced in confirmation of it. It is well known, for example, that snow dissolves more quickly in a meadow than on bare ground; and this has, with apparent force, been attributed to the existence of a slight degree of heat in the vegetation. In certain states of some plants, it has been ascertained, that heat is evolved. M. Hubert relates a striking example of this kind, in the spadices of a Madagascar plant,—the *Arum cordifolium*. On applying a thermometer to five spadices, which had unfolded in the preceding night, he observed a rise of 25° from the temperature of the atmosphere. The temperature became gradually lower, till, in the evening of the second day, the difference between the heat of the spadices and of the surrounding atmosphere, was only 7°. The observation which we have recorded above, of the power

of living buds to resist frost, Willdenow extends to the sap of trees, which, he says, will remain unfrozen in very intense cold. The case, however, is different, as he informs us, in plants of warm and hot regions. The sap of these plants congeals on a very slight cold, and the plants themselves decay; which shows a very remarkable difference between tropical plants and those of colder climates, and strikingly indicates intention. Another observation is, that, although the sap will not congeal in winter, yet, after the buds have been forced out by warm weather in spring, it will readily congeal on exposure to cold,—an effect which Dr Smith ascribes to "the increased susceptibility of the vital principle," at that season. Dead or diseased branches, too, are said to be more liable to be frost-bitten than living and sound ones. These facts, though not conclusive, seem to give probability to the opinion, that the degree of heat necessary to the support of vegetable life, in winter, is maintained by natural processes going on in the plant itself. But, whatever truth there may be in such an opinion, the facts themselves are sufficient to show the impress of an Intelligent Cause, in this, as in every other department of organized matter. We may not be able satisfactorily to trace all the various steps of the process, but we are able confidently to say, Here, too, is the hand of God.

SIXTH WEEK—FRIDAY.

IV. HYBERNATION OF PLANTS.—THEIR PHYSIOLOGICAL CONDITION CONTINUED.

We have already seen some of the provisions made for the preservation, during this inclement season, of plants of larger growth, which are exposed, leafless, and bare, to all the severity of a chilling atmosphere; and we are now

to mention other provisions for a similar purpose, which are no less admirable. One reason, as we have already hinted, why trees of great dimensions throw off their summer clothing of leaves, is, that they may more readily resist the force of the winds, which frequently blow with fury in the winter. But there are some trees which are not endowed with this property; among these, the pine tribe are the most common and conspicuous. Now, remark the contrivances by which the difficulty arising from such a deviation is met. In the first place, the leaves, if they deserve that name, instead of being broad and flat, like those of other trees, are rather in the form of bristles,—which shape suffers the wind to pass freely through, and offers the smallest resistance; and, in the second place, the roots of this class of trees are spread widely along the surface of the earth, laying fast hold of the soil, as they intertwine among each other, and insert their numerous fibres; by which contrivance they are able to stand firm upon their extended base, easily resisting the force of all ordinary tempests. This fact must have struck the mind of any one, who has happened to observe the great breadth of earth and of roots attached to a fir-tree overthrown by some furious storm.

There is a remark, of a more general nature, which occurs here. All trees are known to attach their roots to the soil, with more or less tenacity, in proportion to their exposure to the wind. There is nothing more familiar to the wood-forester than this striking fact, or more necessary for him to know. The trees, on the outside of a grove or wood of pine, are so firmly fixed in the soil, that scarcely any tempest can uproot them; and those shelter the rest, whose hold is not so secure. Were this outer ring to be cut down, the wind, thus suddenly let in, would be sure to injure the rest, and the safety of the whole wood might be endangered. Here we find an instance of adaptation to circumstances, which cannot be too much admired.

Other kinds of evergreens, which enliven the winter months, are to be found among shrubs, and some of the lower species of trees. These are more able to resist the fury of violent winds, on account of their diminutive height, which exposes a shorter, and therefore less powerful, lever to the action of this force, while their roots are equally adapted, with those of the pine, to the peculiarities of their nature. Besides this, the leaves of these hardy plants are generally of a solid texture, and glossy surface, well suited to resist the various vicissitudes of the season. Such delightful varieties seem to have been bestowed on us, for the purpose of affording relief from the stern aspect of winter; and the grounds of the rich show how well a judicious use of these, and of various herbaceous plants, can throw, over the bleakness of this gloomy season, some of the charms of summer.

If, from shrubs and trees, we turn to the numerous and useful classes of herbs, we shall find ourselves introduced into a new field of wonders. Some of these only survive till they have shed their seed in autumn; and, having thus provided for the propagation of their species, perish as individuals, and mingle with their parent earth,—resembling, in this respect, many species of insects. But others survive the winter; and of these, many die down to the root, and thus, like numerous animals, burrow, as it were, underground, where, in virtue of their combined torpidity and vital energy, they remain secure from the attacks of frost, even when it penetrates to their retreats. Here some of them are secretly preparing, by mysterious internal processes, for the coming spring; while others appear to lie entirely dormant, till more genial weather awake them from their deep sleep. Again, other classes of herbaceous plants continue to breathe the rigours of winter, cheering our otherwise desolate gardens and fields with their languid smile, and expanding their blossoms, or stretching their green leaves from soil bound in the iron fetters

of ice, or covered with a cold but bright mantle of snow. Of those species which survive the winter, some are biennial, and others perennial; and of the former species, it has been remarked, that, though their life may be prolonged by transplanting them, and thus retarding the period of flowering and bearing seed, yet no artificial means can prevent their decay, after they have provided for the future propagation of their species, by exercising this important function.

Cowper, with his usual piety and felicity, adverts to these paternal provisions of the God of the seasons:—

> "He marks the bounds which Winter may not pass,
> And blunts his pointed fury; in its case,
> Russet and rude, folds up the tender germ
> Uninjured, with inimitable art;
> And, ere one flowery season fades and dies,
> Designs the blooming wonders of the next."

Before closing this paper, we may just hint at another remarkable provision of Nature, with regard to plants, as applicable to the present season of the year,—that by which the vegetable principle acquires a kind of accelerated impulse, by being pent up for a more than ordinary period. Every one is familiar with the fact, that a cold spring retards the vegetation; and that, when this has been the case to a more than ordinary extent, a few days of warm weather succeeding, will cause a sudden and wonderful burst of vegetation, which soon compensates for the delay. Nature is in haste, as it were, to regain her lost time. This principle is peculiarly remarkable in very northern climates. Where the snow lies on the ground more than ten months of the year, as in Siberia and Lapland, spring, summer, and autumn, are all comprised in the short space of five or six weeks; and, during that period, the whole process of springing, growing, flowering, producing fruit, and ripening, is completed.

This is exemplified in a register kept of the Siberian vegetation, of which the following is a copy:—

July 1. Snow gone.
9. Fields quite green.
17. Plants at full growth.
25. Ditto in flower.
August 2. Fruit ripe.
18. Snow.

And from that time, snow and ice to 23d June, when they begin to melt.

This astonishing elasticity in the principle of vegetable life, is an exceedingly striking provision of the God of Nature, which indicates an admirable adaptation to a very peculiar state of climate. Where Nature sleeps for five-sixths of the year, the plants sleep during the same period; and yet, when they awake, they run their course, like other plants, only hastening their pace, that they may accomplish it within the allotted time.

SIXTH WEEK—SATURDAY.

INSTINCT.

In proceeding from examining the state of plants during winter, to the consideration of that of animals, the subject of Instinct forces itself on our attention. This is one of the most mysterious and wonderful of all the qualities inherent in organized beings, and, in its operations, exhibits so distinctly a Designing Cause, separate from the being which possesses it, as to be calculated, more perhaps than almost any other natural phenomenon, to carry to the inquiring mind a settled conviction of a supreme and intelligent Creator.

Instinct has been defined to be "the operation of the principle of organized life, by the exercise of certain natural powers, directed to the present or future good of the individual;" and it has been distinguished from reason, by considering the latter as "the operation of the principle of intellectual life, by the exercise of certain acquired powers, directed to the same end."* This definition, without entering into the theory with which it is connected, seems sufficiently accurate to answer our present object.

Symptoms of an instinctive principle, as thus defined, are to be found in various productions of the vegetable world. Two or three instances of this kind may be mentioned:—

A strawberry offset, planted in a patch of sand, will send forth almost the whole of its runners in the direction in which the proper soil lies nearest.

When a tree, which requires much moisture, has been planted in a dry soil, in the vicinity of water, it has been observed, that much the greater proportion of its roots have been directed towards the water.

Trees which have sprung up on a bare rock, will send out their roots in every direction, till they reach the soil below. Every one is familiar with this fact, who has frequented a wooded rocky district.

A fact of a similar nature, which is noticed, I think, by Lord Kames, and which I have myself witnessed, occurred at the Abbey of Sweetheart, in Galloway, where an ash-tree, growing on the wall which surrounds the abbey, after exhausting the small quantity of soil which had collected on its site, stopped from growing for a time, and seemed to unite all its strength in sending down a root to the ground. As soon as this root had established itself in the soil, the tree began again to flourish and increase, till it grew to a considerable size.

I have somewhere seen an account of a tree, which grew in the valley of the Earn, in Perthshire, if I mistake not, on a scanty soil, by the bank of a stream, over which, in its immediate vicinity, a foot-bridge, covered

* Good's Book of Nature," vol. ii. p. 141.

with turf, had been erected. The tree, taking advantage of this circumstance, pushed its roots through the dead turf of the bridge, till they fastened in the fertile soil which happened to lie on the other side of the stream; and then, swelling and strengthening its new organ of communication, drew sufficient nourishment from this source to supply all the wants of its nature.

All facts of this kind, and many more that might be mentioned, may, in my opinion, be clearly attributed to the principle of instinct.

Of instinct in animals, Dr Good gives the following curious notices:—"All the different species of birds in constructing their nests, not only adhere to a peculiar plan, but, whenever they can obtain them, to peculiar kinds of materials; but, if these materials be not to be procured, the accommodating power of the instinctive principle directs them to others, and suggests the best substitutes. Thus, the red-breast uniformly prefers oak leaves as a lining for her nest, wherever she can acquire them; but, if these are not to be had, she supplies the want by moss and hair. So, when the bird is of a small size, and the eggs are naturally numerous, the nest is always made proportionally warm, that the nestlings may all equally partake of the vivifying heat. Thus the wren, who lays from ten to eighteen eggs, constructs her little edifice with the greatest care, and of the warmest materials; while the plover and the eagle, whose eggs are so few, that the body may easily cover them, build with little solicitude, and sometimes content themselves with the naked cleft of a rock. And thus, too, in very cold winters in Lapland, the fond water-fowl will occasionally strip the down off its breast, to line its nest and protect its progeny. When a wasp, in attempting to transport a dead companion from the nest, finds the load too heavy, he cuts off its head, and carries it out in two portions."

These illustrations may suffice for the present, especially as by far the greater part of the facts relative to

the animal creation, which I am about to adduce, must be referred to the same principle. Instinct, I may add, as in some of the above instances, does not unfrequently resemble reason, and it may be united with, and modified by, this quality; but it may always be distinguished from it by this, that its operations are generally perfect of their kind; that its powers are precisely the same in all generations; that they belong, nearly in an equal degree, to all individuals of the same species; and that its functions proceed blindly towards the attainment of an important object, the use and tendency of which is not perceived by the creature itself.

I have said, that this principle is probably calculated, better than any other natural phenomenon, to lead the mind to an acknowledgment of a Divine hand. Let us revert, for a few moments, to this view.

In examining the general structure of the universe, we observe a few simple, though vast and comprehensive, powers inherent in matter, which, by their universal and uniform operation, move Nature with the same regularity as if it were a mighty machine impelled by brute force; and hence the indolent or sceptical may be inclined to rest in the existence of these powers as an ultimate fact, without seeking for an intelligent Creator, from whom they emanated, and by whom they have been adjusted and regulated. The same thing may take place in contemplating the structure of organized bodies. So much of mere mechanical power enters into every process of their formation, growth, and preservation, that, although it does seem to be the blindness of utter stupidity to deny to these productions unequivocal marks of wise and beneficent design, it is possible to conceive, that, in tracing the mere physical laws by which their various properties are governed, the cold calculations of a contracted mind may proceed no farther. On turning from these appearances of external nature, to the operations of rational creatures, such minds may be led to admire the wisdom which contrives, and the power and skill which executes,

the various plans of life, without directing one serious thought beyond the intelligence of the immediate agent. But it requires a still greater degree of obtuseness and of obstinacy, to resist the evidence of a designing and bountiful Creator, in the wonders of instinct. These are altogether independent of reasoning powers, and impel organized beings by a sagacity, obviously not their own, to compass important ends, which, though essential to the welfare, and even to the very existence, not only of the individual, but of the species, could not, by any possibility, be within their contemplation, being far beyond the range of their limited faculties. Here, then, there is a designing cause, distinct from, and superior to, the agent; and this is the more clearly discernible, because its operations are governed by other than mere mechanical powers. "I look upon instinct," says Addison, "as upon the principle of gravitation in bodies, which is not to be explained by any known qualities inherent in the bodies themselves, nor upon any laws of mechanism; but, according to the best notions of the greatest philosophers, is an immediate impression from the First Mover, and the Divine energy acting in the creatures; such an operation of the Supreme Being as that which determines all the portions of matter to their proper centre."

SEVENTH WEEK—SUNDAY.

ON SEEING GOD IN HIS WORKS.

Almost all men, not in the lowest stage of barbarism or degradation, are capable of admiring the beauties of Nature. Even the dullest and most unreflecting mind is, at times, more or less vividly impressed with the wonderful skill and beauty so profusely scattered over all creation. But the intelligent eye is always delighted, and frequently kindled into rapture, by the rich and splendid scenery that on every side solicits its attention. Our susceptibility of impressions of grandeur or beauty, deserves to be ranked among our original faculties; for it is observable in all classes of the human family,—refined and exalted in the bosom of the enlightened European, and not unfelt by the savage tenant of the African or American desert. A love of nature appears to be implanted in man, to feed the flame of religion in his soul,—to assist in leading him from the wonderfully contrived objects around him to a belief in an intelligent and bountiful Creator. We are told in Holy Scripture, that God never left himself without a witness to the human race, inasmuch as his power and goodness may be always clearly known from the exuberant plenty and beauty scattered over the earth, their magnificent abode. As they had hearts to feel a sentiment of gratitude for bounty lavishly bestowed, and understandings to reason from effects to causes, the ancient heathen were altogether inexcusable in not knowing the true God, the great First Cause of all, and the source of "every good and perfect gift." They wandered from the right way, only because they were heedless or wilfully perverse. Their feelings and powers became the instruments of their self-delusion; and, instead of seeing in nature a supreme and infinite God, they saw a thousand grovel-

ling divinities; and fancy lent all the fascinations of poetry to their corrupt and irrational mythology.

But if the heathen, who lived in times of rudeness and ignorance, were subject to condemnation for abusing their faculties and opportunities, how much more guilty are we in not seeing God in all his works? How much more worthy of punishment are we, if we turn not into their proper and legitimate channel that sympathy with external nature, and that instinctive admiration of the grand and the beautiful, with which we are endowed! The question is not,—do we, like the heathen of ancient or modern times, believe in a polytheism, and people with the vain creatures of our imagination, the regions of the land and the sea? for we at once, unintelligently, perhaps, and, as it were, mechanically, assent to the received truth,—There is one God; and we also readily acquiesce in the grave lessons that may be read us by some pious student of the book of Nature. But the inquiry to be made at our own hearts is, Do we *habitually* see the Creator in His works, and associate His glorious perfections with every witnessed specimen of His skill? We luxuriate in the glowing summer landscape; we there admire the universal flush of inanimate nature; we listen, with delight, to the sweet singing of birds, and the mingling murmurs of winds and streams: But do we straightway lift up our eyes to heaven in adoring gratitude, and own a God around us? or do all our feelings but minister to a luxurious sensibility, and evaporate in some poetic dream? When we survey, by night, the starry heaven, and direct our telescope to those countless worlds that there crowd upon the vision, are we lost in devout admiration of the wondrous universe of God? or do we merely resign ourselves to those emotions of sublimity that such a magnificent scene is so well fitted to awaken? We are too apt, and too habituated to behold the glories of creation, without looking farther. We are satisfied with a vague sentimental feeling of beauty, and think not of that Hand from

which all beauty flows. We are struck with the endless adaptations of the material world, but we do not always raise our thoughts to the great Designer. We analyze and admire the splendid machinery of the heavens, but we recognize not the matchless power of the Mechanist We philosophize, we speculate, we declaim, on the structure of a flower, or the mechanism of a planetary system, but only talk the while of *Nature* and her works, as if Nature—a mere fashioned mass of inert matter—were the parent of all things, and the grand object of our worship.

Would we read the book of Nature aright, and see God in his works, we must have recourse to the book of Revelation; for these two great volumes, written by the same hand, and for a similar purpose, cast a strong light upon each other. As the book of Nature, by the visible impress of Divinity stamped upon it, is fitted to prepare us for the more glorious display of the Divine perfections contained in the book of Revelation,—so is this latter the truest and safest guide to the profitable perusal of the former. In the Bible, the great productions and aspects of nature are always mentioned in connexion with the glory of God. They are introduced, often in strains of the boldest poetry, to teach the infinite power and goodness of Jehovah. We there find the noblest descriptions of natural objects ever penned; and one great moral runs through them all. Every masterly picture of the grand or the beautiful in nature, is but a delineation of God's wondrous attributes.

It is, therefore, a positive duty, sublimely taught us both by precept and example, to cherish a sense of the infinite skill and bounty displayed in creation. We should associate, with all that attracts the eye by its beauty, or excites our admiration by its delicate structure, the liveliest expressions of adoration and gratitude. Every survey of natural scenery, every examination of even the smallest of God's works, should be to us a devotional exercise. To a mind accustomed to consecrate

all its perceptions of beauty and design to the inward worship of God, every mountain and field, every leaf and flower, teems with instruction. The tiny wing of the ephemeral insect, as well as the noblest animal form, affords food for the loftiest admiration. The man of true piety and refined feeling, enjoys the beauties of nature with the keenest relish; for nature is but a pictured volume in which he reads the character of the Divinity. Every object that meets his eye, be it vast or minute, simple or complex, suggests exalted conceptions of Him

> "Who gives its lustre to an insect's wing,
> And wheels His throne upon the rolling worlds."

All our feelings and intellectual powers should be devoted to the glory of God, their Author and their End. Our purest sympathies, our liveliest sensations, our most exquisite perceptions, are due to His worship, and are all originally fitted to exalt our conception of His character. To behold the wonderful scene in which we are placed with the eye of reason, and with feelings of elevated devotion, is both our duty and our privilege. When we contemplate, therefore, the heavens with the sun, moon, and stars, which God has ordained,—the earth, with all its array of plants and flowers, and animated beings,—the sea, with its multitude of waves and living forms, let us gratefully adore the Almighty Creator, and exclaim with the Psalmist, "O Lord, our Lord, how excellent is thy name in all the earth!"

J. D.

SEVENTH WEEK—MONDAY.

REASON IN THE LOWER ANIMALS.

Instinct, if the definition which I have given of it in my paper of Saturday be correct, will not account for all the operations of the lower animals. Instinct is uniform.

It belongs to all the species nearly in the same degree. The young possess it as soon as they are produced; or, at least, as soon as their bodily powers will enable them to employ it, in as great perfection as the old. It is not communicated by instruction; it is not learned by experience. The young bee, for instance, the moment it leaves the cell where it has been produced and cradled, cleans its body, smooths its wings, then leaves its hive, and flies, without a guide or teacher, to the nearest flower, where, using its feelers, and inserting its proboscis, it sips the sweet nectar with which the Author of Nature has, for its use, filled so many vegetable cups, and then returns to its native roof, tracing its solitary way through the trackless air, and deposits the gleanings of its industry, to add to the hoarded treasures of the parent swarm. Then, again, it exudes the secreted wax from the rings of its body; and, still without instruction, begins to form those wonderful hexagonal cells, the scientific construction of which the mathematician has found such reason to admire. All this is instinct.

Yet, though there is wisdom here, it is not that of the animal, but of its Creator. It has been guided to these intelligent works by a blind impulse. This, however, is not the case with many of the actions of the inferior creation; and, however difficult it may be to draw the line between reason and instinct, I believe no person who has, without prejudice, studied the character and habits of the living creatures below him, will find it easy to deny them at least some glimpses of that higher faculty to which his own species has the most appropriate claim. A few well authenticated instances will illustrate this remark.

I have the following anecdote from a gentlemen* of undoubted veracity, and acute observation, in the vicinity of Dumfries. A few years ago this gentleman had beautified his residence, by converting a morass in its neighbourhood into an extensive piece of water, which he had

* James Lennox, Esq. of Dalscairth.

stocked with fish; and, as places of retreat for these tenants of his lake, he had caused numerous roots of trees to be thrown in here and there, which were usually hid below the surface. In the year 1836, however, the unusually dry spring caused the necessary supply of water unexpectedly to fail, and the pond sank so low, that some of the roots made their appearance, and on one of these, more elevated than the others, a pair of wild ducks constructed their inartificial nest; and the female had already laid some eggs, when the weather changed, and the descending rains having filled the streams by which the lake was fed, the surface gradually rose, and threatened to overwhelm the labours of this luckless pair, and to send their eggs adrift upon the waves. Here instinct had no resource. It was an unexpected occurrence, for which this faculty could not provide; but if any glimmerings of reason belonged to these fond parents, it might be expected to be exerted. And so it was. Both the duck and the drake were observed to be busily employed in collecting and depositing materials; presently the nest, which the rising waters had already reached, was seen to emerge as it were from the flood; more and more straw and grass were added, till several inches of new elevation was gained, and the nest, with its precious contents, appeared to be secure. Here the mother patiently brooded her full time; and one duckling rewarded her care; when, just as it had escaped from the shell, another torrent of rain fell, more sudden and more violent than the first; the water rose higher and higher; the nest, and remaining eggs, were swept away. In this emergency, the whole attention of the parents was given to the living progeny, which was safely conveyed by them to the shore, where another nest was constructed; and thus their sagacity and solicitude were finally crowned with success.

An example, it should seem, of a still higher order of intelligence, is recorded by Mr Jesse, in his "Gleanings in Natural History," which came under his own observation:—"I was one day," says he, "feeding the poor elephant (who was so barbarously put to death at Exeter Change) with potatoes, which he took out of my hand. One of them, a round one, fell on the floor, just out of the reach of his proboscis. He leaned against his wooden bar, put out his trunk, and could just touch the potato, but could not pick it up. After several ineffectual efforts, he at last *blew* the potato against the opposite wall, with sufficient force to make it rebound; and he then, without difficulty, secured it." If we can believe that this extraordinary action was any thing but an ebullition of anger which led him to puff away the root which he could not secure,—that this half-reasoning animal, as the elephant has been called, really intended the potato to rebound within his reach, it is impossible to deny the justice of Mr Jesse's conclusion, that it could not be instinct which taught him to procure his food in this manner; and that it must, therefore, have been reason which "enabled him to be so good a judge of cause and effect."

In some of the insect tribes, there seems to be an extraordinary faculty, which, if it can be called instinct, surely approaches to the highest faculty possessed by man,—I mean the power of communicating information by some natural language. Huber affirms, "that nature has given to ants a language of communication, by the contact of their antennæ; and that, with these organs, they are enabled to render mutual assistance in their labours and in their dangers, discover again their route when they have lost it, and make each other acquainted with their necessities." This power seems to be confirmed by what occurred to Dr Franklin. Upon discovering a number of ants regaling themselves with some treacle in one of his cupboards, he put them to the rout, and then suspended the pot of treacle by a string from the ceiling. He imagined that he had put the whole army to flight, but was surprised to see a single ant quit the pot, climb up the string, cross the ceiling, and regain

its nest. In less than half an hour, several of its companions sallied forth, traversed the ceiling, and reached the repository, which they constantly revisited, till the treacle was consumed. The same power of communication belongs also to bees and wasps; as may be proved by any one who carefully attends to their habits. This is their language, not of articulate sounds, indeed, but of signs,—a language which, as Jesse observes, "we can have no doubt is perfectly suited to them,—adding, we know not how much, to their happiness and enjoyments, and furnishing another proof that there is a God all-mighty, all-wise, and all-good, who has 'ornamented the universe' with so many objects of delightful contemplation, that we may see Him in all His works, and learn, not only to fear Him for his power, but to love Him for the care which He takes of us, and of all His created beings." Whether this power of communication be rational or instinctive, it is obviously only suited to be useful to a being possessed, at least to a certain extent, of intellectual faculties,—of the power of forming designs,—of combining, with others, to execute them,—of accommodating itself to circumstances, and, therefore, of remembering, of comparing, of judging, and of resolving. These are assuredly acts of reasoning; at least I know not under what other category to arrange them.

The instance which Dr Darwin gives of a wasp, noticed by himself, is in point. As he was walking one day in his garden, he perceived a wasp upon the gravel walk, with a large fly, nearly as big as itself, which it had caught. Kneeling down, he distinctly saw it cut off the head and abdomen, and then, taking up with its feet the trunk, or middle portion of the body, to which the wings remained attached, fly away; but a breeze of wind, acting on the wings of the fly, turned round the wasp, with its burden, and impeded its progress. Upon this, it alighted again on the gravel walk, deliberately sawed off, first one wing, and then another, and having thus

removed the cause of its embarrassment, flew off with its booty.

Here we have contrivance, and re-contrivance; a resolution accommodated to the case, judiciously formed and executed, and, on the discovery of a new impediment, a new plan adopted, by which final success was obtained. There is, undoubtedly, something more than instinct in all this. And yet we call the wasp a despicable and hateful insect!

There is, I am well aware, a great reluctance in some minds, to admit that any of the lower animals can be gifted with a faculty superior to blind unreasoning instinct. It is imagined that this would be to confound man with the brutes, and thus to deprive him of that distinctive superiority on which he founds his strongest argument for the immortality of the human soul. Of such a consequence I have no fear. It is not on natural arguments that the Christian's hope of future happiness is founded, but on that gospel, which has "brought life and immortality to light." Yet, I freely admit, that the argument from natural religion is satisfactory as a proof of the coincidence of revelation with the rational expectations, and the analogical reasonings, of man. But these expectations and reasonings are founded on stronger grounds than that of the absence of every thing approaching to reason among the lower animals, otherwise, I fear, they could not be readily sustained. Whatever may be their strength, however, it is delightful to know that our assurance comes from a higher source, and that we are not reduced, like one of the most enlightened and virtuous of heathens, to end all our anxious arguments on this most important subject, with the feeble and doubting conclusion, "*Quod, si in hoc erro, libenter erro.*"*

* Cicero.

SEVENTH WEEK—TUESDAY.

HYBERNATION OF INSECTS.—EGGS.

In attending to the state of animated nature in winter, as compared with that of summer, few things are more striking than the almost total disappearance, during the former season, of all the insect tribes. In the warmth and sunshine of the summer months, all nature was instinct with life; and the abundance and variety of the more minute animals could not fail to attract the observation, and excite the wonder, of all who have eyes to see. The bee, the dragon-fly, the butterfly, the gnat, and the midge, in all their varieties, with myriads of flies of other species, seemed to communicate life and enjoyment to the very air we breathe; while the worm, the beetle, the ant, the caterpillar, the spider, and innumerable other creatures, some of them too minute to be examined without the assistance of art, swarmed on every flower we plucked, and animated the very dust beneath our feet. Where now is all this busy world? Tribe after tribe, they have vanished from our view; and even in days of balmiest air, and brightest sunshine, we seek for them in vain. Has the breath of winter pierced through their tiny forms, and frozen the current of life at its source? And, if so, by what process of reproduction shall all their various species be reanimated in the returning spring? The inquiry is at once interesting and useful; and here, again, we shall have occasion to admire the inexhaustible resources of Divine intelligence.

Of some insect families, it is known, that all the individuals are destined to perish before the cold of winter arrives. The natural term of their existence is comprised within the span of a few months; and their periods of youth, of vigour, and of decay, nay, of resuscitation under new forms, and of the various stages of their

second or even third state of existence, have all been accomplished during the season of genial warmth; so that they naturally cease to exist before the heat which cherished them, and the food which sustained them, are withdrawn. Their modes of life will more properly form the subject of attention at another season; but at present we have to inquire into the provision of Providence, by which the various species are preserved after the whole race has ceased to live.

As the principle of equivocal generation is nearly exploded from natural history, it will readily be conjectured that the Creator must have provided for the preservation of the future generations of these animals by means of their eggs; and this, in reality, is the case. There are various conditions, however, that require to be fulfilled before this could be successfully accomplished. Not to advert, at present, to the wonderful but familiar contrivance of an egg containing the embryo of the future animal, a contrivance which shall afterwards be considered, it is to be remarked that, in the present instance, the egg must be endued with the quality of preserving its principle of vitality for several months, in circumstances which would have proved fatal to the animal itself; that it must only produce the living creature when the wintry storms are past, and when those vegetable substances have begun to appear on which that creature can subsist; and, that it must be so situated, and so endowed, as to be able, when animated, to find its way to the open air, and to its natural food. If any one of these conditions were wanting, it is sufficiently apparent that the species must perish.

Now, let us take an instance, and see what actually occurs. I select the case of the gipsey-moth, which I abridge from the article Insect Transformations, in the "Library of Entertaining Knowledge." The female of this insect has her body thickly covered with a soft down, of a hair-brown colour, apparently for the express purpose of enabling her to protect her eggs during winter;

and she follows the impulse of her nature, in a manner well worthy of notice. Having emerged from her pupa-case in the month of August, she enjoys life for a few days, and then prepares for the propagation of her species, after which she quickly dies. She places herself on the trunk of an oak or elm, invariably with her head downwards. Having made a bed or nest of down, by tearing it from her body, she lays an egg in it; and this egg being covered with adhesive gluten, attaches around it all the hairs of the down with which it comes in contact, and also sticks to the bark of the tree, from its being pushed home. Proceeding in this manner, she continues for several hours adding to the mass; but she does not, in general, finish the operation in less than two days, indulging in occasional rests. At intervals, she takes care to protect the eggs placed in the heap, which is made in a conical shape, with an exterior covering of the same down; and, it is not a little remarkable, that in the external coping, which is designed to keep out the winter rains, the hairs are carefully placed in a sloping direction, like the tiles on a house, or the pile of a well-brushed hat, pointing downwards, towards the base of the cone. The eggs, which are deposited with so much care, are destined to abide all the pitiless pelting of the storms of winter; for, although they are laid in the beginning of harvest, they are not hatched till the elm, which is to furnish food to the future caterpillar, comes into leaf in the following spring. This covering of down, from the manner in which it is tiled and brushed smooth by the mother moth, not only protects them from wet, but, being one of the best non-conductors, keeps them safe from the injury which they might sustain from severe cold, or what might be more fatal, from sudden alternations of heat and cold.

In the instance now detailed, there are some things worthy of particular notice; and, as it is a fair specimen of the wonderful instincts of insects with reference to the preservation of the species during winter, it may be

proper to make a few remarks on the subject. Let it be observed, first, that in the previous states of the insect, whether as a caterpillar or a chrysalis, it had no power of propagating its species. It is not till its last and most perfect stage that this faculty is bestowed; and it enters on that stage just in time to flutter awhile in the sunshine, and then to die before the cold of the waning year interrupts its enjoyments, withers the vegetables on which it feeds, and chills its delicate frame; and in time, too, to lay its eggs, that they may weather the coming storms of winter, which the parent could not endure, and be hatched when the breezes of spring begin to breathe softly, and nature again proceeds to scatter her stores of food. It cannot be here said, either that the insect dies from the inclemency of the season, or that the hatching of the eggs is retarded by the deficiency of warmth; for the season is still genial, when the former, having fulfilled the intentions of nature, ceases to exist, and months of weather not inferior to the heat of spring, succeed the depositing of the latter. It is no other than a wise Providential arrangement.

Another surprising feature of the instinct displayed by this moth (which, however, so far from being peculiar to the species, is only an instance of a general faculty affecting almost the whole insect creation), is the choice of the spot where she deposits her eggs. These eggs, when hatched, are destined to produce caterpillars, whose peculiar food is to be found in the leaves of the oak or elm. From all the trees of the forest, she, therefore, selects one or other of these as the place for depositing her precious gift to a future year, although it is not from them that her own means of subsistence are to be gathered; and, although, so far as we are able to judge, there is nothing in her condition, as a moth, which could lead to the preference.

We have already spoken of the remarkable manner in which the gipsey-moth protects her eggs from the weather; but it may be proper to make an observation or

two on the eggs themselves, applicable generally to all insect eggs, which are exposed to the storms of winter. The glutinous matter by which the eggs are united, when protruded from the insect, and which is so necessary for preserving them in a mass, and for fixing them to the spot, is found, contrary to the nature of many similar substances, to be insoluble in water, and therefore incapable of being affected by the copious rains to which they are destined to be exposed. But this is not so remarkable as another fact, which has been proved by some severe tests, and which shows how admirably the constitution of these eggs is adapted to the season of winter. Both Spallanzani and Hunter made experiments to ascertain the degree of cold which the eggs of insects were capable of enduring without injury; and we subjoin the statement of the latter:—"I have exposed eggs to a more rigorous trial than the winter of 1709.* Those of several insects, and, among others, the silk-worm, moth, and elm-butterfly, were inclosed in a glass vessel, and buried five hours in a mixture of ice and sal gum *(rock salt)*. The thermometer fell 6° below zero. In the middle of the following spring, however, caterpillars came from all the eggs, and at the same time as from those which had suffered no cold. In the following year I submitted them to an experiment still more hazardous. A mixture of ice and sal gum, with the fuming spirit of nitre *(nitrate of ammonia)*, reduced the thermometer 22° below zero,—that is, 21° lower than the cold of 1709. They were not injured, as I had evident proof, by their being hatched."

It is, indeed, a singular and unaccountable fact, that the eggs of these insects are incapable of being frozen even by the intense cold now mentioned. Spallanzani discovered this, by crushing some of them with the nail, when he found that their contents remained fluid; and

* The year 1709 is celebrated for its rigour, and its fatal effects on plants and animals. Fahrenheit's thermometer fell to one degree below zero, and yet the insects were as numerous in spring as ever.

he justly infers, that the included embryos remain equally unfrozen. The final cause of this is easily understood; but the chemical property which resists so severe a trial, has not been ascertained.

The modes by which instinct has taught insects to preserve their eggs during winter, are very various. One of these I have already detailed; but, before leaving the subject, there is another which, on account of its singularity, I cannot deny myself the pleasure of mentioning; I allude to the cochineal insects *(coccidæ)*, so called from one of the species furnishing the well-known valuable dye-stuff. These little insects contrive to render their dead bodies useful to their future progeny, by protecting their eggs from the severity of the weather. They die in the act of incubation. Their eggs are deposited under their bodies, which become glued to the spot, and thus serve as a covering. In this state the dead insects appear on the bark of trees, like small warts, of various forms. The mother is seldom larger than a pepper-corn, yet the number of eggs which she lays amounts to several thousands. Some of them secrete a sort of white silky gum, very like gossamer, as the first bed of their eggs. Some naturalists have supposed this substance to be of the nature of the spider's web; but the author of "Insect Transformations" says he has ascertained it to be "precisely similar to the gluten which envelopes the eggs of most insects."

SEVENTH WEEK—WEDNESDAY.

HYBERNATION OF INSECTS.—VARIOUS STATES.

Turning from the consideration of insect eggs, let us look to some of the other means which the Creator has employed for preserving these minute animals during the rigorous season of the year. Some assume the chrysalis form, in which state they require no food, and can endure