THE

# MOSAIC HISTORY

OF THE

## CREATION OF THE WORLD;

ILLUSTRATED BY DISCOVERIES AND EXPERIMENTS DERIVED FROM THE PRESENT ENLIGHTENED STATE OF SCIENCE; WITH REFLECTIONS, INTENDED TO PROMOTE VITAL AND PRACTICAL RELIGION.

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REVISED AND IMPROVED

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"Every man has a particular train of thought into which his mind falls, when at leisure, from the impressions and ideas which occasionally excite it; and if one train of thinking be more desirable than another, it is surely that which regards the phenomena of nature, with a constant reference to a supreme intelligent author.—*Bacon*.

FIRST AMERICAN, FROM THE SECOND LONDON EDITION.

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# PREFACE

## TO THE SECOND LONDON EDITION.

As God made man with a capacity susceptible of knowledge, so has he furnished him with the means of acquiring it. The Divine Being is incomprehensible to all but himself; for a finite capacity can never fully grasp an infinite object. Neither can he be perceived at all, only so far as he is pleased to reveal himself. He has given us a revelation of his nature, perfections, and will; which could never have been discovered by reasoning and conjecture. He has also favored us with a revelation of his works, without which the origin, constitution, and nature of the universe, could never have been adequately known. The origin, duty, and interest of man, are matters in which we are greatly concerned. How valuable then are the Sacred Scriptures!

The heathen world by wisdom knew not God. On theological subjects, the greatest Philosophers and Poets of whom antiquity could boast, were puerile in their opinions, and absurd and contradictory in their literary productions. Their progress in many of the sciences, and the polite arts, was considerable; but in religion they made none: not because they neglected to investigate the nature of it, as one observes; for there was not a subject they thought on, nor discoursed about, more than the nature and existence of the gods; neither was it for want of natural abilities, nor of learning, for persons who formed the brightest constellation of geniuses that ever illuminated the republic of letters, were devoted to the investigation of the principles and causes of things. Moses, the sacred historian, had access to the Fountain of knowledge, and has revealed the mystery that lay hid for ages, because he was taught it by the inspiration of the Almighty. By the Hebrew Lawgiver we are instructed concerning the Creation of the World; an illustration of whose account is attempted in the following pages.

The attention of the reader is called to that era when the elementary principles of matter were first produced, and the formation of creatures took place; when vitality was given to a vast variety of animals, and mind was infused into Man as the peculiar offspring of God: when motion was impressed on the universe, and the various Planets began their orbicular revolutions: when Time commenced, and

"History, not wanted yet,
Lean'd on her elbow watching Time, whose course
Eventful should supply her with a theme."

What a stupendous fabric is Creation! a marvellous display of omnipotence! It is infinitely diversified, and magnificently grand. Ten thousand objects strike the attentive eye, and afford inexpressible delight to a contemplative mind. The blue ethereal arch is highly illuminated, and richly adorned with sparkling globes of light—whose number, distances, magnitudes, motions, and influences, elude the most diligent research: these millions of suns, the glory of other worlds, are equally the works of the Creator, and, with rays of dazzling splendor, irradiate the peculiar systems to which they belong: and, while they celebrate his wisdom and power, form a brilliant canopy over our heads. That golden globe of light, which is the center of our planetary system, shines forth in his glory, and spreads abroad the lucid day: he does not only emit his cheering rays to surrounding orbs, some of which revolve at immense distances, but, in running his prescribed course, measures out our time, renders our hours joyful, and without whose reviving beams we should dwell in perpetual darkness. The pale silver Moon gilds tne shadows of the evening, and directs the feet of the benighted and lonely traveller in safety to his abode.

In the lower walks of Nature, we perceive numerous assemblages of creatures, which, calling forth the exercise of our understanding, raise our admiration. The vapors arise, unite in the aerial regions, and descend in rain, snow, or hail, according to the different temperature of the climates; and thus the valleys are watered, the green carpet is spread under our feet, delightfully adorned with fruitful trees and variegated flowers. The vast collections of water, called seas, are stored with innumerable finny inhabitants, both small and great, which are amply supplied with necessary food. On earth, there are the wild beasts of the forest, the roaming cattle of the desert, the domestic animals of the field, the feathered tribes with their glossy plumage and delightful notes, beside an incredible number of living creatures that escape the utmost vigilance of the unassisted eye: which are all effects of infinite skill, omnipotent energy, Divine munificence, and conspire to utter his praise. The sultry regions are fanned with cooling breezes, which revive the numerous classes of creatures, and without which they would otherwise faint. But of all the visible effects of omnific power and uncreated goodness, Man has a claim to the first rank, for in his composition are mysteriously joined both matter and spirit.

How wonderfully has God displayed his wisdom, power, and goodness, in the creation of the Universe! What are the most labored and diversified works of Art, when compared with the majestic grandeur and sublimity of those of Nature! The things on which the fertile imagination of man has long been employed, when considered in a detached point of view, gratify our curiosity, raise our admiration, and gain our applause; but when compared with the productions of the Divine Hand, they sink and are deprived of their lustre, like the sparkling glow-worm in the copse, when the Sun shines forth with the refulgence of his meridian splendor.

Religious instruction is here mixed with philosophical discoveries. The works of Nature conduct an enlightened mind to the great Creator. The celebrated Dr. Watts, with this point in view, says,

> "Part of thy name divinely stands,
> On all thy creatures writ,
> They show the labor of thy hands,
> Or impress of thy feet."

Mr. Adams, in his Lectures, says, "The two kingdoms of nature and grace, as two parallel lines, correspond to each other, follow a like course, but can never be made to touch. An adequate understanding of this distinction in all its branches, would be the consummation of knowledge." Stephens, in his Human Nature Delineated, says, "The man who would seek after knowledge in this world, and happiness in the world of spirits, I would advise to pursue his studies without any other guides than the Word and the Works of God." And Dr. A. Clarke, on John iv, 3, affirms, that, "properly understood, earthly *substances* are the types, representatives, and shadows of heavenly things." St. Paul appears to inculcate this idea where he says, "Now we see as through a glass, darkly: but then face to face." The word αινιγματι, rendered *darkly*, is peculiarly important, and the right knowledge of which will assist us to understand his meaning. Parkhurst gives the following definition of the *term* and the *thing*. "Αινιγμα from ηνιγμαι, the *perfect passive* of αινιττω, to *hint, intimate, signify with some degree of obscurity;* an *enigma*, in which one thing *answers* or stands in *correspondence to*, or as the *representative* of another; which is, in *some respects, similar* to it, occurs 1 Cor. xiii, 12. *Now*, in this life, *we see by means of a mirror* reflecting the images of heavenly and spiritual things, εν αινιγματι, *in an enigmatical manner*, invisible things being represented by visible; spiritual, by natural; eternal, by temporal; *but then*, in the eternal world, *face to face;* every thing being seen in itself, and not by means of a representative or similitude."

The idea thus suggested, induced the author to engage in the following work: he thought that if the Mosaic account of the Creation were given in detail, each day apart, using the aid afforded by the present enlightened state of science, and directing the reader to look

"Through Nature, up to Nature's God."

the work would be instructive, and might tend to cultivate the mind and amend the heart. And he is happy that he has it in his power to say, that the plan has obtained not only the general approbation of orthodox and pious Christians, but the warm encomiums of many Ministers of the Gospel, both of the Establishment and among the Dissenters. He has received very flattering Epistolary Communications from persons of piety, literature, and science.

The author has availed himself of various sources of information: some of the best works published on different illustrative subjects have been consulted: and those on Natural History and Chemical Science were found of considerable service. That part which treats on the Anatomical structure of Man, the reader will perceive is written by a gentleman deeply versed in Physiological science. It is from the pen of the late Benjamin Gibson, Esq. who filled the important situations of *Vice-President of the Literary and Philosophical Society of Manchester, and Surgeon to the Infirmary of that town:* and who, unexpectedly, and in the most obliging manner, offered to prepare a Manuscript for this work, which gives it a peculiar excellence it otherwise would not have had.

The favorable reception which the former large edition has met with from the public, and the consequent demand there was upon the author to prepare a new one, produced a considerable excitement in his mind; and, under these circumstances, it was not less his wish, than it has been his endeavor, to make the second edition more worthy to meet the public eye, as well as more extensively useful. The *whole* of the work, with the exception of that part by Mr. Gibson, therefore, has been written anew, and such important additions and arrangements made, as will, he trusts, meet the approbation of his readers. He has received assistance from a writer of eminence, whose name, were he at liberty to mention it, would do honor to his work, and whose corrections have increased its value. The Religious Improvements he believes to be natural and scriptural, and hopes they may be read with advantage by all Christians who have received the truth as it is in Christ. He can say, that he has endeavored to make the whole work both instructive and useful, so far as his leisure from arduous ministerial duties would allow him: by directing the attention of the reader to God, through the medium of his visible works, and by that means to inculcate true religion and genuine piety. May the Divine blessing render this additional effort successful!

# PREFACE

## TO THE AMERICAN EDITION.

THIS work, which is now presented to the public, has not been reprinted in America heretofore, notwithstanding it passed through *two* editions in England, with honorable approbation, in a short space of time. This first American edition, it is confidently believed, will be received with approbation; because the work will be found, on perusal, to answer to its title; and surely no subject can interest the Christian and intelligent reader more deeply, than the *illustration of the creation of the world, as recorded by Moses, the servant of God.*

This volume inspires a deeper interest when the reader is promised, that the illustration of this splendid subject shall be *by means of the discoveries drawn from the present enlightened state of science.* Thus the reader will see clearly confirmed this glorious truth: *Religion and Literature are mutual helpmates to the knowledge, love, and glory of God.*

This important truth has been strangely obscured for several ages; but is now emerging to light with increased splendor. Nor is it important to inquire, at this stage of mental improvement throughout the civilized world, the cause of its obscuration, but rather to rejoice, that it is now assuming its place as a fundamental principle in sound philosophy. It is the duty of every benevolent individual to contribute according to his ability, to an inseparable union of sound literature and vital religion. The one will secure the interests and success of the other, and both combined, the glory of God.

Our author, in this respect, has been very happily successful. He has, generally, illustrated the various parts of the Mosaic Creation, with perspicuity and precision, and then applied the whole to the production and support of vital piety in the heart of the reader. So that while the astonishing magnificence, glory, and wisdom of creation, fills the contemplative mind with admiration, the heart also is fired with an ardent and rational devotion.

The character of this volume is, therefore, neither *purely* scientific, nor *purely* devotional; but both wisely and happily combined, under the high and direct sanction of revelation.

It will be apparent to every person, by a mere glance at the size of the volume, that it is not intended to contain all the *minutiæ* connected with the Mosaic Creation, but the principal, and most important facts, so as to make the work suitable to the great mass of intelligent and thoughtful readers. This object it will be found to have well accomplished.

The *improvements*, which are mentioned in the title-page, have been added to the American edition, with design to adapt the work more nearly to the wants of the American public. They are found incorporated in the body of the volume, in smaller type, and enclosed in brackets; which was judged to be the best method.

These additional papers are written at some length, principally on topics which have become more prominent since our author finished his work, and which are now exciting intense interest in this country. They are, therefore, considered to be real and interesting improvements to the American edition.

Finally, the author of these additional papers, would respectfully commend this American edition of the Mosaic Creation, illustrated by means of the present enlightened state of science, *to the friends of* LITERATURE AND RELIGION COMBINED *for the instruction and salvation of mankind, and for the glory of God.*

J. P. DURBIN.

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THE

# MOSAIC HISTORY, &c.

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## CHAPTER I.

### ON THE CREATOR OF THE WORLD.

Distinguished by his name JEHOVAH—His essence and self-existence expressed by the words I AM—His attribute of goodness the glory of all his other perfections—Elohim signifying a Trinity of Persons in a Unity of Essence—The Creation ascribed to one God, the Father, the Son, and the Holy Spirit—The first production of matter—The creatures made for the manifesting of God's attributes, and that he might impart happiness to them.

As it is proposed, in the following pages to give the Mosaic account of the creation of the world, it is very natural that the mind should come to the meditation of this interesting subject, by contemplating the character of the Great Creator, according to his own revelations.

It is evident that God made himself gradually known, as the state and condition of mankind required. In the earlier ages of the world, while revelation was but dawning on the human race, he was but little known, in comparison of the subsequent diffusion of his glory and perfections. When he, according to his promise, came to deliver the children of Israel out of Egypt, he revealed himself to them by his name JEHOVAH. He had before declared himself by this name to Abraham, Isaac, and Jacob; but not as it imports the performance of his promises; in which sense, their posterity afterwards, in the time of Moses, well understood it.

Of all the names which the Divine Being has been pleased to designate himself by, that of JEHOVAH is the greatest. It comes from a root which imports his eternity, independency, efficacy, and truth. In the Hebrew it is written with four letters, י *yod*, ה *he*, ו *vau*, ה *he*, thus יהוה i. e. JHVH :* the points used in that language, make our English word consist of seven letters, JEHOVAH. God himself gives the interpretation of this name. "And the

* As the name *Jehovah*, in the Hebrew, consists of four letters, so for the most part the name of the supreme Being does in all languages. Thus among the Persians, the name is Σορυ ; among the Arabians, *Alla;* among the Assyrians, *Adad;* among the Egyptians, Θωυθ or Θευθ ; with the Grecians, Θεος ; the Latins, *Deus;* the French, *Dieu;* the Spaniards, *Dios;* the Italians, *Idio;* and with the Germans, *Gott.*

The name *Jehovah* is written differently. Sanchoniathon writes it *Jevo;* Diodorus the Sicilian, Macrobius, Clemens Alexandrinus, Jerom, and Origen, *Jao;* Epiphanius, Theodoret, and the Samaritans, *Jabé* or *Javé:* we find likewise *Jahoh, Javo, Jaou, Juod.* Lewis Capellus is for *Javo;* Drusius for *Javé;* Mercer for *Jehevah;* Hottinger for *Jehva.* The Moors call their God *Juba,* whom some believe to be *Jehovah.* The Latins probably took their *Jovis* or *Jovis Pater* from *Jehovah.* It is certain that these four letters may likewise be expressed by *Javo, Jaho, Jaou, Jevo, Javé, Jehvah,* &c. Mussulmen frequently use the name, *Hu,* or *Hou,* which has almost the same signification as *Jehovah,* i. e. *He who is.* But the great name of God is *Allah,* which they pronounce often, and have great confidence in. Among the Arabians, and all Mahometans the name *Allah* corresponds with the *Elohim* and *Adonai* of the Hebrews, and even that of *Jehovah.* See Calmet's Dictionary.

Lord passed by before him, and proclaimed יהוה YEHOVAH, the LORD GOD, merciful and gracious, long-suffering, and abundant in goodness and truth, keeping mercy for thousands, forgiving iniquity, and transgression, and sin, and that will by no means clear the guilty." These different names have been considered as so many attributes of the Divine Nature. Commentators divide them into eleven, thus: 1. יהוה JEHOVAH. 2. אל EL, the strong or mighty God. 3. רחום RACHUM, the merciful Being, who is full of tenderness and compassion. 4. חנין CHANUN, the gracious One: He, whose nature is goodness itself—the loving God. 5. ארך אפים EREC APAYIM, long-suffering, the Being who, because of his goodness and tenderness, is not easily irritated, but suffers long and is kind. 6. רב RAB, the great or mighty One. 7. חסד CHESED, the bountiful Being: He who is exuberant in his beneficence. 8. אמת EMETH, the Truth, or true One: He alone who can neither deceive nor be deceived—who is the Fountain of truth, and from whom all wisdom and knowledge must be derived. 9. נצר חסד NOTSER CHESED the preserver of bountifulness: He whose beneficence never ends, keeping mercy for thousands of generations—showing compassion and mercy while the world endures. 10. נשא עון ופשע וחטאה NOSE *âvon vapeshâ vechataah:* He who bears away iniquity and transgression and sin; properly the REDEEMER, the Pardoner, the Forgiver, the Being whose prerogative alone it is to forgive sin, and save the soul. נקה (לו) לא ינקה NAKEH *lo yinnakeh*, the righteous Judge, who distributes justice with an impartial hand; with whom no innocent person can ever be condemned. 11. And פקד עון PAKED *âvon*, &c. He who visits iniquity; he who punishes transgressors, and from whose justice no sinner can escape. The God of retributive and vindictive justice. These eleven attributes, as they have been termed, are all included in the name *Jehovah;* and are the proper interpretation of it.*

The Jews had a superstitious respect for this name; and, after the Babylonian captivity, discontinued the use of it, which caused them soon to forget its true pronunciation. They called it the *Tetragrammaton*, or four-lettered name of God, which, to the present day, the Jews will neither write nor pronounce. They deemed it to be ineffable; and therefore when it occurred in reading the Scriptures, substituted אדני *Adonai.*

The Jews tell us that the woman's son, mentioned in Lev. xxxiv, 11, was accused of blasphemy and stoned to death, because he pronounced the name *Jehovah.* But I conceive, that he had spoken contemptuously of God. We read, verse 10, that he and a man of Israel strove together, and it is probable that the Israelite, in the heat of contention, would deny his being a member of the church of God, because he was the son of an Egyptian father

* Dr. A. Clarke on Exod. xxxiv, 6, 7.

who was an idolater; whereupon, no doubt, the son of the Israelitish woman spoke scornfully and opprobriously of the God of Israel, despising the privilege of being one of his people. This, I imagine, was the blasphemy of which he was accused, and for which he was condemned and stoned to death; and not for pronouncing the name of *Jehovah* only.

The Seventy who translated the Old Testament into Greek, at the desire of Ptolemy Philadelphus, King of Egypt, about the 124th Olympiad, were also very sparing in the use of this name *Jehovah;* and therefore did not render it according to the sacred import of the Hebrew, but changed it into the word Κυριος, *Lord*, which is of the same signification with *Adonai* in the Hebrew. Origen, Jerome, and Eusebius, testify, that, in their time, the Jews left the name *Jehovah* written in their copies with Samaritan characters, instead of the common Chaldee or Hebrew characters. And those divines, who at the command of King James translated the Scriptures anew into English, have very rarely used the word *Jehovah*, but rendered it *Lord*. Yet we may observe, that when this word *Lord* is substituted for *Jehovah*, it is printed in large Roman letters. It is to be wished, that the name *Jehovah* had been preserved in the English translation of the Scriptures, and especially in those passages whose sense entirely depends on the meaning of the word.

After the appointment of Moses, by Jehovah, to deliver the children of Israel from the tyranny and oppression under which they groaned, and to conduct them from Egypt to worship God at Horeb, he was anxious to obtain a particular revelation of the Divine nature and attributes, that he might be able to regulate, direct, and superintend their worship; and this he deemed necessary on account of the Israelites having been long conversant among the Egyptians, who were idolaters and polytheists, and called their gods by a variety of names. Hereupon he said to God, "Behold, when I come unto the children of Israel, and shall say unto them, The God of your fathers hath sent me unto you; and they shall say unto me, What is his name? what shall I say unto them?" Intimating, that it was expedient God should call himself by an appropriate name, to distinguish himself from all the gods of the heathen. For men did not, at this time, as Dr. Shuckford observes, know the works of creation well enough to demonstrate from them the attributes of God; nor could they, by speculation, form proper and just notions of his nature. Though he had revealed himself to Abraham, Isaac, and Jacob, by the name אני אל שדי *Ani El shaday*, "I am God all-sufficient," and likewise that of יהוה *Jehovah;* yet a further knowledge of him was sincerely desired and earnestly requested.*

* Philo-Biblius seems to intimate, that the God of the Phœnicians was anciently called by the name *Jehovah;* and that *Jevo*, *Javo*, more recently used by them, is a corruption of it; for it is

Whereupon, says God to Moses, I AM *that* I AM, אהיה אשר אהיה EHEYEH *asher* EHEYEH. The Vulgate translates these words—EGO SUM QUI SUM, *I am who am.* The Septuagint—Εγω ειμι ὁ Ων, *I am he who exists.* The Arabic paraphrases them—*The Eternal, who passes not away.* Not *I was*, but I AM and WILL BE: a name that expresses his own essence, and signifies independency, immutability, and necessary existence. As if he had said, You may inquire who I am, and by what name I would be distinguished: know then that I AM HE who has being from himself, and has no dependence on any other.* This contains in it the whole plenitude and possibility of being, all that is, or can be, or, as the Apostle expresses it, παν το πληρωμα της Θεοτητος "all the fulness of the Godhead." By this name he is distinguished not only from all false gods, but from all other beings whatsoever; implying, that he exists after some very eminent and peculiar manner, and that nothing else besides him truly and essentially is.†

The self-existence of God proves that he always was, and evidently shows that he cannot cease to be. "He is, and was, and is to come." His necessary existence comprehends a duration which has neither beginning, succession, nor end. He can have no succession in his duration, because wherever this is there must be priority, and wherever there is a priority there must be a beginning. He is in the complete possession of an endless life, all at once. He exists in one eternal *now*. He is unchangeable in his essence or manner of existence, so that no perfection can be added to him, nor any excellency taken from him, but he remains invariably the same.

All natural perfections are essential to him as an infinite being, such as eternity, omnipotence, immensity, omniscience, spirituality, and immutability; and all moral perfections belong to him as a good Being, such as wisdom, holiness, justice, goodness, truth, faithfulness. These latter are communicable, because there are some rays of them in his creatures, but none of them in that transcendent degree that are in him, nor ever can be. The former we call his *natural* and *incommunicable* perfections, for the sake of distinction; though it is certain the latter are equally as natural to

said, that Jerombalus, who supplied Sanchoniathon with materials for his Phœnician history, was a priest of the God *Jevo*. Euseb. Præp. Evang. lib. i. c. 9.

* "On the front of the famous temple of Apollo, at Delphos, was graven the Greek word Ει (which signifies *thou art*, being the second person singular of the verb ειμι.) The learned among the Philosophers labored long to discover its meaning, each giving his own opinion; but could not find it out, until Plutarch (who travelled into Egypt and Greece for instruction in ancient sciences and other things) meeting with that passage in the writings of Moses, where God manifested himself by saying, I AM THAT I AM; he was struck with it, and having it explained to him, he then conceived the true and exalted sense of the word Ει, engraved on the front of the temple. It implied, as it were, an admonition to those who were about to enter the temple, to worship God, who is the only self-existent Being in the universe." Creighton's Enquiry into the Origin of True Religion, p. 21. Second Edition.

On a temple dedicated to Neitha, at Sais, the chief town in Lower Egypt, was this inscription: "I am whatever is, or has been, or will be, and no mortal has hitherto drawn aside my veil; my offspring is the sun." It appears highly probable that the ancient Egyptians acknowledged an active as well as a passive principle in nature, and, as Plutarch asserts, worshipped τῳ πρώτῳ Θεῳ, the supreme Deity. Enfield's History of Philosophy, vol. i. p. 76, 77.

† Norris on Reason and Religion. Contemp. i.

him, and incommunicable, in that infinite degree possessed by himself.

God being unchangeable in his essence, must also be so in all his perfections, because they are no other than his essence, and are not distinguished in him, either from his essence, or from one another; but are one and the same Being, revealed and manifested to us, under various notions, which we call *attributes,* to help us the better to conceive of him, who are not able to apprehend what may be known of him, under any one name, or by any one act of our understanding.

The combination of all his perfections renders him a glorious Being; and that fixed and invariable state of contentment and satisfaction, complacency and delight, which result from the secure possession and enjoyment of all that is good and desirable, or, in other words, of all possible excellencies and perfections in the highest degree, constitutes him infinitely blessed.

Moses was favored with another remarkable and interesting manifestation of the Divine Being; for perceiving God's merciful condescension in answer to his prayers offered up for his people, he persevered in the holy exercise, and even asked him for a manifestation of his glory: "Show me," said he, "I beseech thee, thy glory," or, according to the original, "make me see it." He could not mean an open view of the unclouded majesty of God, but only such a display of the Divine glory as a mortal is capable of beholding. God answered, "I will make all my *goodness* to pass before thee:" intimating, that his *goodness* is his glory, and that he could not bear the infinite splendor of his holiness and justice. *Goodness* is the true and genuine character of God, and the glory of all his other perfections, and by it they are all rendered engaging. Without this they would be terrible: for wisdom without goodness degenerates into insidious cunning; and power without it is the character of a tyrant. Were God destitute of this amiable perfection, he would have such a defect in his nature, as infinite perfection itself, in every other attribute, could not sufficiently compensate.

All nations have acknowledged this perfection of the Divine Being. Plato calls him the ιδεα του αγαθου, the idea or essence of goodness. In the three principles of the Platonic Trinity—το αγαθον *goodness,* νους *intelligence,* and ψυχη *vitality.*—The first place is assigned to the το αγαθον *goodness,* which the Platonists conceive to be like an immense and most pure light, continually diffusing and communicating its invigorating beams. To this the Platonist Boetius alludes, in that celebrated description of God, where he calls him *Fons Boni Lucidus,* the lucid fountain of goodness.—There is an ancient cabalistical table, supposed to be borrowed from the Pythagoreans, which represents, in a visible scheme, the order of the Divine perfections: wherein it is observable that *goodness* presides over, and gives laws and measures to all the other attributes of God.

Philo says, God is the name of *goodness;* and our English word, adds a late author, seems to be a contraction of the word *good;* or, however, is the same with the German *Got*, or *Godt*, which came, as is thought, from the Arabic word *Gada*, of the same signification. So that the German and the English name of the Supreme Being, in common use, is taken from the attribute of his *goodness*. "The word itself is pure Anglo-saxon," says Dr. Adam Clarke, "and, among our ancestors, signified not only the Divine Being, now commonly designated by the word, but also *good;* as in their apprehension it appears, that *God* and *Good* were correlative terms; and when they thought or spoke of him, they were ever led from the word itself to consider him as THE GOOD BEING a fountain of infinite benevolence and beneficence towards his creatures." The word GOD, expressed in the old Saxon, is *bona res*, a good thing.

That God is *good*, is the constant language of Divine revelation; for this attribute is every where celebrated, both in the Old and New Testament. It may be distinguished as *natural*, *moral*, and *communicative*. The first of these is the absolute perfection of his nature, which is goodness itself in its very essence. He is originally good, and that of himself; which is a property peculiar to no other creature, for all the goodness of the creature is derived from God. He is infinitely and therefore incomprehensively good to men and angels; hence his goodness knows no limits. We read of the "riches of his goodness," which are as "unsearchable," as is his "greatness." He is immutably good, for "the goodness of God endureth continually." And as his dependence on no one admits not of his being changed by others, so neither does his immutability admit of it by himself; for if he alter for the better he was not God before, and if for the worse, he then would not be God. Thus he is essentially, originally, infinitely, incomprehensibly, and unchangeably good.

The *moral* goodness of God is his perfect purity or holiness; therefore his goodness and holiness are united—"good and upright is the Lord." According to any rational opinion we can form of him, he is a Being possessed, not only of every natural power and perfection, but of every moral excellence. The holiness of his nature removes him to the greatest possible distance from all moral evil, and makes him necessarily approve of moral good. All his designs are pure and upright, and worthy of himself: he always acts according to the perfect rectitude of his own nature. Though he is not under the direction of any superior, yet his own rectitude always determines him to pursue what is right to be done towards his creatures. This property of the Divine Being greatly heightens our idea of his excellence, and naturally points him out as the

Governor of mankind. And as he adheres to it in his own conduct and administration, and likewise approves and loves it in his rational creatures, whom he governs; so he disapproves and hates the reverse in them, and will most certainly animadvert upon the temper and behavior of those who act contrary to his divine admonitions, and make them most sensibly feel the effects of their wickedness.

The *communicative*, or relative goodness of God, or his goodness to his creatures, is his inclination or self-propension to deal well and bountifully with them. As the notion of God includes goodness, so the idea of goodness implies holy diffusiveness. Therefore, says the Psalmist, "Thou art good, and doest good." All that we are, have, or hope for, that is good, proceeds from God as its fountain; hence he is called, "the fountain of living waters." This communicative goodness implies, that, from his all-sufficiency, he is ready to impart to his creatures whatever their necessities require. This attribute is universal: "he is good to all" his creatures from the highest angel to the meanest reptile; especially, to his people, "Truly," says the Psalmist, "God is good to Israel, even to such as are of a clean heart." But, though God is good to all his creatures, yet he is not equally so in the same kind and degree of blessings. His munificence is regulated by his wisdom, and the different capacities with which he has formed his creatures makes this inequality necessary.

[There is one vast and awful question which must occur to every reflecting mind—*What is God?*

As it regards his *Nature*, the Scriptures say, He is a *Spirit*. We must therefore, conceive the Creator to be, a *Living*, *Rational*, *Benevolent*, and *Spiritual* ESSENCE; absolutely, necessarily, and naturally *perfect*, and, therefore, *immaterial*, *uncompounded*, *indivisible*, and *eternal*.

It is necessarily understood that this essence is *peculiar:* that there is nothing in its nature which has any resemblance to *created* substances, whether material or spiritual; and that it is *underived*, and consequently, *independent*.

This Divine Essence being immaterial, impalpable, simple and indivisible, cannot have *body* or *parts:* nor can it be said to be a *whole*, for this would imply an *aggregation* of parts: but is itself a perfect, absolute, single, and eternal INDIVIDUALITY, incapable of self-multiplication, or increase; or of diminishing itself, or endangering its existence.

This essence is a *living* essence; and, therefore, has inherently the power and principles of *action:* It is a *rational* essence, and therefore, must act according to the eternal principles of *reason* and *right:* It is a *benevolent* essence, and therefore, all its actions must be infinitely *good* and *kind*. Absolute *perfection*, *infinitude*, and *sovereignty* in all these respects, constitute the Being we call God.

As God is a single, indivisible, independent, and eternal UNIT, we cannot ascribe *different* perfections, or attributes to him, so as to suppose one attribute *separate from, and independent of* another, capable of acting *per se*, or participating *conjunctively* with other attributes *as an integer*. Nor can we suppose this eternal, and independent Unit to act by being *operated upon* in any degree, by other agents, nor can he operate on himself. All his actions, therefore, spring from himself, and are performed *without excitement, effort, means, or previous ratiocination.*

It will follow from the preceding reasoning, that every action of the Divine Being, in regard to himself, is precisely the same in *nature:* so that we cannot say of one act it is an effort of his *power* to the *exclusion* of his wisdom: nor of his wisdom to the exclusion of his goodness: nor of his goodness to the exclusion of his holiness: and so of the rest. Strictly speaking we cannot say the power *of* God; the wisdom *of* God; the goodness *of* God, &c.; because the power of God *is* God; the wisdom of God *is* God; the goodness of God *is* God.

In contemplating this awful subject *abstractly*, we should say there are no such things as *attributes* in the Divine Being, *as they are commonly understood.* What we call his attributes, are only different modes of the operations of the same eternal, undivided, and independent Unit. Indeed, God is one entire perfection which exerts itself in different ways and actions.

But as we cannot comprehend this single entire perfection; nor understand *how* it exerts the whole of itself, as a single indivisible agent, *in each particular act*, as it really does, mankind have always been in the habit of assisting their contemplations by regarding the *nature* of the acts of this single, indivisible, and eternal agent, and thus *inferring* the nature of the Divine Being. And as these acts appear to differ in *quality*, we infer a quality in the agent, corresponding with the quality of the actions which we see: we call this quality by a *name*, and *thus derive the doctrine of attributes.*

For example: When we see this single, indivisible agent manifesting himself in such a manner as to give us the idea of *unlimited power*, we ascribe *omnipotence* to him, as an attribute. When we see a manifestation indicating *infinite wisdom*, we ascribe *omniscience* to him as an attribute. In the same manner in reference to the manifestations which indicate justice, goodness, mercy, truth, holiness, faithfulness, righteousness, kindness, &c, all of which we ascribe to him upon such indications.

Although *this rationale*, in contemplating the Divine Being, is necessary to *creatures*, yet it is calculated to lead the mind into error. We are insensibly inclined to ascribe the divine actions to those attributes *exclusively* which we suppose they indicate. This, probably, has been the most fatal error of mankind, and, doubtless, laid the foundation of darkness and idolatry. We must never conceive that any act of the Divine Being proceeds from *one* or more attributes to the *exclusion* of others; or that one attribute participates *more* in one act than another. This is the fatal mistake. Hence theologians have become blind and foolish, bewildering the multitude by building up theories on the consideration of a single attribute; thus making the Divine Being to consist of parts, and these parts independent too. Instances of this awful mistake might be given, but it scarcely comes within the design of this paper. It is sufficient to say; if we conceive correctly of the divine acts, *we will ascribe each equally to all the Divine Attributes.*

As we conceive this single, indivisible, underived, independent, and eternal agent, or perfection to be absolutely infinite, and illimitable in all possible ways, or manner, of exerting Himself, we, of course, conceive all the qualities, indicated by the divine acts, which we call attributes, to be absolutely infinite, perfect, and eternal: and thus we derive the doctrine of the absolute perfection, and infinitude of all, and each of the Divine Attributes.

From the foregoing reflections, the reader will readily conceive of the Divine Being, as a Living, Rational, Benevolent, and Spiritual Essence, existing a single, underived, independent, Unit: a Unit, not in reality consisting of attributes, or perfections, but itself one single, entire perfection: exerting itself, not by attributes, but as an individual Unit or Agent, in such a manner that each action is the action of the Divine Being, and not of one or more of his attributes: that the existence of this single, underived, independent, and eternal Agent, was, and is *necessary*, and, therefore, he could not but have existed, and cannot cease to be; that He is absolute, and infinite in all possible ways and manner of acting, and consequently we conceive Him possessed of all possible perfections in an infinite degree.]

By the assistance of Divine revelation we are enabled further to pursue our inquiries concerning this very important subject; and without which, we should be involved in great darkness and uncertainty, not only respecting his moral perfections, but the *mode* of his existence. And this must be a matter of superior interest to mankind, or our adorable Creator would not have communicated it, which he evidently has done through the medium of the Scriptures, written by Divine inspiration.

Moses, having received by Divine revelation instruction concerning the origin and formation of the world, conducts us at once to its great and adorable Architect. "In the beginning God created the heavens and the earth." Here he adopts a phraseology to express the supreme Being, which is generally used in the Old Testament for the same purpose, and is very important and necessary to be understood, as it gives us information after what *manner* he exists. 'The original word אלהים *Elohim*, God,' says a great linguist, is certainly the plural form of אל *el*, or אלה *eloah*, and has long been supposed, by the most eminently learned and pious men, to imply a *plurality* of persons in the divine nature.' As this plurality appears in so many parts of the sacred writings to be confined to *three* Persons, namely, the Father, the Son, and the Holy Spirit, hence the doctrine of the TRINITY.

It is very remarkable that we no sooner open the Bible, than this doctrine is presented to our view. The laws and ordinances established among the Jews were designed to guard that people from idolatry, which in Abraham's time had become very general. On the recollection of this circumstance it appears extraordinary that Moses, when he is describing the creation of the world, should, in order to express his conceptions of the Divine Being, introduce a term which implies *plurality;* and, frequently connecting it with verbs and persons singular, should use that term *thirty* times in the short account of the creation, when the language afforded other words in the singular number that would have answered his purpose equally well; nay, if he did not wish to express a *plurality*, that grammatical accuracy should have led him to adopt. When he made use of a plural noun for the name of God, which he has done, perhaps, *five hundred* times more in one form or other in the five books of his writings, this *plurality*, I apprehend, was the idea he meant to convey to mankind. He, or rather the HOLY SPIRIT, by whom he was inspired to write his history, meant to give some hints and intimations of a doctrine more clearly to be revealed in future ages.*

The ancient Jews understood *Elohim* as conveying the idea of a plurality in the Godhead. "Come," says one of them, "and see the mystery of the word *Elohim:* there are *three degrees*, and each degree by itself *alone*, and yet notwithstanding they are all *one*, and joined together in one, and are not *divided* from each other."†

R. Bechai, a celebrated author among the Jews, discoursing of the word *Elohim*, and of the import and signification of it, adds these words:—"According to the cabalistical way, this name *Elohim* is two words, namely, *El him*, that is, *they are God.* But the explanation of the Yod is to be fetched from Eccles. xii, 1, *Remember thy* CREATORS. He that is prudent will understand it." These words do sufficiently prove the Cabala among the Jews, says Bishop Kidder, that though the Divine Nature was but *one*, yet there was some kind of *plurality* in this Divine Nature; and this is fairly insinuated in the *Bara Elohim*, which we find in the beginning of Genesis.‡

John Xeres, a Jew converted in England some years ago, published a sensible and affectionate address to his unbelieving brethren, wherein he says, that "the word *Elohim*, which we render GOD in Gen. i, 1, is of the plural number, though annexed to a verb of the singular number; which," says he, "demonstrates as evidently as may be, that there are several persons partaking of the same Divine nature and essence."§

* Allix's Judgment of the Jewish Church against the Unitarians, p. 116. Edit. 1699. See also p. 119. Simpson's Apology for the Doctrine of the Trinity, p. 379, 380.

† Rabbi Simeon ben Jochai, in Zoar, on the sixth section of Leviticus. See Ainsworth's Annotations on the place.

‡ Demonstration of the Messias, Part iii. p. 170, 171. Edit. 1700.

§ Jones on the Trinity, chap. iii. sect. 1.

It is clear too, how sensible the Jews have been that there is a notion of *plurality* plainly imported in the Hebrew text, since they have forbidden their common people the reading of the history of the creation, lest, understanding it literally, they should be led unto heresy.* When the Scriptures are suppressed, or the common people denied the use of them, it may with propriety be presumed that their superiors, who act in an arbitrary and unjust manner, have embraced anti-scriptural notions, and, in order to prevent detection, lay aside the only infallible *test* of truth; and, to conceal their base motives, and make their deleterious conduct appear not only plausible, but necessary and proper, they boldly assert the incompetency of the people to judge of scripture doctrines for themselves, and wish to be considered compassionate and friendly in judging and deciding for them. The fact is, the common people are denied the use of the Scripture, lest understanding it in a certain sense, which their superiors call heresy, it should lead them into the understanding of plain and unequivocal facts stated therein, and which are of the utmost importance for them to know.

It may be observed here likewise, that the Hebrew doctors always supposed the first verse of Genesis to contain some latent mystery. The Rabbi Ibba indeed expressly says it does, and adds, "This mystery is not to be revealed, till the coming of the Messiah."

Mr. Parkhurst, who has greatly distinguished himself in Hebrew literature, and to whose pious and learned labors most Biblical students are indebted, says, "Let those who have any doubt whether אלהים *Elohim*, when meaning the true God, Jehovah, be *plural* or not, consult the following passages, where they will find it joined with adjectives, pronouns, and verbs *plural*:" he refers to twenty-five texts in the Old Testament on this occasion.†

If Moses and the Jews held the doctrine of the Trinity, and the word *Elohim* imports *plurality*, it is natural to ask, How comes it to pass that the Septuagint version renders the plural name Elohim, when used for the true God, by the singular one Θεος, and never by the plural Θεοι? The learned Ridley,‡ after Allix, has answered this question. He says, "The Talmudists own that the LXXII Interpreters did purposely change the notion of *plurality* implied in the Hebrew *Elohim* into the Greek singular, lest Ptolemy Philadelphus should conclude that the Jews, as well as himself, had a belief of Polytheism." And Bishop Huntingford adds, "Of all the Greek appellations of Divinity, Θεος was the only sim-

* Allix. p. 132.

† Gen. i, 26; iii, 22; xi, 7; xx, 13; xxxi, 53; xxxv, 7; Deut. iv, 7; v, 23; Josh. xxiv, 19; 1 Sam. iv, 8; 2 Sam. vii, 23; Psal. lviii, 12; Isai. vi, 8; Jer. x, 10; xxiii, 36; See Prov. ix, 10; xxx. 3; Psal. cxlix, 2; Eccl. v, 7; xii, 1; Job v, 1; Isai. vi, 3; liv, 5; Hos. xi, 12, or xii, 1; Mal. i. 6; Dan. vii, 18, 22, 25; Hebrew Lexicon, p. 19. Edit. 1811. See also Mr. Parkhurst's pamphlet against Dr. Priestly and Mr. Wakefield, p. 3—9, and p. 148, &c.

‡ Ridley's Eight Discourses, p. 79.

ple and direct term which they could adopt, to counteract idolatrous misconceptions."

This phraseology, as to its signification, is not peculiar to Moses, but is used by the other sacred writers also, and exactly accords with the whole tenor of Divine revelation. The creation of the world is ascribed to the Father, the Son, and the Holy Spirit, as joint, concurring, equal, and efficient causes thereof, in the Scriptures. It will not surely be presuming too much, says Bishop Huntingford, if we suppose Joshua and Solomon to be more deeply instructed in the Jewish Religion, than to be capable of using improper language respecting the Deity. Yet the former says, "Ye cannot serve the Lord: for he is the Holy Gods;" and the latter says, "The fear of Jehovah is the beginning of wisdom; and the knowledge of the Holies is understanding."* Such is the phraseology of the Hebrew text. In these passages, and others that might be produced, the word in the Hebrew is in the plural number, because of the *plurality* of persons in the Godhead; but in our translation it is in the *singular* number, because of the unity of their essence.

But more particularly. The creation of the world is ascribed to JEHOVAH: "I have made the earth, and created man upon it: I, even my hands, have stretched out the heavens, and all their host have I commanded. I am the Lord that maketh all things, that stretcheth forth the heavens alone, that spreadeth abroad the earth by myself." He had no *moving causes* exciting him to create matter and produce a universe, but his own will, goodness, wisdom, and power. He created all things himself, without the assistance of *any instruments*. The prophet ascribes to God alone the framing and stretching out of the heavens and the earth without the counsel, direction, or ministry of any subordinate agency. "Who hath measured the waters in the hollow of his hand, and meted out heaven with a span, and comprehended the dust of the earth in a measure, and weighed the mountains in scales, and the hills in a balance? With whom took he counsel, and who instructed him, and taught him in the path of judgment, and taught him knowledge, and showed to him the way of understanding?" He created all things without any *toil*, *labor*, *change*, or *alteration* in himself. There was not in him any transition from rest to labor, from idleness to business, from strength to weariness. Though "every good and perfect gift is from above, and cometh down from the Father of lights," yet "with him there is no variableness, neither shadow of turning." The Prophet says, "Hast thou not known? hast thou not heard, that the everlasting God, the Lord, the Creator of the ends of the earth, fainteth not, neither is weary?" And he proceeded in the work of creation without *any delay:* it was not a successive forming of things by alteration, which required

* See Allix's Judgment of the Jewish Church, p. 11?

much time to render them perfect, but was as in a moment, as quickly and readily as a word is spoken, produced in the rapid succession as recorded by Moses. This work then God is said to have done *alone*, to the exclusion, not of the Son and the Spirit, but of all that are not God by nature; and by himself, to the exclusion of all second causes or inferior agents.

It is ascribed also to the SON of God. The evangelist John asserts in very express terms the Divinity of Jesus Christ, of the truth of which he designed his whole Gospel should be a proof. "In the beginning was the Λογος Word." By the εν αρχη *beginning*, here, we are to understand the beginning of the creation, not the beginning of the gospel state, as the Socinians say. We have the authority of Grotius, that εν αρχη is taken from בראשית *Bereshith*, Gen. i, 1, translated by the Septuagint εν αρχη, and consequently must signify, from *the beginning of the creation of God*. It is not said, that *he* was *made* in the beginning, but that he *was* in the beginning, did exist when the world began, which is of the same import as if he said, he was from eternity; for he that did exist in the beginning, never did himself begin to be. The personal Wisdom of God says, "The Lord possessed me in the beginning of his way, before his works of old."—"And the Logos," or "Word, was with God." He could be with no creature, because there was no creature in being; and therefore it is very properly said, that he "was with God," the Father; and his being with him shows, that he is a distinct person or subsistence from the Father.—"And the Logos," or "Word was God." Though he is a person distinct from that of the Father, yet he is of the very same essence with him. He that was with God, was God; and if he was God in the beginning, that is from eternity, he is the same still, he cannot cease to be what he was. Here then the evangelist asserts the eternal existence of Christ, his personal co-existence with the Father, and that he is of the very same undivided nature and essence with him. Though he is a person distinct from the Father, yet he is of the same substance, equal with him in all divine perfections; not a *secondary* God, inferior to the Father, as the Arians assert. "All things were made by him." All things, from the highest angel to the meanest worm, were made by him, not as a subordinate instrument, but as a co-ordinate agent, as a joint efficient cause, co-operating with the Father in this work. 'To say that Christ made all things by a delegated power from God, is *absurd*; because the thing is impossible. Creation means, causing that to exist that had no previous being: this is evidently a work which can be effected only by *omnipotence*. Now God cannot delegate his *omnipotence* to another: were this possible, he *to* whom this omnipotence was delegated, would, in consequence, become God; and he *from* whom it was delegated, would *cease to be such*: for it is impossible that there should be *two* omnipotent beings.' "And without him was not any thing made that was made." This is added for the more certainty, it being usual with the Hebrews, when they would affirm that a thing is so indeed, to confirm by a particular negative what they had before affirmed. Our Lord said to the Jews, "My Father worketh hitherto, and I work." The phrase ὡς αρτι signifies "to this time," "to the present," that is, in all works whatever. Hence he is no creature, or he must have created himself; and if he created himself, he must have been in existence and not in existence at the very same time, which is both contradictory and absurd. And if every work performed by the Father was equally performed by the Son, the Son must, in all respects, be equal to the Father, in nature and perfections. This our Lord's words signify and imply, and in this sense the Jews understood him—as "making himself equal with God."* "He is the image of God," the πρωτοτοχος "FIRST PRODUCER of every creature: for by him were all things created, that are in heaven, and that are in earth, visible and invisible, whether they be thrones, or dominions, or principalities, or powers:" all the angels, however diversified in rank or employment in the heavenly world; and all the rational, animal, vegetable, and inanimate creatures, belonging to this terrestrial abode: "all things were made by him," as the efficient cause, "and for him," as the last end.—"God hath in these last days spoken unto us by his Son, whom he hath appointed heir of all things, by whom also he made the worlds," i. e. the heavens and the earth. The Father does all by the Son, and the Son does all from the Father. Whatsoever the Father does, that also does the Son likewise. "Unto the Son he saith, Thy throne, oh God, is for ever and ever; a sceptre of righteousness is the sceptre of thy kingdom. Thou, Lord, in the beginning hast laid the foundation of the earth; and the heavens are the works of thy hands." In these passages the *Divinity* of Christ is plainly asserted, and the operations of his power are proofs of his Godhead. He that is the Creator of all things is God: but Christ is the Creator of all things; therefore Christ is God. He calls himself "the Beginning of the creation of God," where the word αρχη means the Creator, the efficient Cause of all things, he by whose power the creation had its beginning and perfection. And "he that built all things is God."

The learned Jacob Bryant wrote a very valuable Tract entitled, *The sentiments of Philo Judæus concerning the* ΛΟΓΟΣ, *or Word of God;* from which the following are quotations. "Philo Judæus speaks at large in many places of the Word of God, the second person, which he mentions as *the second Divinity*, the *great Cause* of all things, and styles him as Plato, as well as the Jews, had done before, the LOGOS. Of the Divine Logos or Word he speaks in many places, and maintains at large the Divinity of the second Person, and describes his attributes in a very precise and

* Professor Kidd's Essay on the Doctrine of the Trinity, p. 452.

copious manner, styling him *the second Deity, who is the Word of the supreme God, his first-begotten Son; and the image of God.* In his treatise upon *creation*, he speaks of the Word as *the Divine operator by whom all things were disposed:* and mentions him as *superior to the angels and all created beings, and the image and likeness of God*, and says, that *this image of the true God was esteemed the same as God. This* Logos, *the* Word *of* God, says he, *is superior to all the world, and more ancient; being the productor of all that was produced. The eternal Word of the everlasting God is the sure and fixed foundation upon which all things depend.*"

Creation is moreover ascribed to the Holy Spirit. That the Holy Spirit has a *personality* distinct from that of the Father, and also that of the Son, and a real and proper *Divinity*, is a doctrine of Divine revelation. In his personal capacity, he is not the Father, nor the Son. He neither is nor can be divided either from the Divine essence, nor from the other two persons, but yet is personally distinct from them. His relation to, and mission by, the Father and the Son, clearly evince his personal distinction. He is called the Spirit of the *Father*, and the Spirit of the *Son*. He is represented as *sent* by the Father, and also as *sent* by the Son. These things show that he is a Divine person, and has a distinct personality. The Holy Spirit is the last in the order of subsistence: the Father is the first, the Son is the second, and the Holy Spirit is the third. Yet we should know, that the Father is not before the Son, nor the Son before the Holy Spirit, by a priority of time, nor of dignity and perfections; for the three persons in the Divine essence are *co-eternal*.

The Holy Spirit was equally concerned with the Father and the Son in the work of Creation. "By the Word of the Lord were the heavens made, and all the host of them by the breath (Heb. Spirit) of his mouth." The *breath* or spirit of the Lord's *mouth*, says an excellent author, does undoubtedly mean the third person of the Trinity; who is called, "The Spirit of God, and the Breath of the Amighty."—"They lift up their voice to God with one accord, and said, Lord, thou art God, which hast made heaven and earth, and the sea, and all that therein is. Who, by the mouth of thy servant David, hast said," &c. The terms Lord and God are here used to express the Divinity of *him*, says the same able writer, who spake *by the mouth* of his servant David. But it was the Holy Ghost who *spake by the mouth* of his servant David—for, saith St. Peter, "This Scripture must needs have been fulfilled, which the Holy Ghost," by the mouth of David, "spake," &c. Therefore the terms Lord and God are certainly used to *express the Divinity of the* Holy Ghost.* In the work of creation, the "Spirit of God moved upon the face of the

* Jones on the Trinity.

waters," by an infinite vitality infusing life, and with a formative energy giving form. "By his SPIRIT he hath garnished the heavens" with an incalculable number of luminous stars; all those glittering worlds, which serve for use as well as beauty, were formed by the Spirit of God.

As none but the *third* Person in the Godhead is ever so much as once in the Scriptures called the *Spirit of God;* so the Holy Spirit's agency in the work of creation evinces his distinct personality, and is a confirmation of his proper Divinity. A cause must be equal to the effect it produces: but no finite spirit could be a joint, concurring, efficient cause in the work of the creation: therefore the Holy Spirit is God. Supposing the matter of which the worlds were made to be called into being out of nothing by the Almighty power of the Father, or by the fiat of the Son; yet the animating of the whole lifeless mass, the putting of every part into motion, the assortment of all the particles, the assigning of them their proper places, and the completing of the whole with such astonishing beauty and harmony, which was the peculiar work of the Holy Spirit, required no less than an almighty power, which clearly demonstrates that he is God.

Thus we see that the creation of the world is ascribed to one God, the Father, the Son, and the Holy Spirit. The Son and the Holy Spirit were joint Creators, of equal power, and equal efficiency with the Father. There is no where to be found in the Scriptures the least hint of different degrees of creating energy, nor of sole efficiency in one of the Persons in the Godhead, and a bare instrumental compliance in the other. The creation was the common effect of their joint acting: nor is it ever said, nor so much as hinted or implied, that the distinct Persons in the Godhead had different provinces, nor that one creature was made by one, and another creature was the workmanship of another. The Father, Son, and Holy Spirit, are never represented as acting separately, but always in conjunction.

The sacred historian assures us, that, at the commencement of time, אלהים *Elohim*, the triune God, caused matter to exist, which, previous to this astonishing display of his creating energy, had no being. Moses, as an inspired author, is the only one who could instruct us in the formation and unfolding of the world. He is not an Epicurus, who has recourse to atoms; a Lucretius, who believes matter to be eternal; a Spinoza, who admits a material God; a Descartes, who prates about the laws of motion; but a legislator, who announces to all men without hesitation, without fear of being mistaken, how the world was created. Nothing can be more simple, nor more sublime than his opening: "In the beginning God created the heaven and the earth." He could not have spoken more assuredly, if he had been a spectator; and by these words, mythology, systems, and absurdities, shrink to nought, and are mere chimeras in the eyes of reason.*

Had Moses been a fictitious writer, how natural and how easy would it have been for him to have filled up the first part of his history with marvellous relations about the creation? With what pomp of language, with what waste of rhetoric, could he probably have embellished that surprising scene? With what a grand *apparatus* of celestial machinery might he have made the omnipotent Architect come forth to build a universe? How many sub-agents and subalterns would a fabulous poet or historian have employed in this stupendous and multifarious work? With what solemnity would every part have been gone about, and with how many episodes, digressions, and reflections, would the story have been filled, in order to give it an air of the marvellous? But read the beginning of Genesis, and observe how differently Moses writes. No scope is given to fancy or invention. All is narrated with an ease, plainness, and simplicity, which evidently shows that he kept close to truth, and laid down the facts just as they were presented to his mind; a manner of writing rarely, if at all, to be found in any other historians, but such as had the honor of being the *amanuensis* of the SPIRIT of truth.†

The description which Moses furnishes concerning the creation, as relating to circumstances previous to the existence of mankind, could be derived only from immediate revelation. It was received by the Jews with full conviction of its truth, on the authority of that *inspiration* under which Moses was known to act.‡ And when the creation of the world began, by the lapse of time, to be removed to a remote distance, God was pleased thus to provide a contemporary historian, and appoint a whole nation to be the guardians of his history; as well that this register might be the most authentic, as that all mankind might hence be instructed in the knowledge of a fact, which was so necessary for them to know, and yet so impossible to be otherwise ascertained.§

It may be proper to notice, that some futile objections have been made to the period which is assigned by Moses to the creation, as though it were too recent to be reconciled with reason and philosophical inquiry. How long matter remained in a quiescent state after its creation, we have no data to enable us to determine: but, as its resting in an animate state, so far as we know, could answer no valuable purpose, we may reasonably conjecture the time would not be long. The creation of the world began, according to Usher, before the Christian era 4004 years, if we follow the Hebrew text. The Septuagint version places it 5872, and the Samaritan 4700 before the vulgar era.—Sanchoniathon, the first Phenician historian, according to the most extended accounts of Porphyry, flour-

* Ganganelli's Letters.
† Rev. Hugh Knox's Sermons.
‡ Gray's Key to the Old Testament.
§ M. Pascal's Thoughts.

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ished long after Moses, probably not less than two hundred years. Manetho, high-priest of Heliopolis, wrote the Egyptian history only in the time of Ptolemy Philadelphus, not more than 300 years before Christ, and professes to have transcribed his Dynasties from some pillars of Hermes Trismegistus, written in the Hebrew dialect.—Berosus was the first noted Chaldean historian, and he was contemporary with Manetho.—The Chinese have not any work in an intelligible character above 2200 years old. One of the Chinese emperors, about 213 years before the Christian era, ordered all their historical records to be destroyed.—The Greeks could produce no dates beyond 550 years before Christ, and but little historical information prior to the Olympiads, which began 775 years before the Christian era. Orpheus and Museus, fabulous poets, were not so remote as Moses; for it is supposed they lived about 200 years after him, in the days of Gideon. Daries Phrygius and Dystys Cretensis, fabulous poets, wrote the history of the Trojan war, about 400 years after Moses. Homer wrote his poems after David's time, and about 550 years after Moses. Herodotus, called the father of history, who flourished about 450 years before the Christian era, was the first Grecian historian that deserves the name; yet he begins with fable. Thucydides rejects, as uncertain, all that preceded the Peloponnesian war; and Plutarch, not one of the least historians among the Grecians, ventured not beyond the time of Theseus, who lived a little before the ministry of Samuel.* So that all these poets and historians flourished long after the time of Moses, some of them nearly a thousand years; for he wrote about A. M. 2460. The works of the Jewish lawgiver are not only the most ancient, but also the most authentic, of all the monuments of antiquity.

If the world were some thousands of years older, it must be much better peopled than it is at present. Population has always increased since the deluge, and yet there might be three times as many more inhabitants on the earth than it at present contains. It has been computed that at least 5000 millions of men might live at once on our globe: and yet it does not appear that there are really more than 1080 millions. In Asia are reckoned 650 millions; in Africa and America, 300 millions; and in Europe, 130 millions.

If we consider the arts invented by men, we shall find that few or none of them have been discovered more than two or three thousand years. Man owes not only to his nature and reason the aptitude he has for acquiring arts and sciences, but he is also led to this by necessity; by the desire he has to procure himself conveniences and pleasures; by vanity and ambition; and by luxury, the child of abundance, which creates new wants. This propensity is evident among all men, in all ages. History carries us back to the

* See Gray's Key, Notes, p. 82—85.

time when men had scarcely invented the most necessary arts; when those arts which were known were but very imperfectly understood; and in which they scarcely knew any thing of the first principles of the sciences.

About four thousand years ago, men were still in a state of great ignorance concerning most subjects; and if we calculate according to the progress which they made since that time, and afterwards go back to the remotest periods, we may with tolerable exactness fix the era when men knew nothing; which is, in other words, that of the infancy of the human race. Were their existence to be carried higher, it is utterly improbable that the most useful and necessary arts should have continued unknown to them through such a long series of ages. On the contrary, all that can be discovered by the human mind must have been known a long time ago. From this circumstance therefore we must conclude, that the origin of the human race can have no other era than that which Moses has assigned it in his history of the creation.*

If it be asked, What! was God a *solitary* Being? Did he exist alone, before this exertion of his glorious power? Formed as we are for society, we have no conception of any satisfaction arising from a state of absolute loneliness; nor can we conceive that the Deity should rest *inactive* from eternity, and not exert those amazing powers of which the stupendous creation proves he is amply possessed? There are some particulars naturally deducible from questions like these, which we cannot solve. We have no adequate apprehension of eternity; we are lost in the idea. And when we attempt to contemplate God existing from eternity without *cause* or as *beginning* to exist, we are utterly lost in the speculation; for among all the objects that come within the reach of our senses, we see nothing existing that has not had a cause to produce it. We frequently smile at children, when they ask their little simple questions, as we deem them; but we are mere children ourselves, in this profound ocean of wonder. But something very observable strikes an attentive reader in the Mosaic account of the creation, which suggests that the Deity is not a solitary Being, existing in such an absolute *unity* as to exclude all degree of personality or communion. For אלהים *Elohim*, as we have already observed, the very first name by which Moses calls God, being plural, shows that though he exists in an undivided unity of nature, yet in a Trinity of Persons. And this notion of a plurality, so far from being contrary to reason, is more agreeable to it than any opinion of the absolute *unity* of the Divine nature. For conceive we only three Divine persons mutually to partake of the Divine essence or nature, to be united by the same perfect will, and to possess the same infinite powers and perfections; and all our apprehensions of the loneliness of solitary existence immediately sub-

* See Sturm, vol. iv. p. 206.

side; the Father, the Son, and the Holy Ghost, consummately happy in each other, have been from eternity reciprocal objects of complacence, and will remain such for ever. Let this argument be fairly and impartially considered, and the notion of a Trinity of Subsistences in a Unity of the Divine Nature, will appear far more consonant to reason, and liable to less objections, than that of mere solitary and absolute unity.*

[*A further consideration of the suggestion in the close of the last paragraph.*

Although nothing can be clearer than that the Divine Essence is *one*, simple, and indivisible; *yet* this does not prevent it from subsisting in *personality*, i. e. *in a plurality of persons.*

It must be carefully observed, that the plurality has regard to the *persons*, not to the Essence. We cannot say there is a plurality of Essences; but we can say, the Living, Rational, Benevolent, and Spiritual Essence *subsists in three persons.* This then is the MODUS EXISTENDI of the Divine Being.

Although we are assured this is his *mode of existence*, we do not pretend to comprehend the *nature* of it. We may, without any injury to the proposition, affirm, the *nature* of the fact is incomprehensible by *created intellect.* Yet the fact itself is sufficiently well attested, and is not repugnant to reason, though it is above the comprehension of reason.

It is believed by many very learned, pious, and eminent men, that the doctrine of a *plurality of persons in the Godhead*, can be established by an argumentation founded solely on the acknowledged nature of the Divine Being.

The Rev. JAMES KIDD, Prof. of Oriental Languages, Marischal College and University, Aberdeen, with the approbation of many learned men in England, among whom is Dr. Adam Clarke, in whose house he delivered private lectures on his manuscript, has published a very able and satisfactory essay on this plan, of which a brief clue to the mode of argumentation is here attempted.

A. *The Divine Being is a necessarily existent, and an eternally, immensely, and immutably Living, Intelligent, Rational, Moral, Benenolent, and Spiritual Essence.*

B. *The very* LAW *of the nature of such a being, is eternal, immense, and immutable* ACTIVITY, ENERGY, *and* EFFICIENCY, *exercised eternally, immensely, and immutably,* ACCORDING TO HIS OWN NATURE.

C. *That such a being* WAS *as necessarily existent, perfect, and happy,* BEFORE *creation and providence as since; and would forever continue as necessarily existent, perfect, and happy, if creation and providence should cease to be.*

These three propositions are so obviously true, every reader will readily and cordially grant them. It is proposed, therefore, to show, from the nature of the Divine Being, *that his Essence* MUST *subsist in a plurality of persons.*

* Christian's Magazine, vol. ii. p. 97, 98.

The proposition does not contemplate an explanation of the *manner* of this subsistence; nor, at present, the *number* of persons; but the simple fact, *That* FROM THE VERY NATURE OF THE DIVINE BEING, HIS ESSENCE MUST SUBSIST IN PLURAL PERSONALITY.

The existence of a being, or the possession, or exercise of any principle, passion or attribute, *implies personality*, or individual identity, which is the same thing. The mind cannot conceive of existence, passion, principle, or action, without conceiving of them inhering in actually existing Essence, which *must* assume in the mind the idea of personality. Therefore, *personality* is strictly, and properly applicable to the Divine Essence. But the doctrine of a *plural* personality is to be established at present.

It will be easily conceived, and readily granted, that a being which exists necessarily, eternally, immensely, and immutably, as a Living, Intelligent, Rational, Moral, Benevolent, and Spiritual Essence, *must have exercised Himself, and his perfections, necessarily, eternally, immensely, and immutably.* This then is granted. But the mind will readily and easily perceive, that the Divine Being could not have exercised Himself THUS, *in the works of Creation and Providence.* Because, it is readily admitted, there *was* a time when Creation and Providence *began:* during a whole eternity *beyond* this period, there was no existence except God Himself. Consequently, He *cannot* have been exercised according to his own nature and perfections, *eternally*, in reference to Creation and Providence.

Again: He cannot have exercised his perfections *immensely*, in reference to Creation and Providence: because, however extensive we may conceive the empire of Creation and Providence to be, it is not *immense;* it is actually limited, and, therefore, could not admit of an *immense exercise of his nature and perfections.*

It is readily granted, that the Divine Being was as necessarily, and perfectly happy *before* Creation and Providence as since; and if Creation and Providence should cease, his happiness would continue the same: hence, it follows, necessarily, that the happiness of the Divine Being was, is, and ever will be entirely *independent* of Creation and Providence.

But the happiness of any being consists, essentially, *in the exercise of its powers and perfections according to the law of its own nature.* And as it has been shown, that the happiness of the Divine Being is eternal, immense, and immutable, it follows, *He must have exercised Himself eternally, immensely, and immutably.*

As it has been *granted*, That from the very nature of the Divine Being, He must have been eternally, immensely, and immutably active and happy, according to the law of his own nature: and it has been *proven*, That He could not have been eternally, immensely, and immutably active and happy, in reference to Creation and Providence, it follows, necessarily, that the *means* and *principles* of these eternal, immense, and immutable activity and happiness, *must exist* IN HIS OWN CONSTITUTION, *and be exercised entirely* WITHIN *Himself.*

This conclusion cannot be denied, granting the premises in the propositions A. B. C. in reference to the Divine Being. It remains to be proven, That such principles, and means of eternal, immense and immutable activity and happiness *cannot* be conceived of in the constitution of the Divine Being, *without conceiving his essence to subsist in plural personality.*

The consideration simply of the nature and eternal activity of the Divine Being would establish the idea of *plural personality* in his Essence: because the mind cannot conceive, that the same single being can be both *agent* and *object, in reference to the same action.* And as it has been proven, that *previous* to the existence of Creation and Providence, God existed eternally *alone*, consequently, no possible form of existence but Himself, and yet he was eternally, immensely, and immutably active and happy; it will follow irresistibly, that there *must be a plurality in his single **Essence**;* and the mind naturally assumes, this plurality is *personal;* as it cannot conceive of activity, and happiness without conceiving them to belong to person, or persons. And as action implies both *agent*, and an *object* distinct from the agent; and there being no such agent, or object existing *without* the Divine Being, it *must* be infered, that these agent and object, concerned in the eternal activity and happiness of his nature, must exist *inherently, eternally, immensely, and immutably* WITHIN ***Himself.***

Thus we are **COMPELLED** to admit a plurality of persons in the Divine Essence.

It will be recollected, the Divine Being has not only exercised Himself eternally, but also *immensely*, according to the law of his own nature and perfections: i. e. He has necessarily, and eternally exercised Himself to the extent of his nature and perfections. This will be readily admitted when we reflect, that unless we admit the exercise of the nature and perfections of God *to their full extent*, we must admit a *redundancy* in the Divine Nature, and perfections, which would be manifestly absurd, as it would *imply imperfection.* For it would imply (if we may dare say so) that there is an *efficiency*, or *ability* in the Divine Being, which He has never exercised to its full extent; and in proportion to the *deficiency* in the exercise, we must conclude this *efficiency* or ability is *useless*, which would be repugnant to the true idea of the Divine Being.

It is therefore, *proven*, That the Divine Being necessarily exercised Himself *immensely*, because his nature, and perfections are immense. But it will be readily perceived, this could not be done in the works of Creation and Providence: because, however vast they may be, they are not *immense:* and, therefore, could not admit of the immense exercise of his nature and perfections to their full extent: from which it must follow, inevitably, ***That the immense exercise of his own nature and perfections must be*** WITHIN ***Himself.***

As it has already been proven above, that this internal exercise in the Divine Essence necessarily implies *plurality* in the Godhead; so now also, is it proven, that the admission of such plurality is the only view competent to show HOW the Divine Being could have exercised his own nature and perfections *immensely*, as the attribute of immensity appertains to God only.

As it is granted, that the Divine Being was necessarily as happy *before* Creation and Providence as since, and would continue so, should Creation and Providence cease; of course his happiness consists in the exercise of his own nature and perfections according to their own law. But, in order that the Divine Being should be eternally, immensely, and immutably happy, the WHOLE of the Divine Nature and perfections must be exercised eternally, immensely, and immutably. But if we divest the Divine Essence of its plural personality, we cannot conceive that some of the divine perfections can be exercised at all. For example: the divine goodness, love, wisdom, intelligence, and all his *moral* perfections. We surely cannot say, He manifests his goodness to Himself; or exercises his love towards Himself; or employs his wisdom in understanding Himself: all of which ideas are obviously absurd. But so soon as we admit the idea of a plural personality, or the subsistence of the Divine Essence in a plurality of persons, we can conceive the moral perfections exercised in Himself, between the persons of the Godhead. This is the only ground on which we can conceive of his eternal, immense, and immutable happiness. For we can readily conceive of the distinct persons in the Divine Essence, *communicating mutually* to each other the *whole* of the divine moral perfections; and thus conceive of the perfect and independent happiness of God.

The only remaining view of this subject would be this: the activity, energy, and influence of the Divine Being can only regard Creation and Providence. But as there was a *past eternity before* Creation and Providence began, in which the Divine Being existed, He must be considered as having been *inactive*, *solitary*, and *unconscious;* (because there cannot be consciousness where there is not action,) the whole and every part of which view is derogatory to the acknowledged character of God. How much more reasonable is it to conceive the Divine Essence to subsist in a plurality of persons, and thus to conceive, *consistently*, of the eternal, immense, and immutable activity and happiness of the Divine Being?

*Thus we see, that what the Scriptures declare concerning the plurality of persons in the Divine Essence*, CANNOT BE OTHERWISE, AS IS DEMONSTRATED ABOVE, FROM THE NECESSARY NATURE OF THE GLORIOUS DIVINITY.

The demonstration might be extended to each of the divine perfections, and the same result would be obtained. The above remarks are a mere clue to the argument which is possible, and satisfactory; founded on the necessary nature of Jehovah.

The key to the whole demonstration is this:

1. The Divine Being, from his very and necessary nature, must be eternally, immensely, and immutably active.

2. He must be eternally, immensely, and immutably happy.

3. In order to be eternally, immensely, and immutably active and happy, He must be exercised to the whole extent of his nature and perfections, eternally, immensely, and immutably.

4. That such an exercise of his nature and perfections, in an eternal, immense, and immutable manner, cannot be, in regard to Creation and Providence; because, Creation and Providence are not eternal, immense, and immutable.

5. As there was not any thing *before* Creation and Providence, but God Himself, it must follow, necessarily, that the eternal, immense, and immutable activity and happiness of the Divine Being were **WITHIN** ***Himself entirely.***

6. As it is impossible for the human intellect to conceive, that a being can be both *agent* and *object, in the same action*, and the activity of the Divine Being has been shown to have been within Himself entirely; it follows, **THAT THE DIVINE ESSENCE MUST HAVE SUBSISTED ETERNALLY, IMMENSELY, AND IMMUTABLY IN A PLURALITY.**

7. And as the mind is *forced* to admit a *plurality* in the Divine Essence, it naturally, and necessarily assumes **PERSONS** for this plurality; and thus concludes, ***There must be a plurality of persons in the Godhead as the Scriptures declare.***

From the foregoing elements of the argument, it will be very easy to observe, if a *plurality* must be admitted, there is no objection in the mind to admit it is *triple;* and hence, as the substance of the Divine Essence has been shown to exist necessarily in a plurality, the mind conceives a *triple plurality*, as easy as any other, and thus conceives the reasonableness of the doctrine of the *Trinity in Unity.*

The most successful argument against this conclusion is this: *It is impossible to conceive how three can be one.* This is admitted, *when the objects designated by* "three" *are the same as the object designated by* "one." But this is not the case in the doctrine of the Trinity in Unity. The term *Trinity* applies to the *persons* in which the Divine Essence subsists, and *not* to the essence itself. So the term *Unity* applies to the *Essence only*, and *not* to the persons. This simple distinction removes the whole force of the objection.

The Unitarians, therefore, do us wrong when they say, *we believe three are one.* And Trinitarians do themselves wrong when they say, *to the three one God:* because, it is not true that there is a "three one God." But it is a glorious truth, **THAT THE DIVINE ESSENCE SUBSISTS IN THREE PERSONS, ETERNALLY, IMMENSELY, AND IMMUTABLY.**

It is very natural to suppose, that God imparted a knowledge of Himself to our first parents in Paradise. The Scriptures clearly support this supposition. This knowledge would, of course, include the doctrine of the Trinity; and we cannot admit for a moment, that so important a doctrine as the plurality of persons in the Godhead, could have been wholly lost by mankind, though it might become obscured. Accordingly we find the traditionary remains of this doctrine throughout the Old World.

"The Hindoos" says M. Sonerat, "adore *three* principal Deities, Brouma, Schiven, and Vichenou, who are still but *one;* which kind of Trinity is there called Trimurti, and signifies the re-union of those powers. The generality of Indians at present, adore only one of these three divinities; but some learned men, beside this worship, also address their prayers to the three united. The representation of them is to be seen in many pagodas, under that of human figures with three heads, which on the coast of Orissa, they call Sariharabrama, on the Coromandel coast, Trimourti," &c.

This account of M. Sonerat is very pertinent, and is confirmed by Dr. Buchanan who made extensive researches in that country. See his *Star in the East*.

The same tradition is found in China. "Among the ancient Chinese characters" says Dr. A. Clarke, "which have been preserved, we find the following Δ like the Greek *delta*. According to the Chinese dictionary ***Kang-hi***, this character signifies *union*. According to *Choucouen*, a celebrated work, Δ is *three united in one*. The Lieou-chou-tsing-hoen, which is a rational and learned explanation of ancient characters, says; "Δ signifies intimate union, harmony, the chief good of man, of the heaven, and of the earth; it is the union of three."

Lao-tse says; "He who is as visible, and yet cannot be seen, is denominated *lieou;* he who can be heard, and yet speaks not to the ears, *hi;* he who is tangible, and yet cannot be felt, is named *ouei:* in vain do you consult your senses about these *three;* your reason alone can discourse of them, and it will tell you they are but one," &c.

One of the missionaries at Peking, who wrote the letters from which I have made the above extracts, takes it for granted, "that the mystery of the *Trinity* was known among the ancient Chinese, and that the character Δ was its symbol." *Dr. A. Clarke, on the 1st chap. John's Gospel.*

The existence of this same tradition in China is conveyed to us through another channel. "It was the leading feature in ***Lao-Kiun's*** system of philosophical theology, and a sentence which he continually repeated as the foundation of all true wisdom, that TAO, the eternal reason, produced ONE; *one* produced TWO; *two* produced THREE; and THREE produced all things." *Le Compt's Memoirs of China.*

Traditions of this doctrine are found also in Chaldea and Persia indeed throughout the East; from whence all agree they were imported, through Phœnicia, into Egypt, and thence into Greece. The great and original sources of information being in the neighborhood of the Euphrates, where the *first post-diluvian* families resided; and the mighty intellects which were to influence the world, by the materials which were drawn from thence, being in Greece, the consequence was, we find the Grecian philosophers travelling *up* the streams of knowledge to the fountains, and thence returning to enlighten the world by the results of their researches. For example: Pythagoras, Plato, and others visited Egypt first, thence to Phœnicia, and thence to Chaldea, and the East, from whence they undoubtedly drew their theology. (Nor should it be forgotten that *their* philosophy was *theological.*) The concurrent testimony of history establishes this fact. The consequence of all this is, the doctrine of the Trinity was known to the Greek philosophers, who preserved it to the world in their incomparable writings, a collateral testimony of the authenticity of the Scripture doctrine. For this opinion we have the highest authority in the republic of letters.

"It is said that the first Christians borrowed their notion of a Triune God from the later Platonists; and that we hear not of a Trinity in the church till converts were made from the school of Alexandria.

But if this be the case we may properly ask, *Whence had those Platonists the doctrine?*

"It is not surely so simple, or so obvious as to have occurred to the reasoning mind of a pagan philosopher; or if it be, *why do Unitarians suppose it to involve a contradiction?*—The Platonic and Pythagorean Trinities never could have occurred to the mind of him, who, merely from the works of creation, endeavored to discover the being and attributes of God; and therefore as those philosophers travelled into Egypt and the East in quest of knowledge, it appears to us in the highest degree probable, that they picked up this mysterious and sublime doctrine in those regions where it had been handed down as a dogma from the remotest ages, and where we know science was not taught systematically, but detailed in collections of sententious maxims, and traditionary opinions. If this be so we cannot doubt but that the pagan trinities had their origin in some primeval revelation. Nothing else indeed can account for a doctrine so remote from human imagination, and of which we find vestiges in the sacred books of almost every civilized people of antiquity. The corrupt state in which it is viewed in the writings of Plato and others, is the natural consequence of its descent through a long course of oral tradition. The Trinity of Platonism therefore, instead of being an objection, lends, in our opinion, no feeble support to the Christian doctrine, since it affords almost a complete proof of that doctrine having made a part of the first revelation to man." *Ency. Brit. Art.* THEOLOGY.

"Some have indeed pretended, that the *Trinity*, which is commonly called *Platonic*, was a fiction of the later Platonists, unknown to the founder of the school: but any person who will take the trouble to study the writings of Plato will find *abundant evidence that he really asserted* A TRIAD OF DIVINE HYPOSTASES, *all concerned in the formation and government of the world.*" *Ency. Brit. Art.* PLATONISM.

"Pythagoras, though inferior to Plato in reputation, and lived before him, held the same doctrine, and derived it from the same sources. He visited Egypt, Persia, Chaldea, &c, and thence returned to Greece." *Ency. Brit. Art.* PYTHAGORAS.

These quotations are directly from the Encyclopedia Britannica, than which no authority can be better. I might increase the quotations to the same effect from Dr. Oglevie, the learned Cudworth and others, were it necessary. The above is thought sufficient to establish the fact, *That the doctrine of a Trinity in Unity was once prevalent in the Pagan world, and that remains and traditions of it are yet abundant through all the East, where the revelations of God were made to mankind.*"]

If it be asked, "Why did God conceal himself from eternity till within six thousand years; for, according to Divine revelation, it is not yet so long since the world was made?" I answer, God is at perfect liberty to do what he pleases, to do it when he pleases, and to give no account of the reasons of his conduct. If he had pleased to create the world as many millions of years sooner, as there have been days since its creation, the same question might have been asked, Why did he not create the world sooner, and thereby discover himself? For the longest time that can be imagined is just as nothing in comparison with eternity. If God had pleased, he might have concealed his existence and perfections to all eternity, or, in other words, never have made any thing. Seeing therefore it was only of his sovereign pleasure that he made creatures, to whom he might manifest himself, surely he had a right to fix on the time for doing it. We are sure he is infinitely wise, and consequently all his works are done in the fittest time, and best manner.

God made the world, not because he needed the praise or service of creatures to add to his blessedness; for he who is self-existent must necessarily be infinitely perfect and absolutely independent; and would always have remained the same happy Being, enjoying his own excellencies and perfections, had no creature ever been made. But it was for the manifesting of his own glorious attributes, and communicating happiness to creatures capable of it, that he, in the beginning, created this magnificent fabric of the heavens and the earth, with all things therein, whether visible or invisible, animate or inanimate, material substances or immaterial spirits. For he created beings of different ranks and powers, to whom he might manifest himself, or communicate his goodness. Some of these were pure intellectual spirits, fit for the felicity and employments of the heavenly state, to stand in his immediate presence, and execute his righteous commands: but these were created before the solar system; for the angels, those "sons of God," called "morning stars," were present, and sung together for joy, when "the foundations" of this world were laid. Others he formed out of the earth, with life, sense, and instinct, but destitute of reason, designing them to be subservient to the necessities or conveniences of a higher order of beings. Besides these he created other beings of a middle rank, partaking of an earthly part, fashioned with infinite skill and art, of exquisite symmetry, and adorned with great external beauty; and of a spiritual part akin to angels, and but little inferior to them, being in their constitution a compound of the animal and angelic natures.

It is not by reason alone then, or the light of heathen philosophy, but "through faith," in the infallible testimony of Divine revelation, "we understand that the worlds were framed by the word of God, so that things which are seen were not made of things which do appear." The sun, moon, stars, and earth, which we see, were not made of matter which had existed from eternity, as some of the heathen philosophers supposed, but of what God created anterior to the formation of those wonderful orbs. The word κατηρτισθαι, *framed*, signifies not only to *make* or *produce* simply, but properly *to place* or *set in joint* the parts of any body or machine in their right order. Accordingly Plato says, that in making the world, God proceeded with the exactness of a geometrician, arranging every thing in complete symmetry. All this was done by the *word* of God, which is not to be understood of any articulate sound, but of the simple act of his own will; he willed the universe, with all its variety of furniture, into existence. And this is a matter of *faith*, to be believed; not to be known by mere reason; for reason, without faith, can apprehend a formation of things from matter previously made ready.

A pious expositor very justly observes, By faith assenting to Divine revelation, and not by reason we understand the truth and wonders, the reasons and causes, the manner and end, of the creation of the world. Reason indeed tells us that there was a creation, consequently a Creator; but reason without Divine revelation could never have discovered the circumstances and manner of the creation, which wholly depended upon the will of God. Reason could never have known them, if God had not in his word first revealed them. Reason may propound the question, How was the world made, and all things therein? But revelation must resolve it.

"Oh Lord my God, thou art very great; thou art clothed with honor and majesty. Who coverest thyself with light as with a garment: who stretchest out the heavens like a curtain: who layeth the beams of his chambers in the waters: who maketh the clouds his chariot: who walketh upon the wings of the wind: who maketh his angels spirits; his ministers a flaming fire: who laid the foundations of the earth, that it should not be moved for ever. Thou coveredst it with a garment: the waters stood above the mountains. At thy rebuke they fled; at the voice of thy thunder they hasted away. They go up by the mountains; they go down by the valleys unto the place which thou hast founded for them. Thou hast set a bound that they may not pass over; that they turn not again to cover the earth." Such is the sublime language of Divine revelation!

# CHAPTER II.

## FIRST DAY.

### *Section* I.—Chaos.

Inquiry into the origin of things natural to man—Character of Moses as a sacred historian important—Explanation of the term Created—Chaotic state of the elementary principles of matter—Influence of the Spirit of God upon the chaotic mass—Opinions of the ancients—Similitude between the first and second creation—Agency of the Holy Spirit in the work of regeneration asserted and proved.

As creatures possessed of conscious existence, and furnished with both intellectual and moral powers, it is very natural for us to inquire into the origin and first state of things; and, when difficulties present themselves, to meet with clear and satisfactory solutions of them, removing the darkness in which they were enveloped, affords to reflecting minds a high gratification. Without the aid of divine revelation, the creation of the world would have been involved in uncertainty, and our unassisted reason left to speculate in fields of wide conjecture. But in following the luminous torch of sacred communication, we are safely conducted to the first great Cause, by whose almighty *fiat* matter was called into existence, and afterwards disposed and modified according to the plan devised by the eternal Mind.

Moses, considered as a man of scientific habits, being well versed in all the "wisdom of the Egyptians"—mathematical, physical, moral, and divine; could not but know that his cosmogony would have to pass the ordeal of critical investigation, and undergo the test of philosophical inquiry: that contemporaries, as well as future and remote nations and generations, would minutely examine his historical record; and science, in its progressive state of improvement, try the validity of his system: that it would meet the inquisitive eye of genius and learning, and fall into the hands of both sincere friends and insidious enemies to religious truth: that candor would patiently search into its pretensions, impartially weigh its evidence, and sober inquiry respect its claims: while narrow prejudice, blind bigotry, or superstitious enthusiasm, would dispute its authority, deny its veracity, and disdainfully reject its aid. But listening to an all-wise Instructor, following a Guide that could not deceive him; and disregarding the envenomed tongue of calumny, the lampooning pen of the satirist, the surly frown of literary pride, and the imperious authority of exalted rank; he committed to writing a true account of the creation of the world, for the information and religious improvement of mankind to the latest generation.

Viewed as the ground-work of all future revelations, if any defect or false position were discovered in his relation of things, that would deprive his history of credibility, and decisively prove him to have been led by the sallies of a vain and heated imagination, and not the Spirit of the living God. But of this there was no danger; and, as a distinguished author pertinently observes, "from the book of Genesis, almost all the ancient philosophers, astronomers, chronologists, and historians, have taken their respective *data:* and all the modern improvements and accurate discoveries in different arts and sciences have only served to confirm the facts detailed by Moses, and to show, that all the ancient writers on these subjects, have approached to, or receded from truth, and the phenomena of nature, in the exact proportion as they have followed the Mosaic history." As a writer, Moses does not attack other systems, formed on this or that hypothesis; but in a simple and incontrovertible narrative, acquaints us with the origin of matter, and the progressive formation and completion of the solar system.

The Scriptures inform us, that Moses was privileged to converse with God "face to face, as a man speaketh unto his friend," and from him received clear and manifest revelations, not by visions, ecstasies, dreams, inward inspirations, or the mediation of angels, but familiarly and with confidence, by articulate sounds, in his own language. The Lord said, "With him will I speak mouth to mouth, even apparently, and not in dark speeches; and the similitude of the Lord shall he behold." God being a Spirit, has neither shape nor parts, consequently is invisible, and cannot be seen by eyes of flesh: he is the most simple essence. When he speaks of himself as having a face, mouth, eyes, hands, &c, he adapts his language to our capacities, designing to express by these figures the perfections of his nature; but he is really one undivided essence. That which Moses saw, was only the *Shekinah*, a glorious brightness, the symbol of the Divine presence, and not the essence, which is invisible.

In giving an account of the true origin of things, he attends particularly to the *mode, agent,* and *time* of their being produced. His history commences with the creation of matter, "In the beginning." Before the creative acts mentioned by him, all was eternity. *Time* signifies *duration* measured by the revolutions of the heavenly bodies; but prior to the creation of these bodies, there could be no measurement of duration, and consequently no *time;* therefore, "In the beginning," must necessarily mean the commencement of time which followed, or rather was produced by God's creative acts, as an effect follows, or is produced by a cause.

[From several expressions in this chapter, it is obvious that Mr. Wood considered the account given by Moses, in the first chapter of Genesis, to apply to *universal creation,* and not to be restricted to our *Solar System*. It is also plainly inferable, that he considered this the *first exercise of God's creative energy in any way*. This view is entirely too contracted, is not clearly warranted by the text of the sacred historian, and is unnecessary.

There are no passages of Scripture which say distinctly, the Mosaic creation is the first or only acts of creative energy: but there are several which intimate the *previous existence of creatures*, and of course imply a previous exercise of creative power.

It is sufficiently clear that there were intelligent beings existing at the creation of this world. Hence it is said, "the morning stars sang together, and the sons of God shouted for joy," in view of the rising creation.

Since, therefore, the previous existence of intelligent beings is established, we must, of course, assign to them some *mode* of subsistence; and this will compel us to assign at least what must be *necessary* to every creature, a *place of abode*, suited to his wants and conditions, without which he cannot subsist. Thus we establish even a *material* creation, *anterior* to the creation mentioned by Moses.

After weighing the account which Moses gives in the first chapter of Genesis, together with the facts and analogies in Nature, the conclusion seems irresistible, *that he describes only our Solar System;* which includes the seven primary planets, Mercury, Venus, Earth, Mars, Jupiter, Saturn, and Herschel: the four asteroides, Vesta, Juno, Ceres, and Pallas: and the eighteen moons which attend the primary planets. Because,

1. As this account forms the introduction to a revelation designed for the *human family only*, it is reasonable to conclude it would have reference to those bodies only which operate materially to their benefit or injury. But there are no such bodies except in the Solar System.

2. Moses in describing the formation of the heavenly bodies, mentions only the *sun* and *moon* in a conspicuous manner: because, these are the only luminaries which contribute *essentially* to our comfort: and then, lest a beholder might imagine God did not also make the other suns and stars, says incidentally, "He made the stars also."

3. The conclusion is clear from the fact, that *the Solar System is complete in itself:* forming a perfect whole, which could exist were all other stars and suns destroyed, and vice versâ, all other systems could exist were the Solar System destroyed.

4. It does not well comport with the character of the Divine Being, when we consider his eternal power, infinite wisdom, and boundless goodness, to suppose He never exercised his creative energies but *once*, and that not until a few thousand years since. Yet we are compelled to this conclusion, however reluctantly, unless we restrict the Mosaic account of the creation to our Solar System.

This argument will derive additional weight, when we recollect the *immensity* of God's works taken together, and the *illimitable space* in which he has, and may, exercise his creative energy. We may *approximate towards* a very faint idea of their immensity, by calling to mind the immense number of *fixed stars.* All astronomers admit their number to be very great indeed, but how many cannot be correctly known. There may be millions whose light has not reached us yet. Of those which may be detected, Professor *Vince*, says, there are at least *seventy-five millions;* and each the centre of a system as large, possibly much larger than our own. Indeed we can scarcely approach towards a competent idea of *illimitable space.* The nearerst *fixed star* is supposed to be Sirius, or the dog-star, at the lowest calculation *twenty-two billions of miles distant.* If we compute according to this analogy, and say there are seventy-five millions of fixed stars, each the *centre* of a system, perfect, and independent: what mind can conceive the illimitable space through which these worlds must lie? Yet this would scarcely be an approximation towards the true extent. Beyond this there is still *unoccupied space,* "where existence sleeps in the wide abyss of possibility."

It may, therefore, be asked with justice, whether a being capable of creating, even in this limited view, would have exercised his creative powers *but once,* and that not until a few thousands years since? *Credat qui posset, non ego.* Who can tell what may have been the *successive* creations, durations, and, possibly, destructions of those worlds which we see, and of others, of which the inhabitants of this earth have never heard, whose light has not yet reached us since their creation, though coming at the rate of nearly *twelve millions of miles in a minute?*

Finally: A *succession* of creative acts, whose commencement runs back *almost* parallel with eternity, and will extend forward *almost ad infinitum,* seems to comport best with the eternal, immense, and immutable activity, energy, and goodness of the Divine Being.]

The word *created* means, that God caused that to exist which, previously to this moment, had no being. The Rabbins, who are legitimate judges in a case of verbal criticism on their own language, are unanimous in asserting, that the word ברא *bara* expresses the commencement of the existence of a thing, or its egression from nonenity to entity. It does not, in its primary meaning, denote the *preserving* or *new forming* things that had previously existed, as some imagine; but *creation,* in the proper sense of the term, though it has some other acceptations in other places. The supposition that God formed all things out of a pre-existing eternal nature, is certainly absurd: for, if there was an eternal nature besides an eternal God, there must have been two self-existing, independent, and eternal Beings, which is a most palpable contradiction. *Ex nihilo nihil fit,* "That out of nothing, nothing is produced" is a maxim that applies itself in every case where Deity is not concerned; it was the main argument used by Aristotle and his followers, but is completely refuted by the authority of Divine revelation. God created את השמים ואת הארץ *eth hashamayim veet haarets,* "the heavens and the earth." The word את *eth,* which is generally considered as a particle, simply denoting that the word following is in the accusative or oblique case, is often understood by the Rabbins in a much more extensive sense. "The particle את *eth*," says Aben Ezra, "signifies the ***substance*** of the thing." The like definition is given by Kimchi in his ***Book of Roots***. "This particle," says Mr. Ainsworth, "having the ***first*** and ***last*** letters of the Hebrew alphabet in it, is supposed to comprise the *sum* and *substance* of *all things*." "The particle את *eth*," says Buxtorf, Talmudic Lexicon sub voce, "with the Cabalists, is often mystically put for the *beginning* and the *end*, as Α alpha and Ω omega are in the Apocalypse." On this ground, these words should be translated, "God in the beginning created the ***substance*** of the heavens, and the substance of the earth: i. e. the ***prima materia***, or first elements, out of which the heavens and the earth were successively formed."*

During the first state of things, Moses informs us, that "the earth was without form and void; and darkness was upon the face of the deep." The original terms תהו *tohoo*, and בהו ***bohoo***, translated, "without form and void," convey the idea of confusion and disorder. The translation by Paginus, is ***desert and emptiness***; in the Vulgate, it is *empty and void*; in the Septuagint, *invisible and incomposed*; from the Syriac, ***desert and uncultivated***; the Samaritan is the same as the Vulgate; the Arabic, *covered with abysses*: these translations are allowed by the learned Walton. There is but little difference in their real meaning, and all the Versions express the first state of things.† The whole collection of matter, created in a fluid state, was a crude, indigested chaos: all belonging to our system, as the sun, moon, stars, earth, and seas, lay blended together in one vast, confused mass, without any arrangement of their constituent particles, heavy and light, dense and rare, fluid and solid, being all mixed together; air, water, and earth, (which have since obtained the name of elements,) were promiscuously scattered throughout.

The chaotic mass remained in this primitive state, till God was pleased to assimilate, assort, and arrange the materials,—out of which he built up, in the space of six days, the whole of creation.‡ *The Spirit of God*, represented as sitting upon the vast abyss,

* See Dr. A. Clarke on Gen. i. 1.

† Barington's Dissertations, &c, p. 82.

‡ An eminent chemist and philosopher, Dr. Priestley, has very properly observed, that it seems plain that Moses considered the whole terraqueous globe as being created in a *fluid* state, the earthly and other particles of matter being mingled with the water. The present form of the earth demonstrates the truth of the Mosaic account; for it is well known, that, if a soft or elastic globular body be rapidly whirled round on its axis, the parts at the poles will be flattened, and the parts on the equator, midway between the north and the south poles, will be raised up. This is precisely the shape of our earth; it has the figure of an *oblate spheroid*, a figure pretty much resembling the shape of an *orange*. It has been demonsrrated by admeasuremnt, that the earth is flatted at the poles, and raised at the equator. This was first conjectured by Sir Isaac Newton, and afterwards confirmed by M. Cassini, and others, who measured several degrees of latitude at the equator and near the north pole, and found that the difference perfectly justified Sir Isaac Newton's conjecture, and consequently confirmed the Mosaic account. The result of the experiments instituted to determine this point, proved, that the diameter of the earth at the equator is greater by more than *twenty three* and *a half* miles than it is at the poles, allowing the polar diameter to be 1-334 part shorter than the *equatorial*, according to the recent admeasurements of several degrees of latitude made by Messrs. Mechain and Delambre. L'Histoire des Mathem. par M. de la Lande, tom, iv, part v, liv, vi; and Dr. Adam Clarke, on Gen. i, 10.

like a bird, while either in the act of incubation or fostering its young, *moved* or brooded *upon the face of the waters*, communicating, by his vital energy, life and motion to the unformed chaos.

Some writers understand by רוח אלהים *the Spirit of God*, a "mighty sweeping wind," a "tremendous tempest," separating diversified particles of the elementary principles of matter, and combining those of the same kind together. But this is making an effect to be produced by a cause, which, as yet, had no existence; nor, as a cause, is it sufficient to produce so great an effect. To make an effect superior to its cause, is as absurd and contradictory as to say, a long line and a short one are equal. That the single Hebrew word רוח *ruach*, the Greek πνευμα *pneuma*, the Latin *spiritus*, and the anecint Saxon *ghost* or *gast*, signifies *wind*, as well as the vital breath, the soul of man, a created spirit good or evil, is readily admitted. But concerning the phrase רוח אלהים, *the Spirit of God*, so frequently used in the Scriptures of the Old Testament, there is not one instance that it signifies *wind*, and to attempt to force such meaning upon it, is a most manifest violation done to the text. By *the Spirit of God*, is meant the third subsistence in the Divine essence, distinguished from the person of the Father, and that of the Son; he is called a *Spirit*, to signify his spiritual and immaterial nature, as well as to express his mighty agency; and the works of which he is the author can only be effected by an omnipotent power.

Milton, who was well versed in the Hebrew language, in his address to the Holy Spirit, says,

> "Thou from the first
> Wast present, and with mighty wings outspread,
> Dove-like, sat'st brooding on the vast abyss,
> And mad'st it pregnant."

The Holy Spirit, by his vital influence, infused that efficient power into the great mass of matter, which was necessary for the assumption of different forms, and the discharge of the assigned functions of selecting and arranging the materials out of which the world is formed. By brooding over the mingled earth and water, says Dr. Owen, "he communicated a prolific virtue; and inlaid them with the seeds of animal life; and therefore the earth and the water brought forth all sorts of creatures in abundance, according to the seeds and principles communicated to them by the cherishing motion of the *Spirit of God*."

As several of the ancients have described the elementary principles of all things to be a gloomy chaos, consisting of *darkness* and *water*, we may easily infer from what source they derived this notion. Aristotle observes, the theologists and natural philosophers agreed, that all things were produced, as the former said, "out of night;" or, as the latter, "out of a confused mixture." Whatever knowledge the inhabitants of Chaldea had of the creation of the world, they ascribe to the teaching of an amphibious monster denominated Oannes. He taught his auditors, that there was a time when all things were darkness and water, in the midst of which various monsters of horrible forms received life and light. Over this chaotic mass presided the demon Omoroca, a mythological personification of the ocean. At length arrived the destined hour of the creation. The monster Omoroca fell subdued beneath the victorious arm of Belus: the animals which composed her empire were annihilated; and the world was formed out of her substance. Oannes, however, taught, that this physiological description was to be taken merely in an allegorical sense, and that the whole fable alluded to the aqueous origin of the universe. Matter having been thus created, Belus divided the darkness from the light, separated the earth from the heavens, disposed the world in order, and called the starry host into existence.

According to the Phœnican system, the principle of the universe was a *dark air*, and a *turbulent evening chaos;* an opinion not very dissimilar to that given by Moses. Sanchoniathon afterward ascribes to material operation the origin of that which may be denominated the will or desire of God, when in his great wisdom he thought fit to create the world out of nothing. From this personification of Divine love, a chaotic mixture was produced, and within it were comprehended the rudiments of all things.

The cosmogony of the ancient Egyptians, though more obscure, is given by Diodorus Siculus. "Damascius having inquired about what was the first principle in the world, gives this as an ancient Egyptian doctrine. The Egyptians have chosen to celebrate the first cause as *unspeakable.* They accordingly style it *darkness unknown* and mention it with a three-fold acclamation. Again. In this manner the Egyptians styled the first principle *an inconceivable darkness ; night and darkness past all imagination.*" This is perfectly consonant to passages from the same author, quoted by Dr. Cudworth. "There is one origin of all things, celebrated by the name of *unknown* (incomprehensible) *darkness.*" Again. "They hold, that the first beginning or cause of things was *darkness beyond all conception ; an unknown darkness.*"

Hesiod mentions, "A chaos as first existing. Next was produced the spacious earth, the seat of the immortals; Tartarus hid within the recesses of the ample globe; and divine love, the most beautiful of the deities. From chaos sprung Erebus, and black night; and from the union of night and Erebus were born ether and the day."* Zeno, of Cittium, the founder of the Stoics, said, Hesiod meant by the chaos, "Water, out of which all things were formed, which by concretion became firm earth."

In the work of Aristophanes, we meet with a similar passage. "Chaos, and night, and black Erebus, and wide Tartarus, first

* Hesiod. Theog. 116.

existed; at that time, there was neither earth, air, nor heaven. But in the bosom of Erebus, black-winged night produced an aërial egg; from which, in due season, beautiful Love, decked with golden wings, was born. Out of dark chaos, in the midst of wide-spreading Tartarus, he begot our race, and called us forth into the light."†

It is unnecessary to multiply quotations to prove, that the ancients were not only acquainted with the cosmogony of Moses, but received it as true; to which they added their own coloring.

[It is now generally agreed by cosmogonists, commentators, biblical critics, and natural philosophers, that the *substance* of the earth certainly, and probably the materials of the Solar System, was first created in a chaotic state, and subsequently arranged in order. This opinion is very ancient and almost universal, found in all nations Ovid, an ancient heathen poet, has well described this chaos.

> Ante mare et terras, et, quod teget omnia, Cœlum,
> Unus erat toto naturæ vultus in orbe,
> Quem dixère Chaos; rudis indigestaque moles,
> Nec quicquam nisi pondus iners; congestaque eodem
> Non bene junctarum discordia semina rerum.

> Before the seas, and this terrestrial ball,
> And heaven's high canopy that covers all:
> *One* was the face of nature if a face:
> *Rather a rude and indigested mass:*
> *A lifeless lump, unfashioned and unframed,*
> *Of jarring seeds, and justly* CHAOS *named.*—Dryden.

Notwithstanding the general prevalence of this opinion, and the high authorities which support it, the reader must not imagine it is absolutely *universal.* Some eminent men have suggested, that the earth, and matter generally, was created in a *solid* state at first. This is the view taken by Mr. Ure, of the Andersonian University. He supposes *the earth was created a solid ball, or spheroid, regular on its surface, without hills and vallies, and immersed in a crust of ice, which completely and uniformly surrounded it: that it was a cold lifeless lump; heat not yet having pervaded it.* The first, and all quickening operation of heat he supposes to be indicated by these words of Moses: "And the Spirit of God moved on the face of the waters." He supposes, all the matter of our earth is in the same relative position, in which it was when it first existed at the command of God; *except such cases in which some subsequent force has disarranged it.* These cases he supposes to have been many, and to have operated to the *upheaving* the mountains, and hollowing out the beds of the sea, &c. He says of the earth: "The central mass composed, most probably, of the metallic bases of the earths and alkalies, as volcanic phenomena seem to attest, would fuse, when first the calorific energy was made to actuate the body of the earth, and the exterior parts would oxydize into the crust of mineral strata, and the outermost coat of all, the fixed ice, would melt into the moveable *waters.*" *New Syst. of Geol. B.* 1. *chap.* 1. *p.* 7.

Perhaps Mr. Ure's view might be improved, and made to approxi-

* Aristoph. Aves, 694.

mate much nearer the common opinion, possibly identified with it, by supposing the mass of matter composing our earth, was confusedly mixed,—and of course chaotic—but was in a frozen, hard, inactive state: that the quickening energy, which softened and fused it, was simultaneous with its revolution on its axis. The consequence then would be precisely what we find it to be; viz: an enlargement of the equatorial diameter, and a flattening of the poles. This I conceive to be the true theory in this case.

Mr. Ure confirms his view by a quotation from Sir Isaac Newton; Optics, Book 3. towards the conclusion. "It seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable, movable particles, of such sizes and figures, and with such other properties, and in such proportions to space, as most conduced to the end for which he formed them. All material things seem to have been composed of the hard and solid particles above mentioned, variously associated in the *first creation* by the counsels of an intelligent agent. For it became him who created them to set them in order; and if he did so, it is unphilosophical to seek for any other origin of this world, or to pretend that it might rise out of *chaos* by the mere laws of Nature; though being once formed, it may continue by those laws for many ages."

I have given this quotation precisely as I found it in Mr. Ure's New System of *Geology*, B. 1. chap. 1. p. 10. Considering the well founded reputation of Newton, it adds very much to the probability of the above theory: yet it seems to me to be at variance with the commonly received impression of Newton's opinion on this subject. I have not his work at hand to examine it.

The Encyclopedia Britannica, Article *Earth*, seems to favor this view. It says, "The common notion of the earth's being originally a chaos, seems neither to have a foundation in reason, nor in the Mosaic account of the creation."

The reader will here perceive high authorities on both sides, and all claiming to agree with Moses. The weight of evidence seems to be in favor of a chaotic creation, which does *not* necessarily imply that the mass was created in a *soft* state. But the configuration, and internal structure of the earth abundantly prove it was in a soft, or compressible state when it was assuming its present form and structure. This condition was the effect of the quickening energy of the Spirit of God. The difference between the *equatorial* and *polar* diameters of the earth, which is now well established, and is about twenty-seven miles, can scarcely be accounted for, without supposing the substance of the earth, at least to a great depth, to have been partially or wholly fluid; in which case, by turning round rapidly on its own axis, it would assume the shape it is known to possess. It may, indeed, be said, the Almighty could give it any shape and qualities he pleased, and we cannot well object to it.

As it regards the interior, or central parts of our planet, our author has said nothing; and possibly he would give this very good reason for his silence—*we can know nothing certainly*. Still, however, we may subjoin the conjectures of some eminent philosophers.

Some suppose the central parts of our globe to be *cavernous* or *hollow.* The principal argument for this theory is the transmission of *sound* and *motion* through vast extents of country, in case of volcanoes and earthquakes. It is supposed this could not be done so perfectly and extensively, unless we suppose some *àëriform,* or *gaseous* body within the earth, by means of which it might be transmitted: which would be to suppose it *cavernous* or *hollow.*

Dr. Halley supposes the earth is a hollow sphere, in which there is inclosed a central magnetic globe, and by the motions of this globe the variations of the magnetic needle are produced.

Our own ingenious, but unfortunate countryman, *Symms,* supposed the earth to be hollow, and inhabited within, and its interior accessible to us. He argues, there is no necessity, for the purposes of gravitation, or for any other purposes, to suppose the earth solid to the centre: And it is inconsistent with the divine beneficence to suppose such an amount of matter as this globe would be, if solid, should have been created to afford so small a portion, *scarcely one-fourth,* fit for the actual habitation of man, for whom principally it was created. He, therefore, supported, that the interior of the earth was an immense cavern blessed with changes of season, succession of day and night, cold and heat, and inhabited by human beings, and other animals. He supposed the poles of the earth were hollow, and this hollow entrance gradually verged round towards the equator; and ships have, without knowing it, been within the verge, from whence they found no difficulty of returning.

Others have supposed the central parts of our globe are solid. This is the common supposition, and is principally supported by these two arguments:—As the attraction of gravitation depends on the *quantity* of matter, as well as the distance; unless we suppose the earth a *solid* body it will not be able to exert a sufficient attractive influence on the moon to keep her in her orbit. Again: it is ascertained by actual experiment, that the *mean* density of the earth is about *five* times that of water: from which it is infered it is solid, and must increase in density from the surface to the centre, in order to give this high mean proportion over the bodies at its surface.

The increasing density of the earth, from the surface to the centre is owing to *compression* in part, and partly to the supposed fact, that the heavier substances are placed nearer the centre. Thus we find the different strata of rocks indicate the same. Granite is the heaviest and lowest rock *in situ.*

Some have supposed that *iron,* probably nearly in a metallic state, constitutes the nucleus of our earth. This idea seems to have been suggested to account for the influence of the earth on a magnetic needle.

But the most splendid, and very probable conjecture is founded on the experiments of Berzelius, and Sir H. Davy, on the earths, which experiments prove them to have *metallic bases* universally: hence all our earths are *metallic oxides.* From these circumstances it is conjectured, that the nucleus of our globe is constituted of the metals in a pure, or nearly pure state, which are the bases of our earths, alkalis, and alkaline earths.

It would almost seem a legitimate conjecture to suppose the substances of our globe were, at *first*, *metals* and *gases*: that the oxygen combining with the metals formed earths, and alkalis; and the gases combining among themselves formed air, water, &c. This would be a chimical process, and necessarily *fuse* and soften the earth, and introduce the process of cooling, which would proceed from the surface towards the centre. Hence some eminent philosophers have conjectured that there is a great degree of heat in the interior of the earth yet: probably the central parts are in a state of igneous fusion. Some recent researches of Cordier tend to establish this opinion. The amount of evidence in favor of this conjecture is increasing annually, and probably will prevail. See the *additional* paper on *volcanos* in this volume.]

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## *Section* II.—FIRE.

Omnific word—Moving principles in Nature—Criticism on the original word אור aur—Creation of fire—Its nature—Friction exciting the action of fire—Fire attracted by bodies—Fire conducted—Fire in a state of combination—Fire elastic—Expansive force of fire—Subterraneous fires—Earthquakes and Volcanic Eruptions—Air a storehouse of fire—General and final Dissolution of Nature by fire—Fire a symbol of the Deity, in his gracious presence, vital influence, transfroming energy, and destructive operation.

THE sacred historian here informs us of the first regular production reduced from the chaotic mass. With an astonishing majesty of expression, God said, יהי אור ויהי אור YEHI AUR, *vayehi aur*, *Let there be light: and there was light.* Or, more literally, *Be light: and light was.* Pagninus translates the words יהי אור YEHI AUR, literally, *Sit lux*, *Be light.* In the Greek it is γενεθητω φως, *Be light made*, or *generated.* In the Vulgate, *Fiat lux*, which is much the same as the Greek. The celebrated Dionysius Longinus, meeting with this passage in the Septuagint, considered it as a specimen of the *true sublime.* Though a heathen, he thus expresses himself: "So likewise the Jewish lawgiver, (who was no ordinary man) having conceived a just idea of the divine power, he expressed it in a dignified manner; for at the beginning of his laws he thus speaks: GOD SAID—*What?* LET THERE BE LIGHT! *and there was light.* LET THERE BE EARTH! *and there was earth.*"*

Here we may inquire, Whether this was a word uttered with a sound, like that which God spake from mount Sinai in giving the Law; or only the exercise of the inward faculty of reason or understanding? It could not be a word spoken with a sound, for that requires air as its *medium*, and none as yet existed; neither was there any ear to hear, nor any use of such words. Nor could it be any exercise of the Divine Mind, now beginning to think of the creation and formation of things; for this purpose was in his

* Longin, sect. ix, Edit. Pearce.

thoughts from eternity. The meaning therefore is, that God did, without any instruments, toil, labor, alteration, or delay, for the manifestation of his own infinite goodness, wisdom, power, and will, actually working like a powerful word or command, instantaneously produce *light.** Thus

"Dark Chaos heard his voice."

The Psalmist, touching on the subject of creation, says, "He spake, and it was done: he commanded, and it stood fast"—יעמד *jagnamad,*, *it stood forth*, as a servant at his master's command, prepared to do his will, and to execute his pleasure.†

The divine commandment which produced light, says an intelligent writer, must be considered as operating on the properties of matter already created; and as light is found to proceed from the motion of luminous particles, we must conceive some central force, or attracting power, to be the instrument of producing this phenomenon of light, by its attractive or propelling properties. There seem to be moving principles in all nature, which, when put in action by the first Cause, produce natural effects according to established laws, which cannot be altered unless by the first Mover. As the Hebrew word תהום *tehom, abyss*, translated *deep*, signifies also to move with a sort of confused motion; we may justly conclude that the chaotic mass had some gravitating powers in it, before the forming of the system; and that attracting and repelling force was naturally and originally in the universe; and that the first Mover gave them in a regular course, the specifical direction, and systematical attractions. What our distinguished philosopher, Sir Isaac Newton, has suggested concerning attraction and gravitation, even in point of philosophy, appears to agree with the Principia of Moses.

Another author writes, Whether Moses intended a philosophical account of light in this place, I will not pretend to say; but one thing is certain, that he makes use of a word which points out some of the principal properties of light. The original word אור *aur* signifies that body which renders objects visible, which we call *light;* it also signifies *fire*, and perhaps Moses intended to point out in one word, what in our language requires two, *light* and *fire*. When we consider the words of Moses, it appears evident that what is in our version called *light*, is in the Hebrew rather something that sends forth light. The original word אור *aur* may signify any thing that makes things visible by emitting particles of light. When the Almighty said, "Let there be אור *aur, light,*" it is not certain that he meant elementary fire, or original unpropagated light. It is more probable that he intended by that word, a body that sent forth light by means of the motion of similar particles of luminous and igneous matter.

* Walker's History of the Creation, p. 8, 9.
† Benson on the Text.

Whatever may be the philosophic differences between these two, *light* and *fire*, continues the same author, we are certain that they are seldom separated. The origin of that light which now renders bodies visible to us, seems chiefly to be *fire*, though light and fire are not inseparably connected; for light may be propagated where there is no fire, as from putrid bodies, &c, and fire may be where there is no light, as in iron, sulphur, &c.

The Hebrew word אור *aur*, signifies not only light, but *fire*. God created this powerful agent on the first day, and diffused it through every part of nature; because without it no operation could be carried on and perfected. T. Bartholine quotes Aristotle as saying, "That fire is the efficient cause of all things." Robison says, "Heat is susceptible of fixation—of being accumulated in bodies, and, as it were, laid up till we have occasion for it; and we are as certain of getting the stored-up heat, as we are sure of obtaining from our drawers the things we put in them."* It pervades all bodies: this is not the case with any other substance we know of—not even light. It lies hid in every thing around us. It is a substance which we are ever in want of; it is therefore deposited on every side, and is ready for every exigency.

*Caloric* is the name given by modern chemists, to that substance by whose influence the phenomena of heat are produced, and which had before been distinguished by the terms *igneous fluid*, *matter of heat*, and other analogous denominations. In order to give precision to chemical language, it was necessary to adopt a word by which to distinguish between the substance which produces the sensation we call heat, and the sensation itself; these being connected as cause and effect; for whenever caloric becomes fixed in a body, it loses its property of affording heat. Whatever is the nature of that quality in bodies called heat, we are assured it does resemble the sensation of heat. A man whose mind is destitute of the cultivation of science, if endued with common sense, never imagines the sensation of heat to be in the fire; he only imagines that there is something in fire which occasions this sensation.

Though we are well acquainted with the effects of fire, we know but little of its nature. It is so active, as well as powerful a principle, that it eludes all our researches. We may, however, define it to be the phlogiston or inflammable principle, which pervades in a greater or less degree all substances. Boerhaave thinks it is a fluid of a nature peculiar to itself; that it was created such as it is, and cannot be altered in its nature or its properties; that it naturally exists in equal quantities in all places; and that it is wholly imperceptible to our senses, being only discoverable by such effects as in its operation it produces.†

That fire is really a substance, and not a quality, appears from

* Preface to Dr. Black's Lectures, by Robison.
† Carpenter's Lectures on the Works of Creation, vol. i. p. 87.

its acting upon other substances, the reality of which has never been doubted. Charcoal, in its natural state, contains within its pores a large quantity of air; but if charcoal is heated, this air is expelled by the fire, which assumes its place, and occupies the pores of the charcoal. The burning of lime also, which deprives it of a great part of its weight by expelling the fixable air, demonstrates that fire, as a substance, enters into the pores of the lime, and forces out those other substances which are least intimately combined with it.

Collision or friction of solid bodies, is the means most generally used for exciting the action of fire. The vacuities of all solid bodies are replete with fire, so that it is impossible to agitate or separate their parts swiftly, without giving the same rapid motion to the element contained within them. When a piece of hardened steel is struck with a flint, some particles of the metal are scraped away from the mass, and so violent is the fire which follows the stroke, that it melts and vitrifies them. If the fragments of steel are catched upon paper, and viewed with a microscope, you will find most of them perfect spherules, and very highly polished. Their sphericity demonstrates that they have been in a fluid state, and the polish upon their surface shows them to be vitrified; the fire being disengaged with violence, disposes the particles of the substance to combine with the vital air, while this air accelerates the combustion. The whole of the heat produced is not afforded by the body itself, because in proportion as the interior fire is disengaged, the external air acts upon the body and gives out fire.

If the irons at the axis of a coach-wheel are applied to each other, without the interposition of some unctuous matter to keep them from immediate contact, they will become so hot when the carriage runs swiftly along, as to set the wood on fire; and the fore wheels being smallest, and making more revolutions, will be most in danger. The same will happen to mill-work, or any other machinery, if the necessary precautions are neglected. It is no uncommon practice with a blacksmith to use a plate of iron as an extemporaneous tinder-box; for it may be hammered on an anvil till it becomes red hot, and will fire a match of brimstone. A strong man who strikes quick, and keeps turning the iron, so that both sides may be equally exposed to the force of the hammer, will perform this in less time than would be expected. If in the coldest season you lay one dense iron plate upon another, and press the upper one, by a weight, on the lower one, and then rub the one over the other; by reciprocal motions, they will first grow warm, and at length so hot, as in a short time to emit sparks, and at last grow red hot, as if taken out of a vehement fire.

It is not necessary that the substance should be very hard; a cord rubbed backwards and forwards swiftly against a post or a tree will take fire; a stick of wood pressed against another which is turned swiftly about in a lathe, will soon make it turn black and emit smoke. Even the palms of your hands, if you rub them briskly together, when they are dry, will smell as if they were scorched. The method of exciting fire by rubbing two sticks of wood together, was anciently practised by country people, and is still retained in some parts of the world. The manner is exactly described in Captain Cook's voyage. The inhabitants of New-Holland are there said to produce fire with great facility, and spread it in a wonderful manner. To produce it, they take two pieces of *soft* dry wood; one is a stick about eight or nine inches long, the other piece is flat. The stick they shape into an obtuse point at one end, and pressing it upon the other, turn it nimbly by holding it between both their hands, as we do a chocolate mill, often shifting their hands up and down, and then moving them down upon it to increase the pressure as much as possible. By this method they get fire in less than two minutes, and from the smallest spark they increase it with speed and dexterity.

The matter of fire is attracted more or less by all bodies. When any heated body comes in contact with a cold one, the former loses a part of its heat, and both of them become equally warm. If heated iron is laid upon a stone, its heat will flow into the stone; if thrown into the water, the heat will be diffused through the water. If a number of different substances, as metals, wood, wool, &c, are brought together into a place where there is not a fire, if they are of different temperatures, that is of different degrees of heat, the fire will be attracted from the hottest to those that are colder, till a perfect equilibrium is produced, or till they have all acquired the same temperature, as may be proved by applying the thermometer successively to each of them.

It does not appear, however, that all bodies have an equal attraction for the matter of fire. If a rod of iron is put into the fire for a short time, the end which is at a moderate distance from the fire will almost burn the hand; but a rod of wood, of the same length will be consumed to ashes at the end which is in the fire, before the other end is sufficiently heated to burn the hand. A ball of lead, and a ball of wool, may be of exactly the same temperature by the thermometer, but they will not appear of the same degree of heat on applying the hand. If they are of a temperature below that of our bodies, the lead will appear much colder than the wool, because it attracts the heat more rapidly from the hand; if they are of a higher temperature, the lead will appear much hotter, from the facility with which it parts with its heat. This property in bodies is called their *conducting* power; and those bodies through which the element of fire most rapidly circulates, are called good conductors.

The power of conducting the matter of fire seems to depend upon the texture of bodies, that is, upon the contact of their parts;

hence the excessive slowness with which heat is communicated to bodies of a rare and spongy texture. Thus flannel, wool, and feathers, are considered as warm coverings, not because they possess more heat in themselves—for they serve to preserve any cold body in a cool state better than other substances—but because they prevent the escape of the animal heat from our bodies.

The matter of fire will exist in a state of combination, in a *latent* state, so as not to be perceptible to our senses. It will be found by observation, that every body which exists contains a quantity of the matter of fire in a fixed or neutralized state, disarmed of all its active, penetrating, and destructive qualities, like an acid and an alkili in combination.

Fluids, from their very nature and constitution, contain a greater quantity of caloric in a latent state than solid bodies: indeed it is now universally admitted, and may be easily proved, that the fluidity of all bodies is altogether owing to the quantity of fire which they retain in this latent or combired state, the elasticity of which keeps their particles remote from each other, and prevents their fixing into a solid mass. All bodies, therefore, in passing from a fluid to a solid state, emit a quantity of fire or heat. When water is thrown upon quick lime, it is absorbed by the lime, and in this state it is capable of retaining a much smaller quantity of caloric than in its natural state; on the slacking of lime, therefore, a very intense heat is produced, the matter of fire which preserved the water fluid being disengaged and detached. If spirit of vitriol is added to strong oil of turpentine, they will condense into a solid mass, and a great quantity of heat will be sensibly emitted. Upon the same principle it will be found, on the other hand, that when any body passes from a solid to a fluid state, the adjacent bodies will be deprived of a quantity of their natural heat.

[This theory of what is called *burning lime*, is not sufficiently clear. Fire does not enter into the pores of the lime by burning The mineral commonly used for procuring *quick lime* is the *carbonate* of lime, or common *limestone*, which is composed of carbonic acid with a small quantity of water, 43, and lime 57, in 100 parts. By submitting it to a strong heat, the carbonic acid is driven off, and the quick or pure lime remains, which is an *oxide of calcium*. The loss in weight is owing to the expulsion of the carbonic acid, with the small portion of water. By adding water to the quick lime, it is dissolvd, and falls into a powder. This process is called *slacking lime*, and the product, *slack-lime*. During the process a large quantity of heat is disengaged; and if the slacking be done in the dark, *light* is also observed to be thrown out. This heat is given out by the *water*, not the lime. The lime having a *greater affinity* for the *hydrogen* of the water than exists between the hydrogen and oxygen in water, seizes upon it, and the *oxygen passes off*, together with the *latent caloric* of the water, and thus the heat is produced which is observed in slacking lime. The hydrogen of the water combines with the lime and becomes solid, forming an *hydrate of lime*, which is the common slacked lime used in mortar.]

The matter of fire is *elastic*, as is proved evidently from all its effects. There is indeed reason to believe, that caloric is the only fluid in nature which is permanently elastic, and that it is the cause of the elasticity of all fluids which are esteemed so. From the elasticity of this element it results, that all natural bodies can only retain a certain quantity of it, without undergoing an alteration in their state and form. Thus a moderate quantity of fire admitted into a solid body expands it; a still larger quantity renders it fluid; and if the quantity is still increased, it will be converted into vapor.

Caloric expands all bodies which it penetrates, more or less, in proportion to its quantity, and to the nature of those bodies. The expansion of water, even previous to its assuming the form of vapor, may be seen in an easy experiment. If a quantity of cold water, contained in a clear flask, is immersed in a vessel of boiling water; as the heat enters, the water in the flask will be seen to rise in the neck till it overflows.

An iron rod a foot long being heated red hot, became 1-60 longer than before; and a glass cylinder, a fathom long, under the same circumstances, gained 1-50 in length. A metalline ring thus heated was increased 9-100 in its diameter: and a glass globe became extended 1-100 part by the heat of the hand only applied to its surface.

The *general* effects of caloric are to increase the bulk of the substances with which it unites, and to render them specifically lighter than they were before; but in whatever quantity it is accumulated in bodies, it never adds to their absolute weight. Caloric favors the solution of salts, and promotes the union of many substances. In other cases it serves to separate bodies already united; so that in the hands of chemists it is the most useful and powerful agent with which they are acquainted. It is the cause of fluidity in all substances which are capable of becoming fluid, from the heaviest metal to the lightest gas. Let it be remembered that *all* fluids are formed from solids by an addition of caloric; and that, by abstracting this caloric, solids would be reproduced. It insinuates itself among their particles, and invariably separates them in some measure from each other. We have reason to believe that every solid substance on the face of the earth might be converted to a fluid, or even a gas, were it submitted to the action of a very high temperature in peculiar circumstances.†

[The general and aggregate bearing of the facts and experiments which are now known, render the statement here made by Mr. Wood extremely probable, viz; That caloric is a very subtle fluid which pervades in large quantities every particle of matter in the universe—

* Boerhaave's Chem. by Shaw, vol. i. p. 299.
† Parkes's Chemical Catechism, or Rudiments of Chemistry, chap. ii.

that it is the agent which regulates the *densities* of all bodies, and by consequence, regulates in some measure their *weight* and *dimensions.* It is considered as an almost settled question, *that a stratum of caloric surrounds each ultimate particle of every body, so that the ultimate particles of bodies do not, and cannot be made to touch each other.* Their inherent inclination to come into actual contact is called their *attraction of cohesion:* the power of this attraction is in proportion to the distance at which they are kept from each other by the atmosphere of caloric which intervenes between them. This atmosphere of caloric is *idio-repulsive:* of course the particles of caloric have an inherent *repulsion* among themselves, and are ever struggling to get further asunder.

This idio-repulsive nature of caloric is the great, and constant antagonist power to the attraction of cohesion. Caloric has a tendency to drive the particles of matter further from each other, and these particles have a mutual tendency to approach. Hence these two principles are ever in conflict. As a general rule we may say, when the attraction of cohesion prevails greatly, the body becomes *solid:* when the two forces are pretty nearly balanced, the body becomes *liquid:* when the caloric prevails greatly, the body becomes *gaseous.*

There is sufficient reason to believe, that *every* body in nature might be raised to a *gaseous* state by the addition or action of a sufficient quantity of caloric: and there is, probably, a sufficient quantity in nature, to render the whole *universe* gaseous, were it sufficiently excited to a state of freedom. It is a well known fact, that *all the metals are fusible by heat,* and many of them have been *volatalized,* and it is extremely probable all of them may be.

As caloric regulates the density of bodies, by resisting and modifying the influence of the attraction of cohesion: if it were entirely withdrawn from nature, or the whole of it rendered perfectly latent, *all matter would become perfectly* SOLID and FIXED: even *water* and *air* would assume the *solidity of the diamond.*

We must, therefore, regard caloric as the great conservative principle of the Universe, and yet capable, if called into action, of destroying it instantly.

These views strongly corroborate *our* paper on *chaos.*]

From the experiments of General Roy, in the 75th volume of the Philosophical Transactions, it appears that the expansion of a steel pendulum of a clock is such, that every four degrees of the thermometer will cause a variation of a second per day; and that the difference between the going of a clock in summer and winter will be about six seconds per day, or one minute in ten days, owing to the metallic pendulum varying in length with every change of temperature. A knowledge of this circumstance gave rise to Harrison's self-regulating time-piece, which, by the different expansion of *different* metals, accommodates its movements to every change of seasons or climate.

The fire deposited below the surface of the earth is peculiarly important, having produced earthquakes and volcanic eruptions. Dr. Watson, late Bishop of Llandaff, in his Chemical Essays, says, The most remarkable changes which have taken place in the form and constitution of the earth, since the deluge, have probably been produced by subterraneous fires; for it is to their agency that philosophers ascribe volcanos and earthquakes; those tremendous instruments of nature, by which she converts plains into mountains, the ocean into islands, and dry land into stagnant pools. Mr. Lemery, as far as I have been able to learn, adds the learned Bishop, was the first person who illustrated, by actual experiment, the origin of subterraneous fires. He mixed twenty-five pounds of powdered sulphur with an equal weight of iron filings; and having kneaded the mixture together, by means of a little water, into the consistency of a paste, he put it into an iron pot, covered it with a cloth, and buried the whole a foot under ground. In about eight or nine hours time the earth swelled, grew warm, and cracked: hot sulphureous vapors were perceived: a flame which dilated the cracks was observed; the superincumbent earth was covered with a yellow and black powder: in short, a subterraneous fire, producing a volcano in miniature, was spontaneously lighted up from the reciprocal actions of sulphur, iron, and water.

Volcanic eruptions are awfully terrific, and sometimes extensively destructive. The violent eruption of Vesuvius, in 1767, is reckoned the 27th since that which destroyed the cities of Herculaneum and Pompeii, in the reign of the Emperor Titus; and this eruption of 1767, has been succeeded by several others. Of the eruptions of Ætna, Mr. Oldenburg has given a historical account in the Philosophical Transactions, No. xlviii. p. 967. A very great eruption of this mountain was in the year 1669. The progress of the lava, or fiery deluge, was at the rate of a furlong a day. It advanced into the sea 600 yards, and was then a mile in breadth. It had destroyed, in forty days, the habitations of 27,000 persons; and of 20,000 inhabitants of the city of Catanea, only 3,000 escaped. This inundation of liquid fire, in its progress, met with a lake four miles in compass, and not only filled it up, although it was four fathoms deep, but raised it into a mountain. Borelli, an ingenious Neapolitan, has calculated, that the matter discharged at this eruption was sufficient to fill a space of 93,838,750 cubic spaces. The lava which ran from it is fourteen miles in length, and, in many parts, six in breadth. There have been no such eruptions since, although there have been signs of many, more terrible, that preceded it.*

The principal valcanos in Europe are Mount Vesuvius, near Naples, in Italy; Mount Ætna, in Sicily; Mount Hecla, in Iceland; and Stromboli, the most northern of the Lipari islands, north of Sicily. Of all the volcanos recorded in history, Stromboli seems

* Contemplative Philosopher, vol. ii. p. 149, 150.

to be the only one that burns incessantly. Ætna and Vesuvius are sometimes many months, and even years, without the least emission of fire; but this is ever at work, and, for ages past, has been considered as the light-house of the Mediterranean Sea. It is very probable, that Mount Vesuvius and Mount Ætna form but different portions of *one* chain of mountains that passes under the sea, and the isle of Lipari; for whenever one of the volcanos has a great eruption, it is observed that the other, and the volcano in the isle of Lipari, throw out more flames than ordinary. This remark was made by Huet, Bishop of Avranches, in France, a celebrated philosophical, historical, and commercial writer. The force of volcanos is supposed to be the greatest of any thing yet known in nature. In the great eruption of Vesuvius, in 1779, a stream of lava, of an immense magnitude, is said to have been projected to the height of at least 10,000 feet above the top of the mountain.

[The present state of chemical science, and the geological discoveries of the last ten or fifteen years, seem to discountenance the theory, that volcanic action, and earthquakes result from *sulphur, iron,* and *water,* as Mr. Lemery's experiment seems to indicate.

The vast extent of volcanic action, as indicated by extinct and active volcanos, would require a greater amount of these materials, than can be supposed to exist in the composition of the earth. Thus, according to the Newtonian test of a correct theory, the means, if true, would not be sufficient.

Again: If sulphur and iron were the principal agents in producing volcanic action, and earthquakes, *volcanic products would give evidence of it,* by being, principally, *sulphate of iron.* So far is this from being the fact, that in 100 parts, volcanic product, Dr. Kennedy found, in reference to two volcanos, not exceeding 14.25 oxide of iron, and no sulphur at all.

Volcanic products are generally, "mixtures of the earth in an oxidated and fused state, under intense ignition; water and saline substances, such as might be furnished by the sea and air, altered as might be expected from the formation of fixed oxidated matter." URE.

These two simple considerations must set aside the theory mentioned in the text. Other valid objections might be urged.

As this theory is inadmissible, because, neither true in application to volcanic action and product, nor sufficient in force, it is proper to supply the deficiency.

By a careful inspection of the phenomena attending volcanic action, as well as an examination of its products, we are clearly convinced, the *agents are aëriform;* chiefly *steam* and the *gases,* and they act with an *expansive force from beneath.*

Mouna Roa, in the island Owhyhee, rises 15,000 feet, and has on its top a crater *eight miles* in circumference, containing a vast lake of molten lava. Mr. Goodrich visited it in 1824. He says, "exhalations escape from all the fissures of the lava crust, producing here and there a blast *like strong vapor blowing out of a steam boiler.*"

Subsequently, a party from the Blonde frigate visited it, and the Rev. Charles Stewart, who accompanied the party, has given a description of the crater. He says, "its surface had all the agitation of the ocean. Billow after billow tossed its monstrous bosom into the air, and occasionally the waves from opposite directions met with such violence, as to dash the fiery spray, in the concussion, forty or fifty feet high." *Ure's New Syst. Geol.* pp. 381–2.

In both these accounts we clearly see äeriform agents acting from beneath. The *hissing* noise of steam escaping from a boiler, convinces of the *nature* of the body escaping. The *upheaving* of the melted lava proves, not only, that the agent acts from *beneath* by expansion, but also, by its resemblance to the common phenomenon observed in boiling liquids, that the agent is formed below, and rises through the melted lava, heaving it up in swells and waves, until it escapes in a gaseous state, like vapor from boiling liquids.

We must come to the same conclusion from the experiments, observations, and reports of the celebrated, and intrepid Spallanzani, who visited and examined the crater of the ever-burning Stromboli. His words are nearly these: Fluid lava, resembling melted brass red-hot, and liquid filled the crater to a certain height, and this matter appeared to be influenced by two distinct impelling powers; the one whirling and agitated; and the other upwards, terminating in an explosion like a short clap of thunder. Immediately before the explosion occurred, the lava appeared *inflated*, and *large bubbles*, some several feet in diameter, rose and burst, the detonation followed and the lava sunk. During the rising, *a sound issued from the crater like that produced by a liquid boiling violently in a caldron.* In this case we have every evidence of an *äeriform agent acting from beneath.*

An äeriform agent is detected also by examining the *structure* of volcanic products, which have been ejected in a melted state. They are found to be *vesicular*, *cellular*, and *porous*. This structure proves, incontestibly, that these cavities and cells were filled with an äeriform body, which escaped upon cooling.

This position might be sustained by other proofs, but it is unnecessary. It remains only to ask, *whether these elastic agents are sufficient to produce the astonishing amount and products of volcanic action and earthquakes?*

The force which elastic agents are known to possess, when generated suddenly, and raised to a high temperature, answers this question promptly in the *affirmative.* A very few grains of gunpowder, when converted into gas by sudden ignition in a gun-barrel, by their expansive force drive a bullet with astonishing power and velocity. A few cubic feet of water converted into steam, will burst the strongest metallic barrier which man can construct, unless it find vent.

As we have seen sufficiently clearly that äeriform bodies, as steam and gases, are the elastic agents in producing earthquakes and volcanos, it remains to inquire into the *production* and *action* of those agents.

As it regards their production, the present state of geological and chemical science suggests *three* theories, each of which would be adequate to the object.

It is necessary to premise that *water* is a common agent in each of the three theories.

1. The splendid discoveries of Sir H. Davy, in regard to the *bases* of the earths, demonstrating them to be *metallic*, and the earths merely *oxides* of those metals, have led to the conjecture, *that these metals exist in nearly a pure state in the interior of the earth;* of course the *crust* of the earth is composed of the various metallic oxides.

It is well known that many of these metals *take fire on coming into contact with water, as potassium, sodium, &c;* and *all of them oxidize rapidly on meeting with water and air*, and thus *large quantities of hydrogen gas would be evolved.*

This theory is so reasonable, in view of the *combustibility* of metals, and so conformable to science, that we almost decide it is true, without further examination.

But, in order that its demonstration should be clear, it must first be shown, *that the metals do exist in nearly a pure state in the interior of the earth:* and then, *that they are accessible by water, or air, or both.*

The first point can only be rendered *probable by analogy.* We *know* that the earths which are found in the *crust* of our planet are *metallic oxides.* It is very natural to suppose these metals existed in a pure *metallic state at the creation, as well at the surface as at the centre;* as all other bodies most probably existed in an elementary and uncombined state when God first produced them. From this supposition it is easy to see, that when water and air came into action, which would be at the earth's surface, these metals would be rapidly oxidized, thus forming the earths. But as this process would commence at the *surface* of the earth, and *tend towards the centre*, it is evident its *progress would be arrested by its own action.*

For the *accumulation of the earths*, by the oxidation of the metals, would gradually form the *superincumbent crust*, which would act as a *barrier* to the water and air, preventing their contact with the metals in the interior, *which*, of course, *would not be oxidized.*

In this state they would remain buried deep under the superincumbent oxidated crust of the earth, until water and air should find access to them. When this should take place a rapid, and extensive *chemical action* would commence, generating immense quantities of hydrogen gas, the metals *decomposing* the air and water, in the process of oxidation, and setting the *hydrogen* of the water, and *nitrogen* of the air *free.* Thus a large amount of the most inflammable of all gases would be disengaged. The rapid chemical action would *raise the temperature* of these gases, and thus *increase their bulk* immensely, which would produce an irresistible *expansive force*, which would *increase the pressure* against the sides of the cavern in which the gases were generated, *and the* IGNITION *of the hydrogen would be a necessary consequence.* Such an immense volume of gas being ignited, and confined, would produce such a degree of heat, as rapidly to *decompose* or *melt* the substances in its neighborhood, and set at liberty a vast quantity of other gases; all of which being *ignited*, and of course *expanded* immeasurably, would not only shake a given section of the earth, but, if placed in its centre, would shake the solid globe throughout, and rend it into ten thousand pieces, if it did not find means to escape. If it found means of escape by some opening forced from its seat to the surface of the earth, *that opening would* CONSTITUTE A VOLCANO; from which the gases would escape, and throw out before them the vast amount of volcanic products which are known to come forth of the craters.

It now remains to inquire, *whether a sufficient quantity of water can be supposed to have access to these metals?*

From what we know of the distribution of water generally in the bowels of the earth, we should have no difficulty in admitting the *affirmative*. But this question may be clearly answered by two circumstances.

First: Large quantities of boiling water and mud, are frequently ejected from volcanos. This proves an *excess* of water at, or near the seat of action, which could not be decomposed, before the amount of gases generated, and acting with incredible force, drove it out of the crater. This fact is true in some measure of all volcanos, but eminently so of those in South America. "Bouguer and Condamine saw these formidable torrents tear up the surface of a whole country. Six hours after an explosion of Cotopaxi, a village nearly eighty miles distant in a straight line, and probably one hundred and forty by the winding channel, was entirely swept away by the flood." *Ure's New Sys. Geol.* p. 386.

Secondly: The position of volcanos, *always near the sea*, together with the *agitations of the sea*, previous to, and during an eruption, as well as the *saline* matter in the ejected substances, render it very clear, *that the sea, by subterranean communication, supplies water at the seat of volcanic action.* "The sea seems to sympathise with the agitations of the adjoining volcanos, rising and falling with rapid alternation—*caused by the sudden deflux of a great body of water into the vast volcanic caverns.*" *Ure's New Sys. Geol.* p. 388.

This fact is so well known in the history of volcanos, that it needs no further proof. It has, however, led to the remark, that volcanos are generally situated in islands, or near the sea coast. Indeed many of them are *submarine*, and have actually been seen in operation, throwing up vast columns of water to an immense height, until the edge of the crater appeared above the surface of the sea, and increased into islands, which have become permanent. At such times the water of the sea for a great distance round became *hot*, fishes died; and even the pitch melted from the hulks of the vessels in the neighborhood.

2. Another theory has been proposed which does not differ from the first, in regard to the *materials* employed at the seat of volcanic action, nor in the *manner* of the process; but in regard to the *condition* of those materials when they *begin* to operate in the production of the elastic agents. These materials may be in a state of *igneous fusion* in the interior of the earth. This state is supposed to have resulted thus:

When God created the substances of the earth, they were in an *elementary* and *uncombined* state, promiscuously mixed through each other from the surface to the centre. By his *Spirit brooding over the great deep*, caloric and light, which were in a *latent* state, were called into action, which gave impulse and motion to every particle of matter, thus quickening the whole mass by producing *intense heat*. This would cause the *aqueous* and *gaseous* particles to rise through the mass, and collect at the surface. This would bring them in contact with the metals in a pure state, which would of course *oxidize*, and become *earths*. This action would go on until it arrested its own progress, by forming and consolidating the oxidated crust of the earth inclosing all the interior substances in a state of igneous fusion, which have been gradually cooling ever since. The *primitive* rocks, which have a crystalline structure, are supposed to have been deposited during this process, as it is evident they could not have crystallized under any other circumstances, and they are well known to be composed of the earths which are only metals in a state of oxidation. It is now only necessary to introduce the water to this mass of melted matter, or any part of it, as in the first theory to the metals in their pure state, *and we have the same results in all respects.*

This theory has two advantages over the first. It agrees best with the crystalline structure which primitive rocks are known to possess, and which must result from chemical action on the materials in a state of solution. It also seems to accord best with the Mosaic account of the action of heat and light, in assimilating, arranging and settling the materials of the earth.

Moreover, it is confirmed by experiments made on the *temperature* of the earth at different depths. The following tables are extracted from Mr. Ure's New System of Geology, pp. 426–7. They accord, in their tendency, with the opinions of other eminent philosophers than those whose names appear in the tables.

*Observations on the temperature of the earth.*

In the mines of Giro-Magny, three leagues from Befort, M. Gensanne found:

| | |
|---|---|
| At 333 feet, | 54½ Fahr. |
| 680 " | 62 |
| 1016 " | 66½ |
| 1429 " | 73 |

In the mines of Freyberg, M. D'Aubuisson found

| | |
|---|---|
| External air | 41 |
| In the galleries | 50 |
| 528 feet, water pool | 52 |
| 858 water of a spring | 57 |

| | |
|---|---|
| At Junghohebirke, external thermometer | 32 |
| 1040 feet, water was | 63 |

Observations by Captain Lean in the mines of Cornwall.

| | |
|---|---|
| At surface, in June, | 59 |
| 118 feet deep | 64½ |
| 480 " | 68 |
| 840 " | 69½ |
| 1144 " | 79 |

*December.*

| | | |
|---|---|---|
| At the surface | - - - - - - - | air 50 |
| 120 feet | - - - - - - - - | air 57 |
| 600 " | - - - - - - - - | air 66 |
| —— " | - - - - - - - | water 64 |
| 962 " | - - - - - - - - | air 70 |
| —— " | - - - - - - - | water 74 |
| 1200 " | - - - - - - - - | air 78 |
| —— " | - - - - - - - | water 78 |

M. Humboldt obtained analogous results in many mines in South America. The evidence in favor of a *perpetually increasing temperature as you descend into the earth*, and a *higher temperature formerly at the surface of the earth*, is increasing daily. *See the conclusion of this paper.*

3. There is yet a third theory, founded on *voltaic energy*, or *galvanism* and *electricity*.

The application of these agents to the production of volcanic action, had occurred to me, before I met with the "Outline of the course of Geological Lectures, given in Yale College," by Professor Silliman, from which the following extract is made. I had not regarded their application in the same manner as he has explained it. Indeed, my thoughts on the subject had not assumed any definite direction. I shall transcribe from his "Outline," pp. 118–19, inserted in "Bakewell's Introduction to Geology, first American Edition."

"Whatever we may think of the hypothesis now detailed, may we not suppose, with sufficient probability, that those voltaic powers which we *know* to exist—whose action we can command, and whose effects having been first observed within the memory of the present generation, now fill us with astonishment, are constantly active in producing the phenomena of earthquakes and volcanos?

"Arrangements of metals and fluids are the common means by which we evolve this wonderful power, in our laboratories; and it would seem that nothing more than juxta-position, in a [illegible] in order, is necessary to the effect. Even substances apparently dry and inert, with respect to each other, will produce a permanent, and in proportion to the means employed, a powerful effect, as in the columns of De Luc and Zamboui. It would seem indeed that metals and fluids are not *necessary* to the effect. Arrangements of almost any substances that are of different natures, will cause the evolution of this power. Whoever has witnessed the overwhelming brilliancy and intense energy of the great galvanic combinations, especially the deflagrator of Dr. Hare, and considers how very trifling, in extent, are our largest combinations of apparatus, compared with those natural arrangements of earths, salts, metals, and fluids, which we know to exist in the earth, in circumstances similar to those which, in our laboratories, are effectual in causing this power to appear, will not be slow to believe that it may be in the earth perpetually evolved, and perpetually renewed; and now mitigated, suppressed, or revived, according to circumstances influencing the particular state of things at particular places.

"In our laboratories we see eminating from this source, intense light, irresistible heat, magnetism in great energy, and above all, a decomposing power, which commands equally all the elements, and the proximate principles in all their combinations.

"Sir Humphrey Davy, after discovering that the supporters of combustion and the acids, were all evolved at the positive pole, and the combustibles and metals, and their oxidated products, at thé negative—proved that even the firmest rocks and stones could not resist this power; their immediate principles and elements being separated by its energy. The decomposition of the alkalies, earths, and other metallic oxides being a direct and now familiar effect of voltaic energy—their metals being set at liberty, and being combustible both in air and water—elastic agents produced by this power, and rarified by heat, being also attendant on these decompositions, it would seem that the first principles are fully established by experiment, and that nothing is hypothetical, but the application to the phenomena of earthquakes and volcanos."

The reader will perceive that all of the above theories agree in one respect, viz; in the agency of *elastic bodies*, as steam and gases, produced by the decomposition of substances; and that the same substances are supposed to be employed, though not precisely in the same manner, nor in the same condition. Further Geological and Chemical experiments may, hereafter, settle the question between these theories. They are all scientific in their principles, and fully competent to the object, and it is not impossible but that they may all be true in part or in whole, acting separately in some instances, and combined in others.

Under the agency of either of them the products would be the same. Dr. Kennedy has made experiments on the composition of volcanic products, and found, Silex, 51—Alumina, 19—Lime, 9.5—Oxide of iron, 14.5—Soda, 4—Muriatic acid, 1—in 100 parts.

As it regards the extent of volcanic action and earthquakes, the two first theories agree best with actual appearances. They would lead us to conclude that volcanic action was necessarily more extensive in the earlier ages of the world than now. Because, every action would oxidize the crust of the earth deeper, and increase the superincumbent strata, and render the access of water and air more difficult. *This is found to be the fact by observation an different countries.*

In some parts of France, in which kingdom there is not, and has not been for the last two thousand years, any active volcano, *there are ranges of extinct volcanos, in which may be counted from seventy to one hundred craters.* They are so close their bases touch in many instances. The same fact is observed along the Rhine, and in Hungary, and other countries. *See Ure's New Syst. Geol. and Bakewell's Geology.*

Mr. Ure reckons up two hundred and five *active* volcanos at this time. One hundred and seven in islands, and ninety-eight on continents.

It is very evident that the *seat* of volcanic action is vastly below the surface of the earth. The *extent* of country which is shaken by the effort of the gases to escape, will prove this. The agitations have been felt over all Europe, and even *across the Atlantic!*

Again: If the action were not situated far below the surface of the earth, the mountains, which only serve as *chimnies*, and which have been formed by the action of the volcanos, ***would sink in.*** This has been the case in a few instances. This will appear more clearly if we consider the *amount* of matter ejected. Did it not come from an immeasurable distance beneath, the accumulated mass at the surface of the earth would break down the *substrata* which lie over the immense caverns formed by the ejection. The *dimensions* of those caverns, situated under the volcanic mountains, are far greater than one would suppose at first consideration. *The internal caverns must be as large as the ejected masses, which came out of them.* Ætna is known to have thrown out matter sufficient to form twenty such mountains as it is. It is strongly probable that the whole island of Sicily is of volcanic origin. Humboldt says the dome-shaped craters of volcanos rise from six hundred to eighteen thousand feet in height. He considers the *whole mountainous district of Quito as one immense volcano.*

Indeed, from a close survey of the geological features of the earth, there is reason to believe, that at very remote periods almost the whole surface of our globe has been the theatre of volcanic action. It is a matter of gratitude that its amount is growing less every year, of course the destructions by earthquakes are more limited. In process of time, it may be hoped, the earth may become permanently tranquil, nor flame, nor shake, until the final catastrophe, which God has ordained to destroy our planet, by a general and simultaneous action of all the fires of the earth.

P. S. It may be of advantage to recollect, that the *expansive force of steam is to that of gunpowder as* 140 *to* 5. According to Vauban, 140 pounds of water converted into vapor would produce an explosion capable of blowing up 77,000 pounds, while 140 pounds of gunpowder could only blow up a mass of 30,000. ***See the text under the head,*** "SALUTARY EFFECTS OF WATER."

## APPENDIX,

### *On the temperature of the earth anciently.*

That the temperature of the earth's surface was much higher in the first ages of it sexistence, than since the period of authentic history, seems now to be nearly established, in the opinion of the learned, and only requires time to have the weight of evidence produce its proper effect on the great mass of community.

Though this fact would be apprehended from what is said above, it may be desirable to the reader to see a concise view of the reasons which induce this opionion.

1. *It may be inferred from the original constitution of the globe, and the chemical action consequent upon it.* It has been seen above that the *natural* condition of matter is *cold, frozen, inactive*, and *solid*: and that the elements of this globe were created in a *simple, uncombined* state. If this mass of elements received a quickening impulse, the chemical laws of *affinity* and *attraction*, and also the natural law of *gravitation*, would commence exerting their influence. This we know would create a rise in the temperature of the whole mass, in proportion to the *amount* of matter acted on, and the *force* of the

different principles and agents which were in operation. Upon consideration of these points in regard to our earth, no one can doubt but that they would raise the temperature to an inconceivable height.

*Refrigeration* would commence at the surface as soon as the first violent action was abated, and the water and air began to assume their relative places, through which the heat would escape into celestial space. This refrigeration would be increased by the oxidation of the metals forming the crust of the earth, which would confine the interior heat more effectually, because, the earths are almost complete *non-conductors* of caloric. Thus the crust of the earth would continue to cool, and the oxidation would thicken it, and, of course, contribute to the reduction of its temperature.

From this natural process it is very evident that the earth was much warmer during its first periods; earthquakes, and volcanos much more common than now, and a general instability in the condition of our globe. The deluge was the climax of its alternations, and settled, in some measure, its constitution by a sudden and great reduction of temperature.

2. *It may be inferred from the vast extent of volcanic action, as indicated by the remains of extinct volcanos, and their effects on the earth.* This argument is merely *called up here*, not to be discussed at length, but to be *referred* to, as it has been mentioned in a preceding part of this paper.

It is almost impossible for the ordinary reader, who has not closely studied the geological phenomena which present themselves to the close observer, to conceive of the extent to which volcanic action operated anciently. It would not be exaggeration to say, there was a remote period *when our globe was a single volcano:* the whole surface of it being subject to its action.

Though we may ascribe something of the formation of hills and vallies to the action of water, yet, doubtless, the most effectual agent in upheaving the mountains, and even continents, possibly, was volcanic force.

"Those ranges of volcanos," says the celebrated Humboldt, "those eruptions through vast chasms, those subterranean thunders, that roll under the transition rocks of porphyry and slate in the new world, remind us of the present activity of subterranean fire, of the power, which in remote ages, *has raised up chains of mountains, broke the surface of the globe, and poured torrents of liquid earth in the midst of the most ancient strata.*"

From this constant and extensive volcanic action we may safely infer the high temperature of our earth anciently.

3. *It may be inferred from the origin of primitive, trapean, and basaltic rocks.* The primitive rocks, as granite, gneiss, mica slate, &c, give evidence on this consideration; they must have been deposited when their substance was in solution, admitting of *chemical mobility*, in order that they might assume a crystalline form which they are known to have.

It is not easy to conceive *how* the substances of the primitive rocks could be solved, except by *heat*, as a *principal solvent*. The acids, and water also, may have contributed to their solution, but would not be competent of themselves. This consideration would give a high temperature for the earth anciently.

It is now generally admitted that the trap, and basaltic rocks are of *igneous* origin. When we consider the *magnitude* of the trap and basalt formations, the extent of surface which they cover, the hills, and even elevated and lofty mountains which they form, we shall not hesitate to assign a higher temperature to our earth at the period when fires, so immense as to effect the upheaving and ejection of all these, actually burned in the bowels of the earth.

4. *It may be inferred from the well preserved remains of vegetables and animals of warm equatorial climates, in high northern latitudes where they have not been found since the memory of man.* This is a conclusive argument if its *data* be well established. Because, if *tropical* and *equatorial* animals and fruits are *now* found buried and fossilized in Siberia, and the islands of the *arctic sea*, in such a state of preservation as to forbid the supposition they were transported thither, it will follow inevitably, that they *grew there*, and there flourished, died, and were buried.

Moreover, if *herbivorous* animals are found fossilized in those high northern latitudes, under such circumstances as forbid the supposition, that they were transported thither, it will doubtless, follow, that not only *they* lived there, but also *luxuriant vegetation* must at the same time have covered the plains where their remains are entombed.

The inference which we are forced to draw from these *data* is this: *As no such tropical and equatorial animals or plants have been known to exist there, nor even herbage of any kind, on which such animals might subsist, since the memory of man, there was a time anciently when the climate suited their growth, and of course was very much warmer than it is known to be now, its temperature then corresponding to the temperature of the present equatorial regions, as it produced and subsisted anciently the animals and plants which the tropical regions produce and subsist at the present time, and which cannot subsist in any other climates.*

In proof of the above position, it is well known that animals and plants have their peculiar climates, in which they are *indigenous*, and out of which they cannot thrive, or even live, if too far removed. It is also well known, that the warmer, and more moist the climate is, the more luxuriant the vegetation, and the more huge the animals.

Hence we are in the habit of denominating animals and plants by the climates in which they are indigenous, as *arctic*, or northern; *tropical*, or southern. Let us now see if the tropical animals and plants once lived and flourished in high northern latitudes. The best authorities follow.

"We proceed now to examine the remains of quadrupeds: *these are found accumulated in regions where similar animals do not* NOW *exist.* Some are buried deep in gypsum.—Some present themselves to view, accumulated in vast caverns, and destitute of any envelope. The islands of Lachof, situated to the NORTH *of Siberia*, are, according to a modern traveller, only *heaps of sand, ice, and bones of elephants and rhinoceros*, mixed with those of great cetaceous animals, and even, agreeably to the latest accounts, with the remains of gigantic birds.

"There have been found in *Siberia, whole carcases of the elephant, covered with their* FLESH and SKIN, preserved by the frosts which prevail in those regions.—Germany has furnished the greatest number (of bones:)—In France a great many bones of the elephant have been met with.

"These discoveries, though as yet scarcely commenced, have thrown already *a new light upon the revolutions which our globe must have undergone, and upon the* STATES WHICH MUST HAVE PRECEDED THE PRESENT COURSE AND CONSTITUTION OF NATURE.

"These bones, presenting no trace of having been rolled up and down, occurring only fractured as we find those of our domestic animals, and sometimes joined together in the form of skeletons, often even as it were heaped up in common cemeteries, clearly demonstrate, *that the catastrophe which has destroyed the living beings to which they belonged most have overtaken them in the* SAME CLIMATES WHERE WE MEET WITH THESE RECORDS OF THEIR FORMER EXISTENCE.

"The quantity of nourishment which such huge animated masses required, and their numbers, proved by the existence of the carnivorous kinds, *render it probable that the countries where we find their remains* ONCE *enjoyed a temperature, if not warmer, at least more favorable to vegetation.*" MALTE BRUN, *Physical Geography, Book* 12.

In the above quotations, the data on which our argument rests are so clearly sustained there needs no comment. The authority given is unquestionable, and could be corroberated by scores of weighty names, and in reference to all the *northern* countries of Asia, Europe, and America.

It is impossible to read the above extracts without being convinced that those tropical and equatorial animals lived, flourished, and died *where* their remains are *now* found. And it is equally impossible to avoid another conclusion; viz: that there must have been a heavy vegetation on those plains, where *now* the rein-deer can scarcely pick up a blade of grass.

From these convictions no other inference can be drawn, but that the temperature of the *frigid zones*, was anciently much higher than at present; and of course the general temperature of the earth also.

From the perfect preservation of these fossil remains; from the fact that they are found in their relative position, bone to bone, and, in some instances, with their *hair, skin,* and *flesh undecayed,* it is obvious, *the animals must have perished by a catastrophe which overwhelmed them suddenly, and was, instantaneously followed by a freezing of the overwhelming waters.* Such was the catastrophe of the *scripture deluge,* which *physically* was competent to perform the phenomena, as shall be shown presently.

Let us now see if we do not arrive at the same conclusion by examining the *fossil* VEGETABLES.

At Portland, England, the Rev. Dr. Buckland finds fossil plants *akin to the cycas family of Malabar,* from which he concludes, "it is probable that the climate of these regions, *at the time when the oolites* (a series of rocky strata) *were deposited, was of the same warm temperature with that* (the tropical) *which produces a large proportion of the existing cycadeæ.*" URE, *New Syst. Geol.* p. 433.

"The remarkable development of these vegetables (equisetums) during the first (or coal measure) period of vegetation, and their size in the second (or oolitic) period, *smaller* than before, but still far greater than our existing equisetums, accord with many other facts, furnished by fossil vegetables of many other families, to lead us to regard the *climate of the earth, at these remote epochs, to have been hotter than the hottest of modern climates.*" *Ibid*, p. 443.

"There is no doubt, however, that *palms with fan-shaped leaves covered Europe with their lofty vegetation at this remote period, in regions where no species of these plants could* NOW *grow!*" *Ibid*, p. 452.

The palm is well known to be a *tropical* plant, and cannot thrive, except in a warm climate. The climate of Europe, when it grew in the north, must have been tropical. Indeed, in all parts of northern Europe *tropical flowers, leaves,* and *fruits* are found in such a state of preservation as to convince the most incredulous, *that they must have grown on the spot;* which would be to convince him of the high temperature, anciently, of those regions.

"Professor Kounizin describes in the Isis for 1821, immense beds of fossil wood in several localities of the governments of Novogorod and Twer in the *north* of Russia, *where no such trees are now found to grow.*

"Near Constand on the river Necker, M. Autenrieth found an entire forest of the trunks of *palm trees,* buried along with the remains of elephants." *Ure, Ibid*, p. 455.

"The fossil shells found in the strata of England, and France, and the contiguous countries, having for the most part, no *antitypes alive except in equatorial regions,* harmonize with the preceding details." *Ibid*, p. 456.

To the above testimony might be added the *caves* in Germany, England, and France, in which great quantities of bones are found in such a state of preservation, and under such circumstances as to show that the animals whose bones are found were in the habit of frequenting these caves, and perished in them suddenly, as their remains are found mixed with sand and gravel, *but not water-worn.* Of these bones, the great majority are those of the hyæna; hence these dens, specially in England, are called *hyæna dens.* In them are also found the bones of other animals *gnawed* by the hyænas.

From these facts there can be no doubt but the hyæna inhabited England, France, and Germany, and dwelt in these caves, and here perished when the sudden catastrophe of the flood overtook him. This argues beyond doubt that these countries were once *warm, when these tropical animals lived in them.*

5. *The same fact may be inferred from the immense amount of vegetable matter which was necessary to supply the materials for the coal measures.* This is an irresistible argument in view of the *immense amount* of coal in the bowels of the earth, which must be of

*vegetable origin.* Because at the ratio of vegetable product of *our age*, the earth would not produce a sufficient amount to form the coal-beds, short of millions of years.

The *vegetative power* of the earth, therefore, must have been anciently very much greater than at present, which could only be on the supposition of a *warmer* and more moist climate.

Moreover, the fact that tropical plants are known to have contributed almost entirely to the formation of coal measures in the *northern latitudes*, is proof direct. This is clear from the fact that their roots, stems, leaves, flowers, and fruits are found impressed on the coal, in such a manner that there can be no mistake; and the *perfection* of the impression forbids the supposition that they were *transported* thither from tropical climates.

"Brown coal and black coal, the former sometimes called wood coal, is found chiefly in diluvial or alluvial ground. It contains, besides charcoal and bitumen, *various vegetable principles, and the branches or trunks of trees* partially decomposed, *which mark the origin of this kind of coal.*" *Bakewell's Geology*, p. 111.

"Wood coal, or brown coal, is found in low situations and appears to have been *formed of heaps of trees* buried by inundations under beds of clay, sand, or gravel.—In some specimens of this coal the *vegetable fibre, or grain*, is perceptible in one part, and the other part is reduced to coal." *Ibid*, p. 121.

"In wood coal we may almost seize nature in the fact of making coal, before the process is completed. These formations of coal are of far more recent date than that of common coal, though their origin must be referred to a former condition of our globe, *when the vegetable productions of tropical climates flourished in northern latitudes.* The *vegetable origin* of common mineral coal appears to be established by its association with strata *abounding in vegetable impressions*, by its close similarity to wood coal, (which is undoubtedly a *vegetable product*) and lastly by the decisive fact, that some mineral coal in the Dudley coal-field is *entirely composed of the layers of mineralized plants.*" *Ibid*, p. 122.

"When we see the multitude of reeds filled and surrounded with sandstone, having their thin scaly bark *converted into a true coal*, it is *impossible to doubt of its vegetable origin.*" *Ure's New System Geol.* p. 166.

Quotations from the best authorities might be multiplied to the same effect, but it is deemed unnecessary. It remains to repeat the question, *Could such an amount of vegetable matter have been accumulated, short of millions of years, at the ratio of the present vegetative powers of the earth?* It is impossible. The only remaining conclusion is, the vegetative power of the earth anciently was much greater than at present, which could not have been except its temperature was much higher also.

In conclusion on this question, it is necessary to say, that the reduction of the earth's temperature would be gradual, in a natural way, by the heat flying off into celestial spaces, until the crust became so thick and compact as to prove a perfect non-conductor of caloric. Then the surface of the earth would depend on the heating power of the sun altogether. The thickening of the crust of the earth would be attended with earthquakes, volcanos, and partial deluges, the natural and necessary results of the oxidations of the metals. Hence we would have different strata of rocks, sand, gravel, &c, deposited at different times and over different sections of the country. Hence also forests would be overthrown, and the vegetation of years be thrown together in the nearest lakes or seas; which explains the origin of *coal-basins*. This state of things also well explains the alternations of strata of different kinds, as sand, gravel, chalk, fresh and salt water deposites, &c, as well as the dislocations, fractures, contortions, and confusions observable in the structure of the earth's crust.

There are however various phenomena which indicate clearly that there was *a general and sudden reduction of temperature*. The state of preservation, in which those animals in Siberia are found, proves this. The vestigia of the *last* great revolution in our globe clearly indicate the DELUGE to have been the cause of this general and sudden reduction of temperature. This would be the natural consequence of *submerging* the earth in water: and the suddenness of the event is well attested both by the scriptures, and the physical history of our earth.

The action of the deluge does not come within the contemplation of this volume, and therefore will not be noticed here.]

The air is another storehouse of fire. When lucid igneous particles are strongly attracted to one another in great quantities, their heat becomes intolerable, and is capable of destroying the most solid bodies. It is well known, that when converged in the focus of one of Hartsocker's burning-glasses, they will produce wonderful effects: tin, lead, or any soft metal, will dissolve at the first touch; and iron, which requires a very strong fire for liquefaction, will melt before one of these glasses almost as soon as applied. They will consume wood, though wet, in a moment; vitrify bricks and pumice-stones, and dissolve earthen vessels full of water; and plume-allum, which will resist the fire of the hottest glass-houses, without alteration, is instantly melted. Even gold, that resists the force of common fire, is soon liquefied by their powerful agency. This plainly shows us that, provided there were not a wise and almighty Providence, superintending all his works, those materials which are of the greatest utility to the harmony and order of things, would have a direct tendency to destroy the whole. If lucid igneous particles were to form solid bodies, and depart from their state of fluidity, they would, in an instant, reduce this globe to ashes, or render it liquid fire. Were they all of one kind, it is probable they might unite in solid bodies; but the wisdom of Providence has formed them of various colors, and of different reflections and refrangibility. This prevents them from associating in such a manner as to do harm, which can only be produced by converging them with some instrument which prevents their flying off. As all these have not the same degree of reflexibility and refrangibility, but as some are capable of greater reflections and refractions than others, they cannot, without force, be united in one solid body, yet they are all serviceable for important purposes, contributing to the happiness of man, and the welfare of all living creatures.

Considering the extent of fire, and that its property is, when put into motion, to consume all combustible substances within its reach, it is astonishing that the world has not long since been destroyed! This terrible element is at present restrained and directed by its almighty Creator; but divine revelation informs us, that a period will arrive when its utmost energies shall be called into action. The apostle Peter asserts, that "the heavens and earth, which are now, by the same word are kept in store, reserved unto fire against the day of judgment and perdition of ungodly men;—in the which the heavens shall pass away with a great noise, and the elements shall melt with fervent heat; the earth also, and the works that are therein shall be burnt up." Again he says, "looking for and hasting unto the coming of the day of God, wherein the heavens being on fire shall be dissolved, and the elements shall melt with fervent heat." The *passing away of the heavens* means the same as their being *dissolved by fire*. The word Ῥοιζηδὸν signifies with a *very loud* and *terrible noise:* with a sound resembling that of a great *storm*. In this place it more particularly denotes the horrid crackling noise of a wide-spreading fire.

> "The cloud-capp'd towers, the gorgeous palaces,
> The solemn temples, the great globe itself
> Yea, all which it inherit, shall *dissolve*;
> And, like the baseless fabric of a vision,
> Leave not a wreck behind."

The word rendered *melt*, is a metaphor taken from *metals*, dissolving in the fire, or *wax* before the flame; so will the fierce and spreading fire of the last day *melt down* this globe, and its surrounding atmosphere.* That the world was to be dissolved by fire was the opinion of Anaximander, Anaxiphanes, Anaxagoras, Archelaus, Diogenes, and Leucippus.† The inference which the apostle deduces from this view of the general and final conflagration of the world, is highly impressive. "Seeing then that all these things shall be dissolved, what manner of persons ought ye to be in all holy conversation and godliness."

* See Dr. Burnet's Theory, vol. ii, p. 30.
† Apud Stob. Eclog. Phys. p. 44.

## *Section* III.—LIGHT.

Motion of luminous and fiery particles the first cause of light—Light the most simple body—Velocity of light—Light diffusive—Light the medium through which objects become visible—Light beautiful, or its rays of different colors—Light a visible resemblance of its Divine Author, in his spirituality, simplicity, purity, energy, goodness, manifestation, glory.

MOSES, in the original word אור *aur*, seems plainly to hint at the operation of a principle in the universe which, as a second cause, produced the phenomenon of *light*. This, most probably, was the motion of the luminous and fiery particles in the chaotic mass which, at the Divine command, separated themselves from the other gross materials of the miscellaneous composition, and by an attractive sympathy associated in one body.

It is conjectured, that light was at first impressed on some part of the heavens, or collected in some lucid body. Dr. Wall says, Though the sun was not yet formed into a compact body, yet the most subtile and active particles had already begun to fly together to the centre of the solar system, which gave some light; though probably not so great as when afterward they made the compact body of the sun. And the earth, which was then only a round lump of mud, or muddy salt-water, being turned, as it has been ever since, upon its own axis, receiving that light on its several hemispheres successively, made night and day, or evening and morning. Milton gives his opinion in the following lines:

> "Let there be light! said GOD; and forthwith light
> Ethereal, first of things, quintessence pure,
> Sprung from the deep; and from her native east
> To journey through the aery gloom began,
> Spher'd in a radiant cloud; (for yet the sun
> Was not;) she in a cloudy tabernacle
> Sojourn'd the while."

Light, after a short progression, concentrated in the sun, the common centre of our system; the various parts of this system, by his central light or fire, are balanced, and, by mutual attraction, move in the expanse, according to fixed laws, or determined distances.*

Light was once considered to be a property or quality of matter only; but more recently it has been discovered to be a *body*, a very subtile fluid, consisting of minute particles. We have no certain

* That light is a fluid which encompasses the earth, and requires only to be agitated by some other inflamed body, in order to render it perceptible, is an hypothesis, says a celebrated German divine, that has been adopted by the most eminent philosophers. "It is certain, at least, that there is a great difference between *fire* and *light*. The latter is incomparably more subtile than the former. It penetrates glass, and other transparent bodies, in a moment; whereas fire does it very slowly. The pores of glass are consequently large enough to give a free passage to the light, while the fire meets with more resistance, because it is less subtile. Fire moves more slowly than light. Let burning coals be brought into a room, the heat diffuses itself very slowly, and the air becomes warm by degrees; but the moment a candle is brought into an apartment, the whole is suddenly illuminated; and wherever the rays can reach the parts become more visible. From these facts, and some others, it is concluded, that fire and light are different substances; although we generally see them both together, and find that one may produce the other. But the consequence drawn from this is possibly false."

knowledge of its nature; though a collection of its rays make other things visible, yet its constituent parts themselves are most exquisitely small, and quite imperceptible; and therefore it approaches the nearest to the nature of spirit.*

Of all material bodies, light is the most *simple*. Most others are compounded of several parts, not only of different, but sometimes of contrary natures: but light is an unmixed body. It is also a most pure matter; It has no defilement in itself, neither is it capable of contracting pollution from other objects. When it shines upon a dunghill or sepulchre, which sends forth the most offensive effluvia, it still remains uncontaminated.

[The author is undoubtedly mistaken when he considers light "of all material bodies—the most simple," and "an unmixed body."

It is well known that a beam, or pencil, of light, as emitted from the sun, is *not* a simple body, but is capable of being divided into seven prismatic colors. The image which is formed by the refraction of the pencil, by means of a prism, is called a *Spectrum*, and clearly exhibits the compound nature of light. The refracted rays of the Spectrum may be collected and made to constitute a pencil of light again, which will be white, or colorless as before.

If this prismatic Spectrum be examined closely, it will be found that the different colored rays differ very much in their *heating*, *illuminating*, and *chemical* powers. Dr. Herschell, and other experimenters, have found that the *orange* rays possess a greater illuminating power than the red; and the *yellow* more than the orange: but the *maximums* of illumination lies in the *brightest yellow* or *palest green*.

There is also a very sensible difference in the *heating* power of these colored rays. By passing the bulb of a delicate air thermometer through the different colored rays, it indicates the greatest heat in the *red* rays; next in the *green*, and so on diminishing to the *violet*. But the maximum of heat has been ascertained to lie immediately *beyond* the red rays, and of course *out* of the Spectrum, in an *unilluminated* spot: thus indicating that there are *invisible* rays possessing a greater heating power than any of the seven colored rays. These are called *calorific rays*.

By the experiments of Ritter and Wallaston it is now satisfactorily ascertained that there are also *chemical rays which excite neither heat nor light*, and lie on the *other side* of the Spectrum from the invisible calorific rays, just without the violet. It is true, the chemical effect can be distinguished even to the green rays, but this seems to be by *diffusion*, or a species of sympathy. The sensible chemical power is exerted just without the violet rays.

* A new material has recently been introduced in this country, for the purpose of lighting houses, streets, manufactories, &c, namely, the inflammable gas of coals When coals are burning in a common fire-place, a flame more or less luminous, according as it is more or less encumbered with incombustible smoke and vapor, issues from them; and very frequently emit some very beautiful streams of a flame remarkably bright. All this arises from the gases which are extricated from the coal by the heat. It was natural to imagine that such gas might be received in proper reservoirs, and, on being forced out of small apertures, and lighted, would serve, as the flames of candles, to illuminate rooms or other places. The trial was easily made, and has been attended with the desired effect.

This fact is established more clearly by Berard. He concentrated, by a lens, all the portion of the Spectrum from the green to the red rays, and made them act on muriate of silver *two hours* without effect. He then concentrated all the portion of the Spectrum from the green to the violet rays, and made them act on muriate of silver, and *they blackened it in less than six minutes.* Thus, evidently, are detected very different properties in the different portions of the prismatic Spectrum.

Instead, therefore, of light being a "simple substance," and "unmixed" it is found to be decidedly *compound.* It is capable of being divided into seven differently colored rays, and these rays, according to their natural properties, into three classes: the *illuminating* rays, *calorific* rays, and *chemical* rays.]

The rays of light always proceed in *straight lines*, unless diverted by some intervening body. They are subject to the laws of attraction like other small bodies. If a stream of light be admitted through a small hole into a dark room, and the edge of a knife be applied, it will be diverted from its natural course, and *inflected* towards it. When the rays of light are thrown back by any opposing body, they are said to be *reflected.* When in passing from one medium to another, they are inflected or diverted from their rectilineal course, they are said to be *refracted;* and this property of light is called its *refrangibility.* Refraction arises from this, that the rays are more attracted by a dense, than by a rare medium.

The *velocity* of light is prodigious, and almost incredible; it moves at the rate of near 200,000 miles in *a second* of time! Roemer, a Danish philosopher, was the first who found the means of determining the velocity of light, by the difference of time in the eclipses of Jupiter's satellites, when the earth was on the same, or on the contrary side of the sun, with that planet. This point may be easily proved; for when the earth is between the sun and this planet, those eclipses will happen about 8¼ minutes sooner, than according to the tables; but when the earth is in the contrary position, the eclipses happen about 8¼ minutes later than they are predicted by the tables. Hence, therefore, light takes up about 8¼ minutes in passing from the sun to the earth, a distance of 95,513,794 miles; and it takes about 16½ minutes of time to go through a space equal to the diameter of the earth's orbit, which is at least 190 millions of miles in length; which is near a million of miles swifter than the motion of a cannon-ball, which flies with the velocity of about a mile in eight seconds.* In comparing this velocity of light with that of a cannon-ball, it has been observed, that light passes through a space in about eight minutes, which a cannon-ball with its ordinary velocity, could not traverse in less than thirty-two years! The velocity of sound bears a very small proportion to that of light. Light travels, in the space of eight

* Dr. Rees's New Cyclopædia, Art. Light; and Dr. O. Gregory's Lessons, Astronomical and Philosophical p. 157.

minutes, a distance in which sound could not be communicated in seventeen years; and even our senses may convince us, if we attend to the explosion of gunpowder, &c, of the almost infinite velocity of the one compared with that of the other.* Were the propagation of the rays of light less rapid, the darkness would be very slowly dissipated, and great inconveniences would result to the inhabitants of the earth.

The *divisibility* of the parts of matter is no where more apparent than in the minuteness of the particles of light. The unobstructed rays of light which proceed from a candle, will, almost instantaneously, fill a space of two miles; and it has been computed, says Dr. O. Gregory, that there fly out of the end of the flame of a burning candle, in a second of time, ten thousand millions of times more such particles than there are visible grains of sand in the whole earth. Dr. Nieuwentyt has computed, that an inch of candle, when converted to light, becomes divided into 269,617,040 parts, with 40 ciphers annexed; at which rate there must issue out of it, when burning, 418,660, with 39 ciphers more, particles in the second of a minute; vastly more than a thousand times a thousand million of times the number of sands the whole earth can contain; reckoning ten inches to one foot, and that 100 sands are equal to one inch.† As sound is propagated only at the rate of 1,142 feet in a second, a particle of light must be 786,000 times more subtile than a particle of air. If the particles of light were not extremely small, their velocity would be highly destructive. Indeed, were they equal in bulk to the two millionth part of a grain of sand, this impulse would not be less than sand shot from the mouth of a cannon. If the particles of light had more density, they would not only dazzle us by their splendor, but injure us by their heat.

There is no creature of God that *diffuses* itself, and whose influence reaches so far and wide, and fills so large a vacuum, as light. All that inconceivable space between this globe and the fixed stars, a distance which numbers cannot reach, is replete with light. Nay, the space in which it is diffused is not less than the universe itself; the immensity of which exceeds the conception of human understanding. It is from this almost unlimited diffusion of light that the very remotest of the heavenly bodies in the solar system become discernible, either by the naked eye or by telescopes. And had we instruments that could carry our sight as far as the light is extended, we should discover those bodies which are placed at the very extremity of the universe.‡

Light is the *medium* through which objects become *visible* to us. It is owing to it, that we are enabled to behold and contemplate the wonderful works of the great Creator; to discover unexplored systems in the trackless regions of unbounded space, to

* Gregory's Economy of Nature, vol. i, p. 173.
† See Relig. Philos. vol. iii, pp. 869, 870, Fourth Edition.
‡ Sturm's Reflections, vol. iii, p. 184.

imbibe knowledge from things created, to hold intercourse with each other, to steer the hollow bark to distant climes, and to investigate the records of all science. Without its aid, the world would have been an inhospitable wilderness, involved in sable shades of perpetual night. "Truly the light is sweet, and a pleasant thing it is for the eyes to behold it."

Light *beautifies* every delightful object which comes within the reach of its rays.

> "Nature's resplendent robe!
> Without whose vesting beauty all were wrapt
> In unessential gloom."

All colors are rays of light differently reflected. The cause of their diversity was first rationally accounted for by Sir Isaac Newton. He has shown that color is not a specific property of bodies, but is caused by the different rays of light being reflected from the surface of the body; the rest of the rays passing into or through the body. He discovered that in the rays of light are all the colors in nature; and the primary colors he considered to be seven in number, namely, red, orange, yellow, green, blue, indigo and violet; and that bodies appear of different colors, as they have the property of reflecting some rays more powerfully than others. These colors are poetically enumerated by Thomson.

> "First the flaming *red*
> Sprung vivid forth; the tawny *orange* next;
> And next delicious *yellow*; by whose side
> Fell the kind beams of all-refreshing *green*:
> Then the pure *blue*, that swells autumnal skies,
> Ethereal play'd; and then, of sadder hue,
> Emerg'd the deepen'd *indigo*, as when
> The heavy-skirted evening droops with frost;
> While the last gleamings of refracted light
> Dy'd in the fainting *violet* away."

Since the time of this justly celebrated philosopher, it has been objected, that the seven colors above mentioned are not primitive. It seems very obvious that there can be only three primitive colors, namely, red, yellow, and blue; since all the colors can be made by means of these. It has lately been advanced by Prieur, that the primitive colors are violet, green, and red; that the yellow is formed with red and green, the latter being in excess; and that when the red is in excess, they form orange; the green and violet form blue. The colors excited by the different refrangible rays do not appear to determine what are the primitive colors, since we find that different rays are capable of producing the same color, as a mixture of the yellow with the red produces orange. And it must be admitted, that the violet rays excite, in some degree, the idea of red along with the blue; as in the green, the yellow and blue may be discerned, but none of the red. When the different colored rays are mixed together, either by recomposition, or by getting each color by a separate Spectrum, the result will be white light. Hence Sir Isaac Newton concluded, that when the rays are promiscuously reflected from any surface it will appear white. He also found, and the discovery has since been confirmed by the experiments of Dr. Herschell, that the different colored rays have not by any means the same illuminating power. The violet rays appear to have the least luminous effect, the indigo more, the blue a little more, the green very great, between the green and the yellow the greatest of all, the yellow the same as the green, and the red less than the yellow.* From experiments it is found, that those rays of light are of the largest quantity that paint the brightest colors; and of all these, the red rays have the least refrangibility. Without light vegetables would have no color, but would appear white; this has been remarkably illustrated by Professor Robison. Some bodies absorb one colored ray, others another, while they reflect the rest. This is the cause of color in bodies. A red body, for instance, reflects the red rays and absorbs the rest. A white body reflects all the rays, and absorbs none; while a black body, on the contrary, absorbs all the rays, and reflects none:† this shows, that black colored apparel is very improper during the heat of summer, or in tropical climates.

[There is one difficulty scarcely mentioned, and surely not accounted for, in the preceding chapter: i. e. *How are we to reconcile the creation of light on the first day, and the creation of the sun not until the fourth?*

This has been a standing proposition since the revival of learning. There can be no doubt but the account of the creation, arrangement and nature of the world, as given by Moses, is correct; and would so appear to the most philosophically scientific, could we ascertain certainly the meaning of the sacred historian, and did we understand perfectly the phenomena of nature.

It is reasonable to suppose that the discoveries in natural philosophy would tend to influence the explanations of Moses' account. This is the fact. These discoveries have produced *two* theories in regard to light: The *vibratory*, or Cartesian; and the *corpuscular*, or Newtonian.

The Newtonian theory supposes the sun to be the original and principal source of light; and that light is emitted from the sun's surface in inconceivably small *corpuscles*, in such rapid succession, and in straight lines, as to seem a continuous ray, though, in reality, the particles are a thousand miles apart in their approach to the earth.

This is the most popular of modern theories, and the only one, as I recollect, employed by commentators in illustrating the account of Moses; or rather in solving the difficulty by reconciling this theory with his account.

Some have supposed the sun was created long before our earth, and that his beams took effect on our earth, as now, on the fourth day from his creation. Others have supposed that the sun and earth

* Dr. Rees's Cyclopædia, Art. Light.
† Parkes's Rudiments of Chemistry, chap. xii.

were created *simultaneously*, but that the sun's beams did not fully penetrate our atmosphere, so as to make himself distinctly visible as now, until the fourth day. In both these cases it is supposed that the words of Moses, in regard to the creation of the sun on the fourth day, are to be interpreted of his *appearance*, and *influence* on the earth, by dispensing light. But this does not account for the *existence* of light *from the first to the fourth day*. This is an insuperable objection here.

Finding the foregoing theories pressed with this insurmountable difficulty, other commentators have supposed, Light was a real substance, created *simultaneously*, and in conjunction with the original chaotic mass of our earth; and when God said "Let there be light, and there was light," He, by his divine power, caused the chaotic light to separate itself from the earth, and, departing, *to condense* in the body of the sun; or, as some would probably say, in view of Dr. Herschell's solar discoveries, in the phosphoric clouds which surround the real body of the sun. In this case, if the light concentrated in the body of the sun, then that luminary must be a body of *condensed light*: if in the solar phosphoric clouds of Dr. Herschell, then those clouds would be *condensed light*. This body of condensed light is considered the source of our solar light, which flies off from it in the form of rays or beams.

Dr. Ure, in his Chemical Dictionary, article Light, takes this view. He says, "We learn from scripture, that light pre-existed before this luminary (the sun) and that its *subsequent condensation* in his orb was a particular act of Almighty Power. The phosphorescence of minerals, buried since the origin of things in the bowels of the earth, coincides strictly with the Mosaic account of the creation. We shall therefore regard light as the first born element of chaos, as an independent essence, universally distributed through the mineral, vegetable, and animal world, capable of being disengaged from its latent state by various natural and artificial operations."

This theory, as I understand Dr. Ure's view, has *two* advantages, and *three* disadvantages. It accounts for the production of light on the *first* day, as Moses says. It also accounts for the *artificial production* of light by friction between bodies which have never been exposed to solar light, by combustion, compression, &c. For though it supposes light "subsequently condensed" in the sun, I presume it does not suppose *all* the light thus transferred from the earth, and condensed: much of it is latent, and combined with other substances, from which it is evolved by friction, combustion, compression, &c.

But this ingenious theory, which is mentioned by our author, and attributed to Dr. Wall, is pressed with *three* difficulties:

1. It does not suppose the existence of the sun until the *fourth* day, and of course no common centre of attraction to the earth and other planets. But it is impossible to conceive of the *safe existence* of the planets *previous* to the existence of their common center, which now regulates their order and motion. This is an insuperable difficulty, unless we resort to a "particular act of Almighty Power."

2. If the body of the sun be "condensed light," *abstracted* from the earth, the scene of its creation, then we must suppose that *a body*

*more than a million times greater than the earth was drawn off from it*, which indeed would require an "act of Almighty Power," and is utterly irreconcilable to the laws of attraction.

3. This view also destroys the idea of the sun's being an opake and habitable globe, unless we could conceive the inhabitants capable of dwelling in "condensed light;" which supposition is at variance with all our ideas of rational existence. Hence it robs the mind of the pleasing and almost intuitively correct idea of the sun's being a habitable globe.

These difficulties appeared so great that others, and particularly Dr. Adam Clarke, have offered a new mode of interpretation, founded on the Newtonian theory as improved by Dr. Herschell. Dr. Clarke supposes that *caloric*, or latent heat, was produced on the first day, when God said, "let there be light; and there was light." In this case he considers that latent heat and latent light are, probably, the same: or that it is the same subtile substance diffused throughout creation, which is capable of producing heat and light, when properly excited.

Yet, in his remarks on the sun, he embraces Dr. Herschell's ideas of the sun's real body being opake and habitable, surrounded by phosphoric clouds which are the source of our solar light. Of course the Doctor only transfers the source of light from the real body of the sun to these phosphoric clouds with which he is invested. Our solar light then comes by *impulsion* from these clouds, and not from the sun's real body.

These clouds are supposed to give light to the *Solar* inhabitants also, the intensity of which is regulated by a stratum of clouds placed *below* the *outer* phosphoric clouds, and which defends the sun's real body from too great degree of light.

This is Dr. Herschell's supposition, and seems to be pretty well established.

This ingenious theory solves the difficulty under notice, by supposing that *caloric*, and not light, is intended in the third verse, where God said, "Let there be light." And by supposing latent light, as well as latent heat, it seems to provide for the well known existence of light in combination with many, if not all, terrestrial substances; and yet it refers to the sun as the principal source of light, which according to this interpretation, was not necessary to the existence of the substance intended in the third verse—"Let there be light, and there was light."

This theory has another most excellent suggestion, viz: that the heat excited by the sun at the earth's surface, is produced by the luminous rays of the sun combining with the caloric in the atmosphere, and other substances at the surface of the earth. This suggestion supposes a very close affinity, if not identity in the matter of light and heat.

Although this explanation approaches much nearer a satisfactory solution of the difficulty in question, yet it is by no means unembarrassed.

In the first place it is built upon a singular translation of a word. The text, according to this theory, should be, "And God said let there be *caloric*, and there was caloric." This may be the text; but I cannot help thinking, that a bias to a system of philosophy, and a strong desire to *cut* the difficulty rather than *solve* it, suggested this translation. The text seems to have been so generally and uniformly understood of light, it would be difficult to alter it. It would be better to suspect a defect in our knowledge of the source and nature of light.

Again: this view seems to suppose a *consecutive* creation, which is at variance with a seemingly well settled opinion, in regard to the *Solar System*, and even at variance with Dr. Clarke's own remarks on Gen. chap. i, v. 2. On this verse he says: "God seems at *first* to have created the elementary principles of *all things*."

Finally: as his view is Newtonian, it is liable to all the objections to which that theory is liable: such as the *diminution* which would take place at the source from whence the light came; and the *destructive force* with which it would fall at the surface of the earth.

These considerations, with others, have influenced many of the most learned and acute philosophers to look for another theory. Our own countryman, Dr. Franklin, felt them. He says, in a letter dated April 23, 1752, in reference to the theory, of light being *particles of matter driven off from the sun's surface;* "Must not the smallest portion conceivable have, with such a motion, a force exceeding that of a twenty-four pounder discharged from a cannon? Must not the sun diminish exceedingly by such a waste of matter, and the planets, instead of drawing near to him, as some have feared, recede to greater distances, through the lessoned attraction? Yet these particles with this amazing motion, will not drive before them, or remove the least, and slightest dust they meet with, and the sun appears to continue of his ancient dimensions, and his attendants move in their ancient orbits."

He then supposes the phenomena of light may be more satisfactorily solved by supposing a subtle fluid, universally diffused, which is invisible *when at rest*, but *becomes visible when put in motion*, by affecting the nerves of the eye, as the vibrations of the air affect the ear, and produce the sensation of sound; and that the different degrees of intensity in the vibrations, will account for the different colors. *See Nicholson's Encyclopedia*, LIGHT.

This is the *vibratory* or Cartesian system of light. As already suggested, it supposes the existence of a subtle, luminiferous ether, diffused throughout the universe, pervading every particle of matter, and is capable of being put in motion, so as to become visible, by the sun, as the grand natural *excitant*, friction, combustion, compression, &c. The *laws* of the vibrations of this luminiferous fluid, are precisely the same with those ascertained, and determined, in regard to light as commonly understood. This luminiferous fluid is to be considered an elementary substance, and was created when the different substances composing the chaotic mass were created. At its first creation, like caloric, it was in a *latent* state, as no excitant as yet had put it in motion.

It is to be understood, therefore, that the substances of each planet in the *Solar System*, as well as the sun himself, were created *simul-*

*taneously* in a chaotic state, at their proper relative distances from each other: that the requisite quantity of each elementary substance was present in each mass: but as caloric, and this luminiferous ether were *latent*, these masses were solid, frozen lumps; inactive and lifeless; and darkness necessarily prevailed. This then was the original condition of the elements of our Solar System, according to the scriptures. "And the earth was without form and void; and darkness was upon the face of the deep." Gen. i, 2.

In order, therefore, to produce a quickening in these masses, which rendered them *soft*, it was only necessary to call the latent caloric, and this luminiferous ether into action, which would agitate, and bring to light the whole mass, and thus commence the arrangement and organization of the Solar System. However, as there was no exciting cause *then* in operation, it is evident the Almighty must have given the *first* impulse to these elements. This he did, and the important fact is recorded by Moses in these words: "AND THE SPIRIT OF GOD MOVED UPON THE FACE OF THE GREAT DEEP," Jehovah saying at the same time, "LET THERE BE LIGHT."

Here is the Mosaic account of the production of light, and possibly heat also, which took place on the *first* day. The same process went on *simultaneously* in the sun and planets, and the continued action cleared up their respective atmospheres, and the *sun* became visible at the earth's surface on the *fourth day*. Hence, the sun was said to have been *made* on the fourth day.

This solution of the difficulty is consistent with the account of Moses; and also all the well ascertained phenomena of light can be satisfactorily explained by it. It will naturally lead the mind to observe the resemblance between the phenomena of light and heat, and impel us to the conclusion, that light, or vision, is the *effect* of a material cause, as heat is of caloric: and it is natural to suppose this cause is in the same relation to light, that caloric is to heat. Of course we should conclude that light, or the luminiferous ether in a latent state, enters into combination with all substances, as does caloric; and at the same time a large proportion of it is *free*, or in motion, and of course sensible to the eye, as *free* caloric is to the sense of feeling. Moreover we must conclude that this latent light is capable of being set free or evolved by the exciting influence of the sun, as also by friction, compression, combustion, chemical action, &c. It will be of advantage, therefore, to establish the fact of the existence of *latent* light, in combination with terrestrial substances.

That this is the fact may be proven by a single reflection on the process of *combustion*. It is a daily observation that light is produced by *burning* bodies. Let us suppose these bodies burnt at midnight in a close room; still light will be given out copiously and constantly. *Whence* this light? The natural and obvious answer is, it was in combination in a *latent state* with the burning bodies, and by combustion it was set free, and thrown out, and thus put the surrounding luminiferous ether in motion.

It is said by some, the light evolved in this case is not from the burning bodies, but from the oxygen which is supplied by the air to support the combustion. This does not alter the case at all: for then the light was in combination with the oxygen, and was invisible, being in a latent state, until it was set free from the oxygen by combustion.

The same conclusion is obtained in the process of *compression* and *expansion*. If atmospheric air, or oxygen be suddenly compressed in a glass syringe; or if a glass ball, filled with the latter, be suddenly broke *in vacuo*, a *flash of light* is instantly perceived. In this case the light suddenly becomes visible, which was invisible before, being latent in combination with the air. (URE.)

We arrive at the same conclusion in case of *friction*. It is well known that pieces of wood can be made to *blaze* by rubbing them together. But it is not so well known, that two pieces of rock crystal, or quartz, taken from any depth in the earth, and which cannot be supposed to have ever been in the light of the sun, when rubbed quickly together, even *under water, will give out volumes of light*. *Whence* this light? from the quartz doubtless. Of course it must have been in a latent state, and was set free by friction. Let it be strictly observed, the crystals *never were exposed to the light of the sun, of course could not have derived this light from that luminary.*

We must come to the same conclusion, in regard to the light given out by *animal* substances. Many *insects* are known to have the power of evolving light, or putting the surrounding luminiferous ether in motion, which is the same. Putrescent animal matter has been observed to possess it, in some cases, in a very great degree; sufficiently to illuminate a room, or pantry, for hours together. In some instances the fingers of those who touched the luminous flesh, became luminous.

This is eminently the case in regard to some fishes. A species of fish called PHOLAS, has the power of evolving a large quantity of light. This power is greater when the fish is sound and fresh. Pliny mentions this fish, and says it rendered the hands and clothes of persons luminous. When put in water, under proper circumstances, it renders the water luminous. But when put in milk, a single *pholas* made seven ounces of it so luminous as to enable one to distinguish the faces of persons present. *Ency. Brit. Art.* LIGHT.

The evolution of light from the sea in the night, is a fact of common observation, and is sometimes so great as to enable one to read large print on a ship's deck. *Ency. Brit. Art.* LIGHT.

In all the above instances, and many more might be added, the light evolved, or, (which is the same thing in this investigation,) the luminiferous ether put in motion, must have been in a state of combination with the substances from which it was evolved. The only question which remains is this: *Was all this light transmitted from the sun, and become latent and combined at the earth's surface by absorption?*

It would certainly be hazardous to answer this question in the affirmative. For how could we account for the evolution of light from those bodies which have never been subject to the sun's influence?

Again: If all this light had been transmitted from the sun, it will inevitably follow, that there was a time when the quantity of light at the surface of the earth, and in combination with terrestrial bodies, *was very small*, and of course combustion, friction, and compression of bodies produced anciently a much smaller quantity of light than now; because there was a smaller quantity in combination.

It is evident that this supposition would come to this conclusion: *The quantity of light, in combination at the earth's surface, has increased in the same ratio as the increase of the duration of the influence of the sun on the earth: and, by consequence, the quantity of light produced by artificial means has increased in the same proportion.* Of course, fires and candles burn more brightly now than they did five thousand years since.

Though this conclusion is legitimate from the foregoing supposition, yet it is at war with common sense, and the current observations of the world.

We are therefore compelled to conclude that the MATTER *of light* is diffused throughout the universe, as is caloric, and that it is evolved, or put in motion by the influence of the sun; as also by artificial and chemical means; as combustion, compression, friction, chemical action, &c.

This conclusion is much strengthened by the fact, that the *existence of caloric* is well ascertained, *not as proceeding from the sun*, but in combination with all terrestrial substances; and also by the fact of the constant *analogy* between the phenomena of light and heat. This analogy is so strong and striking that we are compelled to conclude, *if heat be the effect of a real substance, light must be also.* Indeed the analogy is so strong that it almost convinces us of the *identity* of the matter of heat, light, electricity, and galvanism.

Notwithstanding the amount of evidence is against this supposition at present, yet there is a strong tendency in recent philosophical experiments to confirm it; and I am inclined to believe that future discoveries will confirm this identity. Some of the most obvious evidences in favor of it may be introduced here.

1. Almost all the celebrated authors and experimenters have occasionally *suggested* the probability of this identity. Mr. Turner, Elements of Chemistry, p. 67, says, in reference to heat and light: "It has been supposed that *they are modifications of the* SAME AGENT; and though most persons regard them as independent principles, yet they are certainly allied in a way which at present is inexplicable." Again, p. 71. "Mr. Leslie conceives that light when absorbed, *is converted into heat.*" Dr. Henry (Art. Light,) says, "A new fact has been lately ascertained by Dr. Delaroche, which seems to point out *a close connection* between heat and light, *and a gradual passage of the one into the other.* The rays of *invisible* heat pass through glass with difficulty at a temperature below that of boiling water; but they traverse it with a facility always increasing with the temperature, as it approaches the point at which bodies become luminous." "The general facts, says Sir H. Davy, of the refraction and effects of the solar beam, offer an analogy to the agencies of electricity." (*Ure, Chemical Dictionary, Article Light.*) It is well known that this view pressed itself strongly on the attention of Sir Isaac

Newton, during his philosophical investigation. ***See Ure, Chem. Dic. Art. Light.***

2. This identity is strongly suggested by the constant and striking analogy between the laws of heat and light.

*First:* The color of surfaces has an influence on the passage of light and heat.

*Secondly:* The power of light, heat, and electricity diminishes as the squares of their distances.

*Thirdly:* The particles of heat, light, and electricity, are *idio-repulsive.*

*Fourthly:* The passage of the electric spark is generally attended with the production of light and heat.

*Fifthly:* Heat is emitted in all directions from the surface of an ignited body: so is light from the surface of a burning body.

*Sixthly:* The laws of reflection are the same in light and heat.

Other coincidences might be established, and other celebrated names added.

If this identity should be established finally, it would not effect the doctrine of the foregoing pages in the least. It would only be necessary to say, the luminiferous fluid of this essay is the well established substance now called caloric.

### *Addenda on Light.*

1. It is now generally admitted that the real body of the sun is surrounded with a peculiar set of clouds, *phosphorescent* in their nature. It is also allowed that these clouds do not emit heat. And as it is well known that no one of the *planets* has such clouds, but receive their light from the sun, *it is extremely probable that these phosphorescent clouds are intended by the Creator, to be the great dispenser of light to the solar system, by operating as the exciting cause to put the luminiferous ether in motion throughout the solar system.*

By a parity of reasoning, each centre of a system may be invested with similar clouds, which operate in the same way in reference to the planets which belong to it.

2. If light were a real substance, *as commonly understood,* solar light must proceed from the sun by *impulsion,* and artificial light from burning bodies by *evolution.* Take the case of burning bodies. A single candle placed two miles above the surface of the earth in the air, and lighted up in that position, will *instantly illuminate a space of two miles in every direction from itself, or a spherical space four miles in diameter.* In this case a sufficient quantity of light is instantly evolved to fill this space, and the evolution continues as long as the candle burns. The question upon this fact is this: Can it be supposed that there is a sufficient quantity of light, in combination with a single candle, or the oxygen necessary to keep up its combustion, to fill a spherical space four miles in diameter for several hours together? This would indeed be almost incredible in view of the space filled by light evolved from a single candle.

But this difficulty would be satisfactorily solved upon the supposition that light is the *effect,* produced by a luminiferous ether, universally diffused, and put in motion, by which it becomes visible, by the sun, burning bodies, &c. Because, the motion which renders the luminiferous ether visible, commences instantly upon the commencement of combustion, and is propagated from the point of combustion *in right lines*, under the appearance of rays of light: but the motion ceases instantly on the cessation of combustion, and of course darkness instantly ensues.]

After having attended to the production of *light*, and noticed some of its properties, it is a paramount duty to contemplate its glorious Author; especially as by this mysterious production he himself has chosen to be represented. If creatures be excellent, what must be the Creator? and to admire the former without adoring the latter, would be profane and atheistical. "The Deity," says Sir Isaac Newton, "in infinite space, as in his own *sensorium*, has an intimate perception of all things:" so we, possessing intellect, should "look through nature up to nature's God." Then matter, however rarefied or diversified, would serve as his minister to introduce us into his presence. A pious ancient, on being asked by a profane philosopher, How he could contemplate high things, since he had no books? answered, That he had the whole world for his book, ready open at all times, and in all places, and that he could therein read things heavenly and divine. As the visible creation is the outward expression of the existence of God, and displays several of his infinite perfections; so we should study him in the works of nature, and trace him in the operation of his hands.

The late excellent and pious Bishop Horne very beautifully observes,—"When the angels beheld the dark and disordered state of created nature upon its first production, they were, doubtless, thrown into some perplexity to conceive how it should ever be made a means of manifesting forth the glory of the Creator. But when they saw the light spring up, at the Divine command, from that blackness of darkness, and fix its residence in its tabernacle the sun, illuminating and adorning the firmament of heaven with its glorious show, and the earth with its beautiful furniture, all formed out of rudeness and confusion, then they confessed that the difficulty of the work served only to display the skill of the workmaster, which is proportionably estimated by the unpromising nature of the materials.

In like manner, whoever views the chaos to which the infinite wisdom of a presiding Providence sometimes permits the moral world to be reduced by the prevailing power of the prince of darkness, and the agency of his instruments, will scarce be able, at first, to discern any traces of the Divine counsels in a mirror so sullied and clouded over by the enormities of sinful men. Yet let him wait with patience for a little season, and those clouds shall pass away; a light shall shine, and some great end present itself to sight, so worthy of God, so beneficial to man, that standing amazed at a power able to bring the greatest good out of the greatest evil, he will be forced to cry out concerning the economy of the spiritual system, as David did concerning the operations of the natural—"Oh Lord, how manifold are thy works! In wisdom hast thou made them all."*

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## *Section* IV.—Day and Night.

Original terms of Day and Night—Motion the effect of a Divine power—Commencement of Time—Utility of Day and Night—Religious improvement of Time—Sin moral darkness—The Gospel a Light to dispel it—A Christian the subject of a transition from the one state to the other.

The separation of *light* from the *darkness*, was the work of the *first day*. This was an arrangement made by infinite Wisdom, as well as a display of almighty power. When this took place, it is highly probable that God gave to the earth its rotation upon its own axis, to produce the necessary succession of *day* and *night*. "The word ערב *êreb*, which we translate *evening*, comes from the root ערב *ârab*, to *mingle*, and properly signifies that state in which neither absolute darkness, nor full light, prevails. It has nearly the same grammatical signification with our *twilight*, the time that elapses from the setting of the sun till he is eighteen degrees below the horizon, and eighteen degrees before he arises. Thus we have the morning and evening twilight, or *mixture* of light and darkness, in which neither prevails; because, while the sun is within eighteen degrees of the horizon, either after his setting, or before his rising, the atmosphere has power to refract the rays of light, and send them back to the earth. The Hebrews extended the meaning of this term to the whole duration of night, because it was ever a *mingled* state; the moon, the planets, or the stars, tempering the darkness with some rays of light. From the *ereb* of Moses came the Ερεβος *Erebus* of Hesiod, Aristophanes, and other heathens, which they *deified*, and made with *nox*, or night, the parent of all things. The word בקר *boquer*, which we translate *morning*, from בקר *boquar*, he *looked out*, is a beautiful figure, which represents the morning as *looking out* at the east, and illuminating the whole of the upper hemisphere."†

All bodies continue in a state of rest, till they are put into motion by some external force impressed on them. Motion is the removal of a body from one place to another, or a continual change of place.‡ Any force acting on a body to move it, is called a *power*.

* Sermon on 1 Pet. ii, 21.    † Dr. Adam Clarke on Gen. i, 31.

‡ When Zeno, the Prince of the Stoics, was endeavoring to prove, by a sophistical argument, that there was no motion, Diogenes, the cynic, who had come into his school to hear him, quickly started up and walked: which was an ocular demonstration of motion, and sufficient to refute all his sophisms adduced to the contrary.

The *momentum*, or quantity of motion, is in proportion to the force impressed. The heavier any body is, the greater is the power required to move it.

There are but three possible ways of accounting for motion:— either by supposing that there has been an infinite succession of impulses communicated from one body to another from eternity, without any active principle either in matter or without it: or, that there is an active principle in matter that renders it self-active, and motion essential to it: or, else, that there is a Being distinct from matter, and is the cause of its motion.

An infinite succession of impulses, without an active or moving principle, will never give birth to motion, because this would be to produce an effect without the assistance of a cause. This absurdity was asserted by Spinosa; yet when urged by his friends to explain how matter could ever come into motion, if motion was neither essential to matter, nor proceeded from any external cause, he always avoided giving a direct answer. This conduct makes it reasonable to believe, that he himself would have given up his account of motion, if he could have saved his atheistical scheme and his reputation.

That motion is essential to all matter, and action as much an attribute of matter, as extension or solidity; and, consequently, every atom of matter is necessarily self-moving, or active from the necessity of its own nature, is asserted by Toland. Though he thought fit to reject the hypothesis of Spinosa as indefensible, yet he believed in the atheistic notion, that motion is essential to matter, and thinks it will be sufficient without troubling the Supreme Being. The reason which has always determined mankind to look out for a cause of motion extrinsical to matter, was this: though they could easily conceive it capable of being moved and divided; yet the conceiving of it to be undivided, and unmoved, was a more simple notion of matter, than the conceiving it divided and moved. This being first in order of nature, and an adequate conception of it too, they thought it necessary to inquire, how it came out of this state, and by what causes motion, from whence this diversity in matter arose, could come into the world?

Descartes, though he allowed the infinity of matter, as well as Toland, was yet sensible that even this would not alter the nature of matter, nor the idea that every person had of its inactivity, and therefore could see no way of altering its primitive idea, and reconciling it with the motion of matter, but by introducing an infinite Being, who had sufficient power to rouse matter out of that sleepy state in which its original idea had represented it.*

That such a circumstance exists, and what it is, a French author very clearly states. He says, The universe is composed of matter, and, as a system, is sustained by motion. Motion is not a

* See Gurdon's Sixth Sermon at Boyle's Lecture.

property of matter, and without this motion the solar system could not exist. Were motion a property of matter, that undiscovered and undiscoverable thing, called perpetual motion, would establish itself. It is because motion is not a property of matter, that perpetual motion is an impossibility in the hand of every being but that of the Creator of motion. When the pretenders to atheism can produce perpetual motion, and not till then, they may expect to be credited.

The natural state of matter, as to place, is a state of rest. Motion, or change of place, is the effect of an external cause acting upon matter. As to that faculty of matter called *gravitation*, it is the influence which two or more bodies have reciprocally on each other to unite and be at rest. Every thing which has hitherto been discovered with respect to the motion of the planets in the system, relates only to the laws by which motion acts, and not to the cause of motion. Gravitation, so far from being the cause of motion to the planets that compose the solar system, would be the destruction of the solar system, were revolutionary motion to cease; for as the action of spinning upholds a top, the revolutionary motion upholds the planets in their orbits, and prevents them from gravitating and forming one mass with the sun.

> "By ceaseless action all that is subsists;
> Constant rotation of the unwearied wheel
> That nature rides upon, maintains her health,
> Her beauty, her fertility. She dreads
> An instant's pause, and lives but while she moves.
> Its own revolvency upholds the world."

In one sense of the word, philosophy knows, and atheism says, that matter is in perpetual motion. But the motion here meant refers to the state of matter, and that only on the surface of the earth. It is either decomposition, which is continually destroying the form of the bodies of matter, or recomposition, which renews that matter in the same or another form, as the decomposition of animal or vegetable substances enter into the composition of other bodies. But the motion that upholds the solar system is of an entirely different kind, and is not a property of matter. It operates also to an entirely different effect. It operates also to perpetual preservation, and to prevent any change in the state of the system.

Giving then to matter all the properties which philosophy knows it has, or all that atheism ascribes to it, and can prove, and even supposing matter to be eternal, it will not account for the system of the universe, or of the solar system, because it will not account for motion, and it is motion that preserves it. When, therefore, we discover a circumstance of such immense importance, that without it the universe could not exist, and for which neither matter, nor any, nor all, the properties of matter can account, we are by necessity forced into the rational and comfortable belief of the existence of a cause superior to matter, and that cause is God.

The motion of the earth, therefore, is an effect of Divine power, because there is none other equal to it; and the constant operation of the same cause is requisite to perpetuate its progress. How amazing it is that this globe, so large in circumference, should move at all! Plato attributes motion to the power of God, "How is it possible," he argues, "for so prodigious a mass to be carried round for so long a time, by any natural cause? For which reason," he says, "I assert God to be the cause, and that it is impossible it should be otherwise."* "Every thing that is moved," adds Aristotle, "must of necessity be moved by some other thing; and that thing must be moved, either by another, or not by another thing. If it be moved by that which is moved by another, we must of necessity come to some Prime Mover that is not moved by another. For it is impossible that what moves, and is moved by another, shall proceed *ad infinitum*."† Since motion then is not a property of matter, but an effect produced by the power of a Divine agent, what a constant display we have of this efficient energy, in moving this earth, and with such a surprising swiftness! Surely all men should fear and reverence a Being, who possesses and exercises such a power! He who created all things out of nothing, could, if he pleased, extinguish the light, and shake the solid earth into atoms!

When the ponderous wheel of nature first began to move, *time*, consisting of days, months, years, and ages, and measured by the duration and revolutions of the heavenly bodies, commenced.

> *Time* (in eternity parenthesis)
> Is meas'ur'd by successive days and months,
> Seasons and years; which closely like the links
> Of an extended chain progressive join:
> Or as a clock, with all its hidden springs
> And constant motions, wound up to the top,
> Begins its course, revolving until down.

The distinction between *day* and *night* is a wise and gracious provision for man. In the morning, after the weary limbs have repaired their exhausted vigor by the indulgence of soft repose, we are pleased with the blessing of light; and, after a few fleeting hours engaged in our diversified pursuits of the day, we begin to court the evening shades, pleased again to enjoy that balmy retreat which alone refits us for the fatigues of the ensuing day. When a few fleeting hours are spent, the day is no longer gratifying; but its light becomes burdensome, and we wish for the shadows of the evening to be stretched over us. This sable period is scarcely gone, when we welcome the dawning day, and leave the place of our rest with gladness.

* Plato in Epinom. † Aristot. Physic. lib. vii, c. 5.

*Day* and *night*, and their alternate changes, are adapted to suggest useful thoughts, and calculated to employ our serious meditation.

"From night to day, from day to night,
The *dawning* and the *dying* light
Lectures of heavenly wisdom read;
With silent eloquence they raise
Our thoughts to the Creator's praise,
And neither sound nor language need."

A force continually impressed by the supreme Being produces and preserves these different and useful motions, which measure out that portion of time assigned us, for the performance of his work, and the securing of our own salvation. We are directed in his word how to employ this important *talent* lent to us; also warned to guard against a misapplication of it, and told that a day will come when we shall have to give an account of our stewardship. As *day* is afforded for the management of those employments which could not be done in the night, how unwise would it be to postpone such concerns till the approach of darkness? So the short period of life is given us that we may "work out our own salvation." We are favored with the light of Divine truth to illuminate our understandings; the operation of the Holy Spirit to influence our wills; and our pressing necessities should impel us to perform what God requires.

The Greeks have two words for *time*, χρονος and καιρος: the former signifies time in general; and the latter that part of it which is proper for doing a thing—the present season in which any thing to be done may be done fitly and to advantage. Accordingly Solomon says, "To every thing there is a season, and a time to every purpose under heaven."

What the apostle says to the Christians at Ephesus is equally applicable and interesting to persons in succeeding ages of the world; giving a view of the importance of time, and directing to a right improvement of it. "See that ye walk circumspectly, not as fools, but as wise, redeeming the time, because the days are evil."

*Walking*, in the Scripture style, is a word frequently used to denote the whole course of a man's life and conversation, including all his thoughts, words and actions. Walking *circumspectly*, ακριβως, signifies correctly, accurately, consistently, or perfectly. In another place the same word is rendered *diligently*. Herod said to the wise men come from the east, Go to Bethlehem, and search ακριβως, *diligently*, narrowly, for the young child Jesus. But the word *circumspect* is from the Latin *circumspicio*, and signifies to look round about, on all hands, to be every way watchful, wary, and cautious, in order to avoid danger, discern enemies before they come too nigh, and secure a man's interest by every possible and lawful means.*

* Dr. A. Clarke on Eph. v, 15.

The necessity of this duty is suggested in the Greek text, βλεπετε ουν *see then* or *therefore*, take care of this as a matter of the highest concern and greatest importance; it is that on which your all depends. He adduces a cogent reason for this—"Not as fools, but as wise." As if he should say, It is your *wisdom* to walk circumspectly, and not to walk so would be your *folly*: to walk circumspectly is the wisdom that God recommends to you, and which is adapted to make you truly wise, both in this world and in that which is to come.

The word *redeeming*, εξαγοραζομενοι, literally signifies *buying time*. The term *buying* is proper in reference to civil contracts, but it is here applied morally. Properly speaking, time cannot be bought; it is a commodity for which all the treasures in the world would not be an equivalent. Its price is above rubies. But the term imports the great value of time, and intimates that we should be willing to suffer any privation or inconveniences, rather than lose it. *Redeeming* properly implies the laying down a price for re-purchasing or recovering that which was ours, but which has fallen into the possession of another. A captive sometimes is redeemed out of the hand of an enemy. Now, in this sense, to redeem time already past is impossible, for when once gone it is irrecoverable. So that by *redeeming* time, nothing else can be understood but a diligent and prudent improvement of it, which is the only way in our power to counterbalance the loss we have sustained by our former neglect. The effects of our past negligence should be counteracted by double diligence in future: we should do much work in a little time. This is to redeem that time, concerning which we have allowed worldly business, unprofitable visits, sensual indulgence, carnal recreations, and vain thoughts, to rob us, and, as it were, to take and keep us captive. To redeem time then is to be diligent in future, wisely improving it so as may make amends for our very culpable remissness. Future diligence is, as it were, the price of redemption paid down for what we had mortgaged into the hands of those things which we have suffered to deprive us of it.

The argument used to enforce the practice of this duty is, "because the days are evil." Time, in itself, properly speaking, is neither good nor evil; but in regard to the moral state of mankind may be so called. The days here primarily intended by the apostle, denominated *evil*, were those of his own time, in which he himself and his cotemporaries lived, and which abounded with trouble and danger, by reason of the opposition made by unbelieving Jews and Gentiles against Christianity. But all our days, as well as those, may be called evil, because of the prevalence of sin, Satanic delusion, and hostility of the ungodly against real religion. Many persons can adopt the language of the patriarch Jacob, "Few and evil have the days of the years of my life been." Job gives a similar testimony, "Man that is born of a woman, is of few days, and full of evil."

The whole argument runs thus: seeing that you cannot enjoy true quiet and substantial comfort in this terrestrial abode, and are in danger of being quickly deprived of all opportunity of getting and doing good, fail not to improve the present time to the best advantage, in reference to the future state, that you may secure for yourselves a happy and glorious eternity.

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# CHAPTER III.

## SECOND DAY.

## ON THE ATMOSPHERE.

Composition of Atmospheric Air—Atmosphere divided into three regions—Air a fluid—Its compressibility and elasticity—Weight and pressure—Equilibrium—Transparency—Wind—Causes of Wind—Variety of Winds—Velocity of Winds—Destructive Winds—Wind under the control of God—Wind a similitude of the Holy Spirit's operations.

ON the *second day* God made a space or *expansion*, surrounding the solid earth to a certain height, called the *atmosphere*. This word is derived from ἀτμός and σφαῖρα, and signifies a body of vapor in a spherical form. By this name we understand the "entire mass of air which encircles all parts of the terrestrial globe, which moves with it round the sun, which touches it in all parts, ascending to the tops of its mountains, penetrating into its cavities, and incessantly floating on its waters. It is a fluid which we inhale from the first to the last moment of our existence." The Hebrew word רקיע *rakiâ*, from רקע *rakâ*, used by Moses, (and which our translators, by following the *firmamentum* of the Vulgate, which is a translation of the στερεωμα of the Septuagint, have improperly rendered *firmament*,) signifies to *spread out as the curtains of a tent or pavilion.** It corresponds with those beautiful words of Isaiah, "It is he that STRETCHETH OUT the heavens as a curtain, and SPREADETH THEM out as a tent to dwell in." "Thus," as a learned and pious author justly observes, "the second great production of the Almighty was the element which is next in simplicity, purity, activity, and power, to the light, (or, rather *fire*,) and no doubt was also used by him as an agent in producing some subsequent effects."†

It is particularly deserving notice, that, after the creation of caloric, the atmosphere was the next regular production. If heat had not previously existed, could the atmosphere have been formed?

* Dr. Clarke on Gen. i, 6. † Benson on Gen. i, 6.

The Creator, having first impressed certain principles on matter, impregnating it with repelling forces and systematical attractions, proceeded with his work according to these radical and fixed laws. One of the general laws discovered by Dr. Black, and which is laid down as a chemical axiom, is, that "Whenever a body *changes* its state, it either combines with caloric, or separates from caloric." "The most probable opinion concerning the nature of caloric," says Mr. Dalton, "is that of its being an elastic fluid of great subtlety, whose particles repel one another, but are attracted by all other bodies. Every kind of matter has its peculiar affinity to heat, by which it requires a certain portion of the fluid, in order to be in equilibrium with other bodies at a certain temperature."* It is now generally supposed, adds Mr. Parkes, that the air owes its elasticity to the caloric which it contains; and, that if it could be deprived entirely of this, it would lose its elastic form. The expansibility of the air is effected by the operation of caloric: for being rarefied by heat, it occupies a larger space than otherwise it would. It is extremely probable, says Lavoisier, that air is a fluid naturally existing in a state of vapor; or, as we may better express it, that our atmosphere is a compound of all the fluids which are susceptible of the vaporous or permanently elastic state, in the usual temperature, and under the common pressure.†

For the discovery of the composition of atmospheric air, we are indebted to Scheele, an able chemist, born 1742, at Stralsund, in Germany, who was a member of the Academy of Stockholm, and one of the Royal Society of Medicine at Paris, and whose laborious investigations of nature have perpetuated his memory. When the nature of atmospheric air began to be understood, it was imagined that it was a mere *mixture* of oxygen gas and nitrogen gas; and Mr. Dalton is still of this opinion: but, says Mr. Parkes, we have now abundant reason to believe that it is a mere chemical compound; that is, that the oxygen and nitrogen form atmospheric air by a chemical union. Atmospheric air is a chemical mixture of oxygen and nitrogen rendered aërial by the expansive power of caloric: it likewise contains a portion of carbonic acid gas, which was formerly calculated at one per cent.; but Mr. Dalton has lately demonstrated that it does not amount to more than one part in a thousand.‡ Carbonic acid gas is nearly twice as heavy as common air; hence it is evident that it must combine *chemically* with the atmosphere, or it would be found only near the surface of the earth. If it were merely *mixed* with atmospheric air, its gravity would prevent it from ascending to any great height: but it is found to exist in the atmosphere at the greatest heights, (though probably not in the same proportion) as well as near the surface of the earth; which is a proof that it is not a mere mixture,

* Dalton's New System of Chemical Philosophy, part i, p. 1.
† Lavoisier's Elements of Chemistry, p. 78.
‡ Manchester Memoirs, New Series, vol. i, p. 254.

but that it is chemically combined with the air. There are about 22 parts of oxygen, and 78 of nitrogen, in every 100 measures of atmospheric air, or 23 of the former and 77 of the latter, if the calculation be made by weight.*

Antony de Marti observes, If a few hundredth parts of oxygen only were wanting in atmospheric air, fire would lose its strength, candles would not diffuse such complete light, and animals would with difficulty separate the necessary quantity of the vivifying oxygen. On the other hand, if the atmosphere were more charged with oxygen than nitrogen, animals indeed would acquire a more free respiration; but, let us consider the activity which fire would acquire by air of superior purity. We know that, on some occasions, the least spark excites the strongest flame in a combustible body, and which increases so much as to consume it in a few moments: candles *then* would be no sooner lighted than they would be destroyed, without answering any other purpose than that of dazzling us for a few moments: iron would be calcined, instead of acquiring from the fire that softness necessary for transforming it into its various instruments, and which it cannot receive in a more moderate heat. Nothing would be capable of checking the progress of this destructive element, which is nourished by vital air, if this aëriform substance were not abundantly mixed with mephitic air, which serves to restrain it.

Pure atmospheric air is composed of three gaseous substances only, but is perpetually contaminated by a variety of exhalations from the earth. "The atmosphere is a vast laboratory," says Fourcroy, "in which nature operates immense analyses, solutions, precipitations, and combinations: it is a grand reservoir, in which all the attenuated and volatilized productions of terrestrial bodies are received, mingled, agitated, combined, and separated. Not-

* When solid substances are rendered permanently aëriform by heat, the air thus produced is called a *gas*. John Baptist van Helmont, a physician and chemist, born at Brussels, in 1577, and educated at Louvain, was the first chemist who made use of this term to denote an elastic fluid. He gave fixed air the name of *gas*.

The oxygen gas in atmospheric air is the principle of combustion, as the vehicle of heat; and is absolutely necessary for the support of animal life. Pure oxygen gas has the property of accelerating the circulation of all the animal fluids, and occasions the most rapid combustion of all combustible substances; so that it is the most energetic and powerful agent that chemists are acquainted with. Oxygen gas is a little heavier than atmospheric air, and 740 times lighter than water.

Nitrogen gas is chiefly distinguished by certain *negative* qualities, such as its being incapable of supporting combustion and animal life. It is uninflammable, and somewhat lighter than atmospheric air. Nitrogen gas has the effect of neutralizing, in some measure, the properties of oxygen gas, and rendering it fit for respiration and combustion. By the union of nitrogen gas with the oxygen gas this change is effected: the latter, which would burn every thing within its reach with an unparalleled activity, is, as it were, dissolved and diluted; and the nature of the former is so much enveloped by the latter, that the compound possesses properties different from either of these gasses, so as to be fitted for every purpose for which it was designed.

Though nitrogen gas is, by itself, so noxious to animals, it answers an important end when mixed with oxygen gas in atmospheric air. Were it not for this large quantity of nitrogen in the atmosphere, the blood would flow with too great rapidity through the vessels, and all animals would have too great spirits; the consequence of which would be, that the life of man would not be protracted to the length that it now is. "If the proportions of oxygen and nitrogen were reversed in the atmospheric air, says Dr. Lambe, the air taken in by respiration would be more stimulant, the circulation would become accelerated, and all the secretions would be increased: but the tone of the vessels, thus stimulated to increased action, would be destroyed by over-excitement; and, if the supply from the stomach were not equal to the consumption, the body must inevitably waste and decay." Hence the wisdom of God is remarkably displayed in the constitution of the atmospheric air! See Parke's Chemical Catechism, chap. ii.

withstanding this mixture, of which it seems impossible for us to ascertain the nature, atmospheric air is sensibly the same, with regard to its intimate qualities, wherever we examine it." Hence, whatever may be the nature of the aërial fluid, when absolutely pure, that which we breathe, and which commonly goes under the name of *air*, must be considered as an exceedingly heterogeneous mixture, various at various times, and which it is by no means possible to analyze with accuracy. The whole mass of it contains a great deal of water, together with the vast collection of particles raised from all bodies of matter on the surface of the earth by effluvia, exhalations, &c, so that it may be termed a *chaos* of the particles of all sorts of matter confusedly mingled together. And hence it has been considered as a large chemical vessel, in which the matter of all kinds of bodies is copiously floating; and thus exposed to the continual action of that immense surface, the sun, from whence proceed innumerable operations, sublimations, separations, compositions, digestions, fermentations, putrefications, &c.

Though, in this view, the atmosphere seems to be a kind of sink or common sewer, where all the poisonous effluvia arising from putrid and corrupted matter is deposited; yet it has a wonderful facility of purifying itself, and one way or other, of depositing those vapors contained in it; so that it never becomes noxious, except in particular places, and for a short time; the general mass remaining, upon all occasions, pretty much the same.* The way in which this purification is effected, is different according to the nature of the vapor with which the air is loaded. Aqueous vapor ascends; and also much of that vapor arising from decayed and putrid animal and vegetable substances, (and which, by some modern philosophers, is called *phlogiston*, attaching itself to the aqueous vapor,) ascends along with it; and probably descends again with the rain; whence the fertilizing qualities of rain-water above those of any other: while another part is absorbed by vegetables; for the phlogistic vapor is probably the food for plants. But sulphureous, acid, and metalline exhalations, produced principally by volcanos; vapors, arising from houses where lead and other metals are smelted; descend, in consequence of their specific

* "Mr. Cavendish," says Dr. O. Gregory, "is the first who endeavored to establish that the proportions of the two principal elements of the atmospheric air were constant. The observations since made by M. de Mairy in Spain, M. Berthollet, in Egypt and in France; Mr. Davy, in England; and by Dr. Beddoes on the air brought from the coast of Guinea, seem to have confirmed this grand result. But one of the finest experiments made on this subject is that of Gay Lussac, in France, who, having been elevated alone in a balloon to the height of 6,900 metres, the greatest ever attained by any person, brought some atmospheric air from these regions. This air, being analysed at his return, comparatively with that on the surface of the earth, gave the same principles in the same proportions; a proof that the chemical constitution of the atmosphere at these great heights, is the same as at the surface of the earth. This result has been since confirmed by the experiments made by Messrs. Humboldt and Gay Lussac on eudiometry. The air of the surface of the earth, analysed at different days, at various hours and temperatures, presented no change in its composition: it always contained 0.21 of oxygen in volume, 0.783 of azote, 0.003 of hydrogen, and 0.004 of carbonic acid. Biot and Arrago have also lately verified this grand result. The atmospheric air, analysed in places the most distant from each other, in deep valleys, on high mountains, on banks of lakes, and in the glaciers of Chamouny, always presented to them the same composition." Haüy's Natural Philosophy, Note, vol. i. p. 218.

gravity, and suffocate and spread destruction around them, poisoning not only animals, but vegetables also. From all these, the air seems not capable of purifying itself, otherwise than by winds, or by letting them subside by their superior gravity, till they are absorbed either by the earth or water, according as it is their nature to unite with one or other of these elements. Of this kind also seem to be the vapors which are properly called pestilential. The contagion of the plague itself seems to be of a heavy, sluggish nature, incapable of rising in the air, but attaching itself to the walls of houses, bed-clothes, and wearing apparel. Hence, scarcely any constitution of the atmosphere can dispel these noxious effluvia; nor does it seem probable that pestilential distempers ever cease until the contagion has operated so long, and been so frequently communicated from one to another, that, like a ferment much exposed to the air, it becomes vapid, communicates a milder infection, and at last loses its strength altogether.

The atmosphere, or body of air encompassing the earth on all sides, is generally divided into *three* regions. The lowest region extends from the earth to the place where the air is no longer heated by the rays which the earth reflects: this region is the warmest. The *middle* region begins where the preceding one ends, and goes to the summit of the highest mountains, or even the highest clouds ; this is the space where rain, hail, and snow are engendered : this region is much colder than the preceding one. The *third* region extends from the middle one to the utmost height of the atmosphere; whose limits have not been ascertained.* If the air were of an equal density throughout, the height of the atmosphere might be determined : but since the density of the air decreases with the pressure, it will be more rarefied and expanded the higher we go ; and by this means the altitude of the atmosphere becomes indefinite, and terminates in pure ether. But though we cannot assign its real height, it is certain, from observations and experiments, that a distance of 45 or 50 miles is the utmost limit where the density is sufficient to refract the rays of light. For the beginning and ending of twilight show, that the height at which the atmosphere begins to refract the sun's light is about 45 English miles ; and therefore that may be reckoned the altitude of the air to the least degree of density.

The air is justly reckoned among the number of *fluids*, because it has all the properties by which a fluid is distinguished. It requires but little attention to be convinced of this. The air yields to the smallest force impressed on it; its parts are easily moved among themselves; it presses according to its perpendicular height, and its pressure is every where equal. That the air is a fluid consisting of such particles as have no cohesion among themselves,

* Sturm's Reflections, vol. iv. p. 49.

but easily glide over one another, and yield to the smallest impression, appears from the ease and freedom with which animals breathe in it, and move through it without any difficulty or sensible resistance. The ease with which it is penetrated, and driven about in every direction, and the motion of it in pipes and channels, however crooked and intricate, demonstrate its fluidity. It is also known to be a fluid, by the easy conveyance which it affords to sound.

*Compressibility* and *elasticity* are evident properties of air. Its elasticity was first ascertained by some experiments of Lord Bacon. The air nearest the earth is in a state of compression, occupying a smaller space than it otherwise would do, were it not compressed by the superincumbent air. It must therefore be in a state something resembling that of a quantity of fine carded wool thrown loosely into a deep pit; the lower strata supporting the weight of the upper strata, and being compressed by them; and so much the more compressed as they are further down, while the upper stratum only is in its unconstrained and most expanded state. If we should suppose this wool thrown in by a hundred weight at a time, it will be divided into strata of equal weights, but of unequal thickness, the lowest being the thinnest, and the superior strata gradually increasing in thickness.*

When the air is in a state of compression, we find that the same force with which we compressed it is necessary to keep it in its bulk; and that if we cease to press it together, it will swell out and regain its natural dimensions, which shows its elasticity. This distinguishes it essentially from such a body as a mass of flour, salt, and such like, which remains in the compressed state to which we reduce it. There is something therefore which opposes the compression of air, different from its simple impenetrability, and produces motion, by repelling the compressing body. As an arrow is gradually accelerated by the bow-string pressing it forward, and at the moment of its discharge is brought to a state of rapid motion; so the ball from a pop-gun or wind-gun is gradually accelerated along the barrel by the pressure of the air during its

* "Galileo, to whom was reserved the glory of preparing, long before, the way for the theory of Newton, by the discovery of the law to which the acceleration of heavy bodies is subjected, having let fall from a great height different balls of *gold*, of *lead*, of *copper*, or *porphyry*, with a ball of wax, observed that all these bodies employed nearly the same time in falling to the earth. The ball of *wax*, the only one that was sensibly retarded, was no more than four inches from the earth at the end of the fall of the other bodies. Galileo, considering that this difference was very far from being proportional to that of the weights, concluded that it depended solely on the resistance of the air. This conjecture has been since verified by direct experiments, consisting in letting fall from the top of a tube, within which the vacuum has been made the most perfect possible, bodies of different materials, such as lead, iron, wood, cork, feathers, wool, &c, and it has been found that none of these bodies will then permit of our perceiving any sensible difference in the duration of their fall. As to bodies which raise themselves in air, such as smoke, it is known that their ascension is occasioned by the circumstance of their being specifically lighter than air: they are, with respect to this fluid, situated as a piece of cork is with respect to water, which when immersed in that water to a certain depth, and then left to itself, rises again to the surface. The vulgar regard all as being without gravity which rises instead of falling: whence Newton remarked that the weight of the vulgar was the excess of the absolute weight of a body above the weight of the air. The ascent of air-balloons in the midst of the air is well calculated to undeceive the partisans of this theory of bodies without heaviness." Haüy's Natural Philosophy, vol. 1. p. 48.

expansion from its compressed state, and finally quits it with an accumulated velocity. These two motions are indications perfectly similar to the elasticity of the bow and of the air.

Mr. Parkes observes, that atmospheric air in all states, and in all seasons, is *permanently* elastic. This elasticity arises from caloric being chemically combined with the solid substances of which it is composed. I say *solid*, because we have abundant evidence that oxygen and nitrogen are both capable of taking a solid form, and actually do, in many instances, exist in a state of solidity. Nitrogen is a component part of all animal substances, and exists in a solid state in all the ammoniacal salts. Oxygen takes the same state when it combines with metals and other combustibles; and in the composition of the nitrous salts they both take the same state of solidity. These facts surely evince that atmospheric air owes its fluidity to caloric.

Dr. Hales, by means of a press, condensed the air 33 times; and, afterwards, by forcing water in an iron globe, into 1,551 times less space than it naturally occupies. The dilation of the air, by virtue of its elastic force, is found to be very surprising. In experiments made by Mr. Boyle, it dilated to 10,000, and even, at last, in 13,679 times its space; and this altogether by its own expansive force, without the help of fire. In fact, it appears that the air we breathe is compressed by its own weight into at least the 13,679th part of the space it would occupy in *vacuo*. But if the same air be condensed by art, the space it would take up when most dilated, will be, according to the same author's experiments, as 550,000 to 1.

It is only by means of the experiments made with pumps,* and the barometical tube, by Galileo and Torricelli, that we came to the proof, not only that the atmosphere is endued with *weight* and *pressure*, but also of the measure and quantity of that pressure. The rise of water in a pump was formerly attributed to the horror that nature had of a vacuum. This absurd notion was refuted about the middle of the seventeenth century, by the following occurrence. The Duke of Florence, having occasion to raise water to the height of 50 or 60 feet, ordered a common pump to be made for that purpose; but when it was completed, the workmen were astonished to find that it would not work. The matter was referred to Galileo, but he was unable to account for it in any way. All they were able to determine was, that water would not rise in a common pump more than 32 or 35 feet. The fact remained inexplicable till philosophers caught the idea of atmospheric pressure; since when, the suspension of mercury in the barometer, and water in a pump, have been well understood.†

* To Otto Guericke, a burgo-master of Magdeburgh, we are indebted for the invention of the pneumatic machine, or air-pump.

† The atmosphere presses equally on the whole surface of the water in the well, until the rod of the pump is moved; but, by forcing the rod down, the bucket compresses the air in the lower part of the

That the air is a heavy body, has been demonstrated by a variety of experiments. The air next the earth is more dense than that at a distance, because, as it is of an elastic or springy nature, it is pressed down by the whole weight of the superincumbent air. Its general force of gravity appears, from its surrounding the earth, and always accompanying it in its orbit round the sun. As the matter of which the air is composed is always variable, so likewise will its weight or gravity be, as barometers of various kinds and structure evince. The weight of the air at the earth's surface, is found by the quantity of mercury that the atmosphere balances in the barometer; in which, at a mean state, the mercury stands 29½ inches high. And if the tube were a square inch wide, it would at that height contain 29½ cubic inches of mercury, which is just 15 pounds weight; and so much weight of air every square inch of the earth's surface sustains; and every square foot, as containing 144 inches, must sustain a pressure of 2,160. At this rate, a middle-sized man, whose surface is about 15 square feet, must sustain a weight of 32,400 pounds, or 16 tons; for the air, like other fluids, presses equally upwards, downwards, and sideways, in every direction. But because this enormous weight bears equally on all sides, and is counterbalanced by the spring of air diffused through all parts of the body, it is not in the least felt by us.*

By this enormous pressure we should undoubtedly be crushed in a moment were not all parts of our bodies filled either with air or some other elastic fluid, whose spring is just sufficient to counterbalance the weight of the atmosphere. The human body is a bundle of solids, hard or soft, filled or mixed with fluids, and there are few or no parts of it which are empty. All communicate either by vessels or pores; and the whole surface is a sieve through which the insensible perspiration is performed. The whole extended surface of the lungs is open to the pressure of the atmosphere; every thing therefore is in equilibrio: and if free or speedy access be given to every

pump tree, which being elastic, forces its way out of the tree through the valve; so that when the bucket is again raised, that part of the pump tree under the bucket is void of air; and the *weight of the atmosphere*, pressing on the body of water in the well, forces up a column of water to supply its place; the next stroke of the pump rod causes another column of water to rise; and as long as the bucket fits the pump tree close enough to produce a vacuum, a constant stream of water may be drawn from below. Parkes's Chemical Catechism, pp. 47, 418.

* As the earth's surface contains, observes Mr. Ferguson, in round numbers, 200,000,000 square miles, it must contain no less than 5,575,680,000,000,000 square feet; which being multiplied by 2,160, the numbers of pounds on each square foot, amounts to 12,043,468,800,000,000,000 pounds, for the weight of the whole atmosphere. Mr. Coates computed that the weight of the air which pressed upon the whole surface of the earth, is equal to that of a globe of lead sixty miles in diameter.

The following simple experiments within the reach of every one's observation, show clearly the weight or gravitating power of the air. Let any one lay his hand on the top of a long perpendicular pipe, such as a pump filled to the brim with water, which is at first prevented from running out by the valve below: then let the valve be opened, so that the water may descend, and he will find his hand so hard pressed to the top of the pipe that he cannot draw it away. The prop is now gone; he has no pressure under his hand; a column of air, 45 miles high forces it down by its weight; and he must let in the air under it before the hand can be withdrawn.—If we shut the nozzle and valve-hole of a pair of bellows after having squeezed the air out of them, we shall find that a very great force, even some hundred pounds, is necessary for separating the boards; they being kept together by the pressure of the air which surrounds them.—If any one will apply the open end of a syringe to his hand, and then draw up the piston, he will find his hand sucked into the syringe with great force, and it will give pain, and the soft part of the hand will swell into it, being pressed in by the neighboring parts, which are subject to the action of the external air.

part, the body will not be damaged by the pressure, however great, any more than a wet sponge would be deranged by plunging it any depth in water. The pressure is instantaneously diffused by means of the incompressible fluids with which the parts are filled: and if any parts are filled with air or other compressible fluids, these are compressed till their elasticity balances the pressure. Besides, all our fluids are acquired slowly, and gradually mixed with that proportion of air which they can dissolve or contain. The whole animal has grown up in this manner from the first vital atom of the embryo. For such reasons the pressure can occasion no change of shape by squeezing together the flexible parts; nor any obstruction by compressing the vessels or pores.

Sometimes the air is so heavy and elastic as to support the mercury in the tube at the height of 31 inches nearly; at other times it is so light and unelastic, as to suffer it to fall as low as 28 inches. The difference between these two altitudes is three inches, that is, about 1-9th of the whole weight of the atmosphere. Our bodies, therefore, are sometimes pressed with a weight one-ninth more than at other times, that is, with about 3,360 pounds more weight at one time than another. This has considerable effect on our feelings, and consequently on our health, but we are apt to ascribe this effect to a wrong cause. When we feel ourselves dull and languid, we think it is owing to the air being too thick and heavy about us. But it is just the reverse: the air is then too light and thin, as is evident from the mercury's sinking in the barometer, and its not bearing up the clouds: it is seldom dense enough at two miles height to bear them up.* The weight of the air is proved by its supporting the clouds and vapors which we so frequently see floating in it; in the same manner that the swimming of a piece of wood indicates the weight of the water which supports it.

It may be remarked, says Mr. Parkes, that the Creator has endowed atmospheric air with the property of preserving its own *equilibrium* at all times and in all places. Its elasticity is such, that, however it may be consumed by respiration or combustion, its place is immediately supplied with a new portion; and though by a mistaken policy the doors and windows of our habitations may be constructed so as to exclude it as much as possible, it will have admission; it forces its way through every crevice, and performs the most important office assigned it, in defiance of all our exertions. If the properties which are given to the different sub-

* A heavy air is more favorable to health than a light one, because it promotes the circulation of the blood, and insensible perspiration. When the air is heavy, it is generally clear; whereas a light air is generally accompanied with clouds, rain, or snow, which render it damp. Too great a dryness of the air is very injurious to the human body: but this seldom happens for any length of time, except in sandy countries. A damp air is very unwholesome, because it relaxes the fibres, obstructs insensible perspiration, and if heat accompany the dampness, it disposes the humors to putrefy. An air too hot dilates all the fluids of the body, and occasions sweatings, which bring on weakness and oppression. On the other hand, when the air is too cold, the solid parts contract excessively, and the fluids are condensed; hence result obstructions and inflammations. The best air is that which is neither too heavy nor too light, too moist nor too dry, and which is not impregnated with noxious vapors. Sturm's Reflections, vol. iv, p. 50.

stances in nature, and the laws by which they are governed, be thus examined, we shall find them all tending to promote the welfare and felicity of every species of animated beings.

The *transparency* of the air is a very beneficial property it possesses. According to Dr. Keill, and other writers on astronomy, it is entirely owing to the atmosphere that the heavens appear bright in the day-time. For, without an atmosphere, that part of the heavens only would shine in which the sun is placed: and if we could exist without air, and should turn our backs toward the sun, the whole heavens would appear as dark as in the night, and the stars would be seen as clear as in the nocturnal sky. In this case we should have no twilight; but a sudden transition from the brightest sunshine to the blackest darkness immediately after sunset; and from the blackest darkness to the brightest sunshine at sun-rising; which would be extremely inconvenient, if not fatal to the sight of men. But, by means of the atmosphere, we enjoy the sun's light, reflected from the aërial particles, for some time before he rises, and after he sets. For, when the earth by its rotation has prevented us from seeing the sun, the atmosphere, being still higher than we, has the sun's light imparted to it, which gradually decreases until he has descended 18 degrees below the horizon; and then, all that part of the atmosphere which is above us becomes dark. The atmosphere refracts the sun's rays so, as to bring him in sight every clear day, before he rises in the horizon; and to keep him in view for some minutes after he is really set below it. For, at some times of the year, we see the sun ten minutes longer above the horizon, than he would be if there were no refractions; and about six minutes every day at a mean rate. We cannot but perceive the wisdom of God displayed in this contrivance, to prevent the sudden transition from light to extreme darkness, and his goodness manifested therein to man.

Besides these, there are many other advantages we derive from the atmosphere. Were it not for the atmospheric air, which is the vehicle of light and sound, our eyes would be useless, and the pleasures which arise from the variegated prospects that now surround us, unknown. Sound would never strike our ears, nor convey the charms of language from one person to another; all the delights of mutual converse would be lost. The sense of smell would never be regaled with odoriferous sweets; nor annoyed with exhalations from putrid and morbid substances. In short, life would become extinct, and a chaos of darkness and emptiness ensue. It has been well remarked, that, if the Deity had intended only to give us existence, and had been indifferent about our happiness or misery, all the necessary purposes of hearing might have been answered without harmony; of smell, without fragrance; of vision without beauty. The consideration of the various *uses* to which the different substances in nature may be applied, gives so satisfactory an assurance of the goodness of the Almighty, as is calculated to produce in us gratitude and obedience. With this view, an elegant French writer has said on this necessary fluid, "In the use of atmospheric air, *man* is the only being who gives to it all the modulations of which it is susceptible. With his voice alone, he imitates the hissing, the cries, and the melody of all animals; while he enjoys the gift of speech denied to every other. To the air he also communicates sensibility; he makes it sigh in the pipe, lament in the flute, threaten in the trumpet, and animates to the tone of his passions even the solid brass, the box tree, and the reed. Sometimes he makes it his slave: he forces it to grind, to bruise, and to move for his advantage an endless variety of machines. In a word, he harnesses it to his car, and obliges it to waft him over the stormy billows of the ocean."

*Wind* is air in motion. As the air is a fluid, its natural state is that of rest, which it cannot have but by an universal equilibrium of all its parts. When, therefore, this natural equipoise of the atmosphere is destroyed in any part, the circumjacent air necessarily moves towards that part, to restore it; and this motion of the air is called *wind*. Hence, where the equilibrium of the air is disturbed, the wind may blow from every point of the compass at the same time: those who live northward of that point have a north wind; those who live southward have a south wind; and so on of the rest: but those who live on the spot, where all those winds meet and rush together, will have turbulent and boisterous weather, such as whirlwinds and hurricanes, accompanied with rain, lightning, and thunder. For sulphureous exhalations from the south, torrents of nitre from the north, and aqueous vapors from every part, are there violently blended together, and seldom fail to produce these phenomena.

The causes of wind augment or diminish the gravity or elasticity of the atmosphere; for two portions of air, which are equal in elasticity or gravity, remain mutually immoveable. We must look for the causes of wind in the variation of heat and cold, the position of the sun, the nature of the soil, the inflammation of meteors, the condensation of the vapors into rain, and other similar circumstances: but the most general causes are heat and cold. Fire, which expands and rarefies the air, diminishes its elasticity, and, consequently, makes it lighter in some places than in others; hence the pressure of the ambient air is greater than that of the rarefied, whence a motion arises; and thus several winds blow towards the part where the air is rarefied by the heat; which currents of air, if strong, are called *winds*, if gentle, *breezes* or *gales*. Thus the air is constantly carried from the polar regions towards the torrid zone, where it is also affected by the diurnal motion of the sun from east to west.

"When we reflect attentively upon the nature of winds in general," says Dr. O. Gregory, "considering all the causes which disturb the equilibrium of the atmosphere, the great mobility due to its fluidity and its elasticity, the influence of heat and cold upon the latter, the immense quantity of vapor with which it is charged and discharged alternately, the mutual effect of contiguous air and water in motion, the varied attractions of the sun and moon, upon the aërial fluid, and finally the changes produced by the earth's rotation in the velocity of the atmospherical moleculæ at different parallels of latitude; we shall no longer be astonished at the inconstancy and variety which infringe upon the regularity of some of our winds, nor of the extreme difficulty of reducing the whole to laws wearing the semblance of certainty."*

There is a great variety of winds. The ancients observed only four, called *venti cardinales*, because they blow from the four cardinal points. Homer mentions no more than *eurus*, the east; *notus*, the south; *zephyrus*, the west; and *boreas*, the north wind.† In imitation of him, others do the same. Afterwards intermediate winds were added, first one, then two, between each of these. Most writers, make only eight winds, and Vitruvius‡ informs us that the Athenians built a marble tower in the form of an octagon with eight winds marked, every one on that side which faced it. The moderns make 32 winds, the four cardinal winds 90 degrees distant, and 28 collateral or intermediate, 11 degrees and 15 minutes distant from each other, of which those in the middle between two cardinals, are 45 degrees distant from each cardinal.§ But some make as many points on the compass, and as many winds, as there are degrees on the horizon, namely, 360.

The winds for a considerable space north of the equator, about 30 degrees in the open sea, blow from the north-east, and as far south of the equator, from the south-east. These are called *trade-winds*, from their facilitating trading voyages. In the Indian ocean, from its particular situation, and that of the lands which

* "The most ingenious theories of the periodical winds we recollect, are those of Mr. Hadley, first proposed in Phil. Trans. vol. xxxix, p. 58, and lately revised by Mr. Dalton, in his Meteorological Essays,—and of Dr. Halley, first published in Phil. Transac. vol. xvi, p. 153, and recently defended by Dr. Kirwan, in his paper, 'On the Variations of the Atmosphere.' In the latter mentioned paper Kirwan has given some interesting information relative to variable winds, as westerly, easterly, southerly, northerly, and opposite concomitant winds; also relative to the succession of winds, and the Sirocco. See likewise the Philosophical Magazine, No. 60. Some curious facts respecting winds, and waves on the surface of the sea, are related by Mr. Horsburg in the Philosophical Journal, No. 60." Haüy's Nat. Phil. vol. i, pp. 285, 286.

† Odyss. v. 295.

‡ A celebrated architect, born at Formio, in Italy. He was greatly esteemed by Julius Cæsar, and employed by Augustus in constructing public buildings and warlike machines. He wrote a valuable Treatise on Architecture.

§ This division, with the several names on each point, was made by the Germans, as most commodious; but these names are not easily expressed in other languages. They are thus marked in English:

| North. | East. | South. | West. |
|---|---|---|---|
| N and by E | E and by S. | S and by W | W and by N |
| N N E | E S E | S S W | W N W |
| N E and by N | S E and by E | S W and by S | N W and by W |
| N E | S E | S W | N W |
| N E and by E | S E and by S | S W and by W | N W and by N |
| E N E | S S E | W S W | N N W |
| E and by N | S and by E | W and by S | N and by W |

surround it, from April or May, to October or November, the wind blows from south-east to north-west; and during the rest of the year from the opposite quarters: these winds are called *monsoons*. In Jamaica and the Caribbee islands, in the months of July, August, or September, there are usually violent storms of wind, called *hurricanes;* the wind during the hurricane frequently veering, and blowing in every direction.

> "Winds from all quarters agitate the air
> And fit the limpid element for use,
> Else noxious. Oceans, rivers, lakes, and streams,
> All feel the fresh'ning impulse, and are cleansed
> By restless undulation. E'en the oak
> Thrives by the rude concussion of the storm.
> He seems indeed indignant, and to feel
> The impression of the blast with proud disdain,
> Frowning, as if in his unconscious arm
> He held the thunder. But the monarch owes
> His firm stability to what he scorns,
> More fixed below, the more disturbed above."

Winds have been measured, and their velocity calculated. The following is Mr. John Smeaton's table of the rate at which the wind travels:

| Wind. | Miles in an Hour. | Feet in a Sec. |
|---|---|---|
| Hardly perceptible - - - - - - - - - - - | 1 | 1,47 |
| Just perceptible - - - - - - - - - - - - | 2 | 2,98 |
| - - - - - - - - - - - - | 3 | 4,40 |
| Gentle, pleasant - - - - - - - - - - - - | 4 | 5,87 |
| - - - - - - - - - - - - | 5 | 7,35 |
| Pleasant brisk gale - - - - - - - - - - - | 10 | 14,67 |
| - - - - - - - - - - - - | 15 | 22,00 |
| Very brisk - - - - - - - - - - - - | 20 | 29,34 |
| - - - - - - - - - - - - | 25 | 36,67 |
| High winds - - - - - - - - - - - - | 30 | 44,01 |
| - - - - - - - - - - - - | 35 | 51,34 |
| Very high - - - - - - - - - - - - - | 40 | 58,68 |
| - - - - - - - - - - - - | 45 | 66,01 |
| Storm, tempest - - - - - - - - - - - - | 50 | 73,35 |
| Great storm - - - - - - - - - - - - | 60 | 88,02 |
| Hurricane - - - - - - - - - - - - - | 80 | 117,36 |
| ——— that tears up trees, destroys buildings, &c. &c. - - - - - - - | 100 | 146,70* |

There are some winds that are awfully destructive. In the

* "The most decisive circumstance tending to show the great velocity of brisk winds," says Dr. O. Gregory, "is that of the rapid passage of the celebrated aëronaut M. Garnerin, from London to Colchester. On the 30th of June, 1802, the wind being strong, though not impetuous, M. Garnerin and another gentleman ascended with an inflammable air-balloon from Ranelagh Gardens, on the south-west of London, between four and five o'clock in the afternoon; and in exactly three-quarters of an hour they descended near the sea, at the distance of four miles from Colchester. The distance of the places of ascent and descent is at least 60 miles; so that, allowing no time for the elevation and depression of the balloon, but, supposing the whole period occupied in transferring it in a path nearly parallel to the earth's surface, its velocity must have been at the rate of 80 miles per hour. If, therefore, the wind moved no faster than the balloon, its velocity was then 80 miles per hour, or 117⅓ feet per second; a celerity but little less than the greatest assigned by Kraaft: and hence it is probable, that the velocity of very impetuous winds is not less than 130 or 140 feet per second." Haüy's Nat. Phil. vol. i, p. 282.

Gulf of Persia, particularly at Ormus, during the months of June and July, a hot suffocating wind sometimes blows from the west, for a day or two together, which scorches up and destroys any animal exposed to it. On this account the people of Ormus then leave their habitations, and retire to the mountains. Winds similar to this in kind, but not in degree, are sometimes felt on the coast of Coromandel, where they are called *terrenos;* and likewise on the Malabar coast. On the coast of Africa, north of Cape Verd, during the months of December, January, and February, an easterly wind sometimes blows for a day or two, called by sailors *harmattan*, so intensely cold, as to be almost as destructive as the west winds at Ormus. The *simoon* is a hot wind which blows occasionally in the deserts of Arabia, parched by a vertical sun. If inhaled in any quantity, it produces instant suffocation, or at least leaves the unhappy sufferer oppressed with an asthma and lowness of spirits. Its approach is perceived by a redness in the air, well understood by those who are accustomed to journey through the desert; and the only refuge which they have from it, is to fall down with their faces close to the ground, and to continue as long as possible without respiration.* *Sirocco* is a periodical wind which generally blows in Italy and Dalmatia every year about Easter. It blows from the south-east by south; it is attended with heat, but not rain; its ordinary period is twenty days, and it usually ceases at sunset. When the sirocco does not blow in this manner, the summer is almost free from easterly winds, whirlwinds, and storms. This wind is prejudicial to plants, drying and burning up the buds; though it hurts not man any otherwise than by causing in him an extraordinary weakness and lassitude; inconveniences that are fully compensated by a plentiful fishing, and a good crop

* Mr. Bruce, who, in his journey through the desert, suffered from the *simoon*, gives of it the following graphical description. "At eleven o'clock, while we contemplated with great pleasure the rugged top of Chiggre, to which we were fast approaching, and where we were to solace ourselves with plenty of good water, Idris, our guide, cried out, with a loud voice, 'Fall on your faces, for here is the simoon.' I saw from the south-east a haze come, in color like the purple part of the rainbow, but not so compressed or thick. It did not occupy twenty yards in breadth, and was about twelve feet high from the ground. It was a kind of blush on the air, and it moved very rapidly: for I scarce could turn to fall on the ground with my head to the northward, when I felt the heat of its current on my face. We all lay flat on the ground as if dead, till Idris told us it was blown over. The meteor or purple-haze which I saw, was indeed passed, but the light air that still blew was of heat sufficient to threaten suffocation. For my part, I found distinctly in my breast that I had imbibed a part of it, nor was I free of an asthmatic sensation, till I had been some months in Italy, at the baths of Poretta, near two years afterwards." Though the severity of this blast seems to have passed over them almost instantaneously, it continued to blow so as to exhaust them till twenty minutes before five in the afternoon, lasting through all its stages very near six hours, and leaving them in a state of the utmost despondency.

*Fatal Simoon.*—Extract of a letter from Smyrna:—We have received intelligence of a dreadful calamity having overtaken the largest caravan of the season, on its route from Mecca to Aleppo. The caravan consisted of 2,000 souls, merchants and travellers from the Red Sea and Persian Gulf, pilgrims returning from Mecca, and a numerous train of attendants; the whole escorted by 400 military. The march was in three columns. On the 15th of August last, they entered the great Arabian Desert, in which they journeyed seven days, and were already approaching its edge. A few hours more would have placed them beyond danger; but on the morning of the 23d, just as they had struck their tents, and commenced their march, a wind arose from the north-east, and blew with tremendous violence. They increased the rapidity of their march to escape the threatening danger; but the fatal Kamsin had set in. On a sudden dense clouds were observed, whose extremity obscured the horizon, and swept the face of the desert. They approached the columns, and obscured the line of march. Both men and beast, struck with a sense of common danger, uttered loud cries. The next moment they fell beneath its pestiferous influence lifeless corpses. Of 2,800 souls, composing the caravan, not more than 20 escaped this calamity; they owed their safety to the swiftness of their dromedaries. Literary Panorama, for January, 1814.

on the mountains. In the summer time, when the westerly wind ceases for a day, it is a sign that the sirrocco will blow the day following, which usually begins with a sort of whirlwind. When St. Paul was sailing close to the shore at Crete, there arose in the north-east, a tempestuous wind, called by the sacred historian, *euroclydon;* by Pliny, the *mariner's plague;* and in modern language, a *levanter*, which drove the ship from the coast: this not being a point wind, but rather a kind of hurricane, often shifting its quarter, tossed them backward and forward in the Adriatic.

On Saturday, November 27, 1703, a tremendous storm shook all Europe, which has been considered the most dreadful tempest that has ever taken place since the deluge. This storm commenced three days before it arrived at its height. A strong west wind set in about the middle of the month, the force of which was increased every day till the 27th. Great damage was sustained, and much alarm excited, both by sea and land. The late Rev. Dr. Stennett, in endeavoring to account for it, observes, that "having most probably taken its rise in America, it made its way across the western ocean, and collecting confederate matter in its passage over the seas, spent its fury on those parts of the world, whither this army of terrors was principally commissioned." The violence of the wind produced a hoarse, dreadful noise, like one continued peal of thunder; whilst the excessive darkness of the night added to the horror of the scene. Some accounts say, that it lightened; but it is probable, that this apprehension arose from there being, at times, many meteors and vapors in the air; the hurry and agitation of nature being too great to admit of thunder and lightning, in their usual course.

Great loss of property was sustained; many painful accidents happened to those who escaped with their lives; and not a few had all their apprehensions realized, as they met death in some of its most dreadful forms. In the city of London and its vicinity, more than 800 dwelling-houses were laid in ruins, and above 2,000 stacks of chimnies were precipitated to the ground. As a further proof of its strength and fury, we are informed, that the lead which covered the roof of 100 churches, was rolled up, and hurled, in prodigious quantities, to great distances. But the dreadful devastation spread throughout the country. In one extensive plain, on the banks of the Severn, not less than 15,000 sheep, being unable to resist its violence, were driven into the river and drowned. Such was the quantity of trees torn up by their roots, that a person anxious to ascertain the number, had proceeded through but a part of the county of Kent, when, arriving at the prodigious amount of 250,000, he relinquished the undertaking. If such were the dreadful ravages of this storm by land, it will be anticipated they were still more disastrous on the water. Accordingly we are informed, that the best part of our navy being then at sea, if it had been at any other than a full flood and spring tide, the loss might have proved fatal to the nation. It was computed that not less than 300 ships were utterly destroyed by this tempest; among which were 15 of the royal navy, containing upwards of 2,000 seamen, who "sunk as lead in the mighty waters." The whole loss of property was estimated at four millions of money—of lives, about eight thousand—and cattle without number.

Towards the evening of the 27th, it pleased Him, "who gathereth the wind in his fists," gradually to suppress the storm, till there was a perfect calm. Men were encouraged to leave the retreats in which they had taken refuge, and view the "desolations which God had made in the earth."*

Though the winds are produced by the operation of natural causes, and seem to move in natural courses, yet there is a first Cause, whose efficiency is necessary to their existence, motions, and continuance. We shall select the following remarkable instance as an illustration of the truth of this assertion.

The disciples of Christ were once in imminent danger from a storm at the sea of Tiberias, which is also called the Sea of Galilee, and the Lake of Gennesaret, and, according to Pliny, is sixteen miles long, and six broad. It is said, "Behold, there arose a great tempest in the sea," σεισμὸς μέγας, a great concussion or shaking. The same expression is frequently used, both in the Scripture and in other writings, for an earthquake; but here it is applied to the sea. Luke calls this tempest "a storm of wind;" Mark, "a great storm of wind;" and both of them use the word λαιλαψ, which the philosopher says is a particular kind of wind, or rather a conflict of many winds. The most probable derivation, says Mr. Parkhurst, seems to be from λα or λιαν, *very much*, and λαπτω, *to lick* or *lap up*, as wolves do water in drinking; for a whirlwind *violently licks up*, as it were, the dust of all light bodies in its way. Hence λαιλαψ is a wind that is suddenly whirled and rolled about downwards and upwards. Aristotle explains the word by *a violent whirlwind, moving from beneath upwards*. Hesychius, a learned Grecian, defines it to be a storm or tempest of wind, with rain. It seems to have been a whirlwind and hurricane in which the disciples then were. Luke says, that this storm of wind *came down*; it descended with great force into the sea, and lifted up its waves, which beat into the ship, and pressed it much, so that it was in great danger of being swallowed up and sunk by them. All the views given us of this tempest show the disciples to have been in imminent danger. It is said, "that the ship was covered with the waves," which "beat into it, so that it was now full of water," as Mark expresses it. Nay, Luke says, "they were filled with water, and were in jeopardy," or in great danger. The ship was immersed, or just sinking into

* See Baptist Magazine, for December, 1816.

the deep. So that the disciples were brought to the utmost extremity. The great distress they were in is expressed in these words, "We perish, ἀπολλύμεθα, *we are lost*."* This way of speaking is still in use among sea-faring men, and indeed among others. Nothing is more common than for men to say, Such a vessel, or such a ship's crew, or such a person, was lost at sea, in such a place, and at such a time. It is also to be observed, they do not say, We are in danger of being lost, or we are ready to be lost, or we shall be lost, but, *we are lost*. Which shows what apprehension they had of their condition; they saw no probability of escaping by any naturally rational method; they looked on themselves as lost.

All the Evangelists agree in this, though they do not use the same word. Mark mentions the place where he was asleep, *in the hinder part of the ship*, or stern, where he, as Lord and Master, should be. But to the great concern of the disciples, he was there in a deep or sound sleep, as the word αφυπνωσε, which Luke uses, signifies, and is confirmed by the loud cry, and repeated call of the disciples to him, saying, "Master, Master, we perish!" This sleep, doubtless, was brought on him through his great fatigue in preaching all the preceding day, and from the great concourse of people resorting to him, to have the sick healed, and devils cast out. He seems to have signified that he was very weary, just before he entered into the ship, to a man who said to him, "Master, I will follow thee whithersoever thou goest:" the answer he returned was, "The foxes have holes, and the birds of the air have nests; but the Son of Man hath not where to lay his head." Intimating as though he wanted an opportunity to lie down, and take some rest: and accordingly, when he was come into the ship, placing himself at the stern, he lay down, and fell fast asleep.

Christ was their last resource, but he was asleep in the same ship. However, they resolved to apply to him, and in so doing were certainly right. They used this language, "Lord, save us;" which implies that they believed he was able to save them; and indeed the considerable miracles which had been so lately wrought in their presence, were sufficient to convince them of his ability to deliver them in their greatest extremity. Our Lord indeed blamed them for their incredulity and want of faith. The question he put to them, as related by Luke, is "Where is your faith?" You professed to have faith in me, and doubtless had a little while ago; where is it now? Mark expresses himself, "Why are ye so fearful? how is it that ye have no faith?" that is, none in exercise, none sufficient to suppress your alarming fears? Matthew says, "Why are ye fearful, Oh ye of little faith?" It would seem they had no faith in Christ when sleeping, though not destitute of it when awake; but for this he justly reprimanded them. For

* So the word is translated Luke xix, 10; 2 Cor. iv, 3.

though, as the Son of Man, he was asleep, yet as the Son of God, by nature, he neither sleeps nor slumbers. He was equally able to save them when sleeping as well as when waking.

It is not only certain that he was able to save them, but it is matter of fact that he in reality did so. Being awaked by his disciples, he rises up, and, with a majestic voice, and in an authoritative manner, showing, as it were, some kind of resentment at the wind and sea, as if they had exceeded their commission, and the one had blown and the other raged too much, and too long, rebukes them, saying, "Peace, be still:" Σιώπα, πεφὶμωσο, be silent, hold thy peace, stop thy mouth, put a bridle on it, (as the last Greek word signifies;) go on no longer to threaten with shipwreck, and loss of lives. On this the wind ceased, and the sea became calm and smooth. The ship now moved quietly on, and they all arrived safe at the land of the Gadarenes, which is opposite to Galilee.

This had a very considerable effect both on the mariners and disciples, who rightly concluded from hence that their deliverer was more than a man. There was such a display of majesty, such a lustre of Divine power appeared in this behest, as filled them with astonishment and fear. They *marvelled* greatly, and *feared exceedingly*. Matthew seems to relate this, as though the mariners were the only persons who were affected with their deliverance: the men said one to another, "What manner of man is this, that even the winds and the sea obey him?" But Mark and Luke represent it as a question of the disciples to one another, "What manner of man is this?" of what qualities, powers, and perfections? He must be more than a mere man, he can be no other than the mighty God, "whom the winds and the sea obey." It is to be observed, that the word *man*, inserted in our translation, is not in the question, as expressed by any of the Evangelists, in the original, but "Who is this?" The disciples were sufficiently convinced by this miracle, which so nearly concerned themselves, that their Master must be God over all, blessed forever.

This amazing instance of the power of Christ, shows clearly his Deity. Since he has such authority over the wind and seas, it must unavoidably follow that he is truly and properly God. It is said, "he rebuked the wind and the sea," a phrase that is used only of the Most High God, who stands distinguished from all other beings by this, that "he stilleth the noise of the seas, the noise of their waves, and the tumult of the people." The Messiah makes use of this as an argument to prove, that he is able to redeem, because he can rebuke the sea, dry it up, and cover the heavens with clouds. "Is my hand shortened at all, that it cannot redeem? or have I no power to deliver? behold, at my rebuke I dry up the sea: I make the rivers a wilderness. I clothe the heavens with blackness, and I make sackcloth their covering." That it is the

Messiah who here speaks, the following words abundantly declare: "The Lord God hath given me the tongue of the learned, that I should know how to speak a word in season to him that is weary: he wakeneth morning by morning; he wakeneth mine ear to hear as the learned. The Lord God hath opened mine ear, and I was not rebellious, neither turned away back. I gave my back to the smiters, and my cheeks to them that plucked off the hair: I hid not my face from shame and spitting." Now on our Lord rebuking the wind and the sea, the one *ceased*, and the other became *calm;* this was done by speaking a word only, in an authoritative manner. Moses divided the waters of the Red Sea with a rod; Joshua, the waters of Jordan with the ark of the covenant; Elisha, with the Prophet's mantle: but here Christ calmed the raging billows with a word. When he rebuked the wind and the sea, not only the former instantly ceased to rage, but the sea immediately became calm, which was very unusual and extraordinary; for after the wind has ceased, and the storm is over, the waters of the sea commonly continue raging, and in a violent motion for a considerable time. Must not that man be an infidel, who can read this account, and deny the Deity of Jesus Christ? Or, must he not be forced to one or other of these two conclusions, either to deny the truth of the fact, or to believe that Jesus Christ is truly and properly God?

[*Addenda on Atmosphere.*

1. By more recent and accurate experiments it is established, that the relative proportions of oxygen and hydrogen in air, are not precisely as given by Mr. Wood; but are 21 of oxygen, and 79 of hydrogen in 100 parts.

2. Experiments on the *compressibility* of the atmosphere have been carried to a much greater extent than stated in the text, and since our author wrote. It was generally believed that air might be made to assume a *liquid* form by pressure; and it has been recently accomplished by Mr. Perkins, as he states, by a pressure of 2,000 atmospheres.

3. Our author very justly states, that the *gaseous* state of the atmosphere is owing to the quantity of *caloric* in combination, the entire *abstraction* of which would render our atmosphere a body as solid as the diamond. This caloric is not imparted to it by the beams of the sun *passing through* it; because, radiant matter does not warm gaseous bodies by passing through them. This caloric is chiefly supplied from the *earth*, by the lowest stratum of air coming in contact with it, and when heated ascends, and thus gives place to a colder stratum. Hence the air is much warmer at the surface of the earth, than in its higher regions.

4. Our author inclines to the opinion that the atmosphere is the product of a *chemical* combination of the gases, yet great names, and weighty arguments are in favor of the opposite theory of a *mere mixture* of gases.

5. There is one point not presented in the preceding section. It is well known that oxygen is abstracted from the air by *combustion*, and the *breathing* of animals. This abstraction is very large. From whence then comes the supply of oxygen sufficient to keep up the constitutional quantity of this gas in the atmosphere? The only answer I have met with to this difficult question is this: The *growing of vegetables* is supposed to supply it, as it is well known that they absorb carbonic acid during the day, and evolve oxygen. But it is also well known that this process is *reversed* during the night. Hence it would appear that this is not a sufficient cause. Still it would seem there must be a sufficient supply from some source, as chemists have not been able to detect any change in the constitution of the air.

May not the oxygen be *restored* back again by *evolution* from those bodies which have *absorbed* it, *upon their decomposition?* Thus there would be a successive absorption and evolution as the process of nature went on; which would tend to keep up an equal distribution of oxygen.]

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## CHAPTER IV.

### THIRD DAY.

### *Section* I.—The Sea.

Water and land separated—Formation of the sea—Its restrictions—Extent—Depth—Composition—Saltness—Motion—Tides—Four states of water—Circulation—Religious improvement.

On the *third day*, the earth was drained, and the waters, which before covered its surface, were gathered into copious receptacles, and called *seas*. God said, "Let the waters under the heaven be gathered into one place, and let the dry land appear; and it was so. And God called the dry land Earth; and the gathering together of the waters called he Seas." The almighty Creator proceeds to separate, put in order, and control the element nearest to *light* and *air* in quality and use, and, although not elastic, yet of great power. Probably the air was used by him as the great agent in gathering the waters into one place. Thus, instead of the confusion, which existed when the earth and the water were mixed in one great mass, there is now order; and by their separation each is rendered useful: the earth affording a habitation and support for man and the various orders of land animals; and the water forming an abode for the numerous tribes of living creatures adapted to subsist in that liquid element.*

Previous to this arrangement, the water, being a pure element, was above the earth. Thus the Psalmist, "Thou coveredst it

* Benson on Gen. i, 9, 10.

with the deep as with a garment: the waters stood above the mountains," so that they did not appear. "At thy rebuke they fled; at the voice of thy thunder they hasted away." At the omnipotent word they started back, and shrunk away, says Bishop Patrick; like an affrighted slave at the thunder of his master's threatenings, if his commands are not obeyed. They gathered themselves in those places where they now are, which by Moses are called seas; and there God shut them up, confining them that they might not return to cover the earth. God "brake up," for the reception of the waters, his "decreed place," that vast concave or hollow in the earth; "and set bars and doors," banks and shores, the weak sand to control this element, which, however it roar and struggle, it cannot pass.

It is wonderful that the sea, which has a natural disposition, from its being a purer and lighter element, to be above the earth, should not overflow it; but the amazing power of Omnipotence retains it within its prescribed limits. For he has pronounced, "Hitherto shalt thou come, but no further; and here shall thy proud waves be stayed." As if he had said, Though thy tides flow with mighty strength, though the swelling billows of thy pride (so the original) rise high in a storm, and dash against the shore with impetuous force and overwhelming rage, yet here shall they stop: though they roar and foam, as if irritated at the opposing strand, yet dare not to approach beyond those limits to thee assigned; but, obedient to thy Lord and Master, submissively retire. Here we see the power and dominion of the supreme Being in the kingdom of nature, whose sway the sea is subject to! Our preservation from its threatening destruction, by the continual restrictions it is under, is a perpetual expression of Divine goodness and mercy, and should induce all men to live always in the reverential fear of God. "Fear ye not me? saith the Lord: will ye not tremble at my presence, which have placed the sand for the bound of the sea, by a perpetual decree, that it cannot pass; and though the waters thereof toss themselves, yet they cannot pass over it."

If we look upon the map of the world, we shall find that the ocean occupies a considerably greater surface of the globe than the land is found to do. Although the ocean, properly speaking, is but one extensive sheet of water, continued over every part of the globe without interruption; and although no part is divided from the rest, yet geographers have distinguished it by different names, as the Atlantic or Western Ocean: the Northern, Southern, Pacific, Indian, and German Oceans. In this vast receptacle, almost all the rivers of the earth ultimately terminate. And yet these vast and inexhaustible supplies do not seem to increase its stores; for it is neither apparently swelled by their tribute, nor diminished by their failure; it continues constantly the same. Indeed, the quantity of water of all the rivers and lakes in the world is nothing compared to that contained in this prodigious reservoir. And some natural philosophers have carried their ideas on this subject so far as to assert, in consequence of certain calculations, that, if the bed of the sea were empty, all the rivers of the world flowing into it with a continuance of their present stores, would take up at least 800 years to fill it again to its present height.*

To ascertain the *depth* of the sea has been found impracticable, both on account of the numerous experiments which it would be found necessary to make, and the want of proper instruments for that purpose. Beyond a certain depth the sea has hitherto been found unfathomable; and though several methods have been contrived to obviate this difficulty, none of them has completely answered the purpose. We know in general that the depth of the sea increases gradually as we leave the shore; but if this continued beyond a certain distance, the depth in the middle of the ocean would be prodigious. Indeed, the numerous islands every where scattered in the sea demonstrate the contrary, by showing us that the bottom of the water is unequal like the land, and that so far from uniformly sinking, it sometimes rises into lofty mountains. If the depth of the sea be in proportion to the elevation of the land, as has been generally supposed, its greatest depth will not exceed five or six miles; for there is no mountain six miles perpendicular above the level of the sea. The sea has never been actually sounded to a greater depth than a mile and 66 feet; every thing beyond that, therefore, rests entirely upon conjecture and analogical reasoning, which, in this case, are in no wise conclusive. Along the coasts, where the depth of the sea is generally well known, it has always been found proportioned to the height of the shore; when the coast is high and mountainous, the sea that washes it is deep; when, on the contrary, the coast is low, the water is shallow. Whether this analogy holds at a distance from the shore, experiments alone can determine.

Water is an uninflammable fluid, says Dr. O. Gregory, and, when pure, is transparent, colorless, and void of taste and smell. Mr. Cavendish made a discovery that it is formed by the union of *hydrogen* and *oxygen*. It may, therefore, be considered as *oxide of hydrogen:* oxygen and hydrogen appearing to unite, only in that certain proportion of which water is the result. In 1798, (observes Mr. Parkes) Mr. Sequin made a grand experiment for the composition of water. He expended no less than 25,582 cubic inches (or nearly two hogsheads) of inflammable air, and 12,457 of vital air. The first weighed 1,039 grains, and the second 6,210, amounting to 7,249 grains, and the water obtained amounted to 7,245 grains, or about three-fourths of a wine pint. The loss was only four grains. Another experiment was afterwards made by Le

* Contemplative Philosopher, vol. ii, pp. 177—179.

Fevre, in which nearly two pounds and a quarter of water was produced.

The sea water contains a quantity of *salt*, but not in the same proportions every where. In the torrid zone, where otherwise, from the excessive heat, it would be in danger of putrefaction, the water is found most salt; as we advance northward its briny quality diminishes, till at the poles it is nearly gone altogether. Under the line, Lucas found that the sea comprised a seventh part of solid contents, consisting chiefly of sea-salt. At Harwich, he found it yielded 1-25 of the same matter. At Carlscroon, in Sweden, it contains 1-30 part, and on the coast of Greenland a great deal less. This gradual diminution of saltness from the equator to the pole, is not, however, without particular exceptions. The Mediterranean sea contains 1-22 of the sea-salt, which is less than the German sea contains. The saltness of some seas, or of particular parts of the same seas, may be increased, as Mr. Boyle intimates, from rocks and other masses of salt, either at the bottom of the sea, or dispersed near their shores.

This phenomenon of the sea perplexed the philosophers before the time of Aristotle, and surpassed even the great genius of that philosopher. Father Kircher, after having consulted three and thirty authors upon the subject, could not help remarking, that the fluctuations of the ocean itself were scarcely more various than the opinions concerning the origin of its saline impregnation. Bernadine Gomesins, (observes Bishop Watson) about 200 years ago, published an ingenious treatise on salt: in this treatise, after reciting and refuting the opinions of Empedocles, Anaxagoras, and Aristotle, on the subject in question, he proposes his own; wherein he maintains, that the sea was originally created in the same state in which we at present find it, and impregnated, from the very first, with the salt which it contains. Indeed, we cannot account for the general saltness of the sea from second causes; hence we must suppose it has had this property from the creation. Naturalists assure us, that, though some few species of fishes thrive in fresh water, and some others live alternately in fresh and salt, yet by far the greatest number cannot exist out of the sea; which is a proof that the sea was at the creation impregnated with salt.

The saltness of the sea has been considered by some as a peculiar blessing from Providence, in order to keep so great an element pure and wholesome: but facts prove that this property is not capable of preserving it from putrefaction. Sir Robert Hawkins, one of our most enlightened navigators, gives an account of a calm, in which the sea continuing for some time without its usual motion, began to assume a very formidable appearance. "Were it not (says he) for the moving of the sea, by the force of winds, tides, and currents, it would corrupt all the world. The experiment of this I saw in the year 1590, lying with a fleet about the islands of

Azores, almost six months; the greatest part of the which time we were becalmed. Upon which all the sea became so replenished with various sorts of gelies, and forms of serpents, adders, and snakes, as seemed wonderful; some green, some black, some yellow, some white, some of divers colors, and many of them had life; and some there were a yard and a half and two yards long; which had I not seen, I could hardly have believed. And hereof are witnesses all the companies of the ships which were then present; so that hardly a man could draw a bucket of water clear of some corruption. In which voyage, towards the end thereof, many of every ship fell sick, and began to die apace. But the speedy passage into our country was a remedy to the crazed, and a preservative for those that were not touched."* Mr. Boyle informs us, that he once kept a quantity of sea water, taken from the English channel, for some time barrelled up; and, in a few weeks, it began to acquire a fetid smell. He was also assured by one of his acquaintance, who had been becalmed for about fourteen days in the Indian ocean, that the water, for want of motion, began to stink; and, that had the calm continued much longer, the stench would probably have poisoned him. It is the motion, therefore, and not the saltness of the sea, that preserves it in its present state of salubrity.†

The sea has three kinds of motion: the *first* is that undulation which is occasioned by the wind. This motion is evidently confined to the surface; the bottom, even during the most violent storms, remains perfectly calm. Mr. Boyle has remarked, from the testimony of several divers, that the sea is affected by the winds to the depth only of six feet. It would follow from this, that the height of the waves above the surface does not exceed six feet; and that this holds, in the Mediterranean sea at least, we are informed by the Compte de Marsigli; though he also sometimes observed them, during a very violent tempest, rise two feet higher.

The *second* kind of motion is that continual tendency which

* M. Savary, in his instructive and entertaining Letters on Greece, has the following pertinent reflections: "We enjoy the finest weather imaginable; not a cloud obscures the sky, and a south-east wind wafts us directly towards the port to which our wishes tend. We have now entirely lost sight of land, and, as far as the eye can reach, only view the immense abyss of the waters, and the vast expanse of the heavens. How awful is this sight! How does it inspire the mind with great ideas! How adventurous is man, who trusts his fortune and his life to this frail vessel he has built, which a worm may pierce, or a single blast dash to pieces against a rock. Yet in this he braves the fury of the ocean! But how admirable is his ingenuity! He commands the winds, enchains them in the canvas, and forces them to conduct him where he pleases. He sails from one end of the world to the other, and traverses the immense liquid plains without any signals to direct him. He reads his course in the heavens. A needle, which wonderfully points perpetually to the pole, and the observation of the stars, inform him where he is. A few lines and points mark out to him the islands, coasts, and shoals, which his skill enables him to approach or avoid at pleasure. Yet has he cause to tremble, notwithstanding all his science and all his genius! The fire of the clouds is kindling over his head, and may consume his dwelling. Unfathomable gulfs are yawning beneath his feet, and he is separated from them only by a single plank. His confidence might make us imagine he knew himself immortal; yet he must die—die never to revive again, except in another state of being."

† As it is sometimes necessary to preserve sea water in casks for bathing and other purposes, it is of importance to know how to keep it from putrefaction. Dr. Henry from many experiments made by him for the preservation of sea water from putrefaction, has concluded, that two scruples of quick-lime are sufficient to preserve a quart of sea water. The proportions, however, may vary a little according to the strength of quick-lime employed.

the whole water in the sea has towards the west. It is greater near the equator than about the poles; and, indeed, cannot be said to take place at all in the northern hemisphere beyond the tropic. It begins on the west side of America, where it is moderate; hence that part of the ocean has been called *Pacific.* As the waters advance westward, their motion is accelerated; so that, after having traversed the globe, they strike with great violence on the eastern shore of America. Being stopped by that continent, they turn northward, and run with considerable impetuosity in the Gulf of Mexico; from thence they proceed along the coast of North America, till they come to the south side of the great bank of Newfoundland, when they turn off, and run down to the Western Isles. This current is called the *Gulf stream.* It was first accurately described by Dr. Franklin, who remarked also, that the water in it having been originally heated in the torrid zone, cools so gradually in its passage northward, that even the latitude might be found in any part of the stream by means of a thermometer. This motion of the sea westward has never been explained: it seems to have some connection with the trade-winds, and the diurnal revolution of the earth upon its axis.

The *third*, and most remarkable motion of the sea, is the tide; which is a regular swell of the ocean every 12 hours, accounted for from the principal of gravitation. The sagacious Kepler long ago conjectured, that the earth and moon, and every particle of them, mutually gravitate towards each other, and are the cause of the tides. If, says he, the earth ceased to attract its waters towards itself, all the water in the ocean would rise and flow into the moon: the sphere of the moon's attraction extends to our earth, and draws up the water. This, at that time, was mere conjecture; for Sir Isaac Newton was the first who clearly pointed out the cause of this phenomenon. On the shores of the ocean, and in bays, creeks, and harbors, which communicate freely with it, the waters rise above their mean height twice a day, and as often sink below it, forming what is called a *flood* and an *ebb*, a *high* and *low water*. It has been stated, that in the middle of the sea the tide seldom rises higher than one or two feet; but, on the coast, it frequently reaches to the height of 45 feet, and, in some places, even to more. At Plymouth, it is sometimes 21 feet between the greatest and least depth of the water in the same day, and sometimes only 12 feet.

When the sun and moon act conjointly on the tides, which is at the change and full of the moon, they are stronger and run higher than at other times, and are called *spring tides;* but when the sun and moon are 90 degrees apart, their attractive powers, being in opposition to each other, occasion the tides to be weaker and lower than at other times, and these are called *neap tides.* The word *neap* is derived from the Saxon; it signifies low, de-crescent, and is used only of the tide. These different heights of tide are observed to succeed each other in a regular series, diminishing from the greatest to the least, and then increasing from the least to the greatest, according to the age and situation of the moon.

> "The moon turns ocean in his bed,
> From side to side, in constant ebb and flow,
> And purifies from stench his watery realms."

Sir Isaac Newton calculated the attractive powers of the sun and moon on the tides, and found the attraction of the latter to be about three times greater than that of the former.

Water is found to exist in four states: namely, solid, or ice; liquid, or water; vapor, or steam; and in a state of composition in other bodies. The younger Lemery observes, that ice is only the re-establishment of the parts of water in their natural state; that the mere absence of fire is sufficient to account for this re-establishment; and that the fluidity of water is a real fusion, like metals exposed to the fire; differing only in this, that a greater quantity of fire is necessary to the one than the other.

Underneath the poles, water is always solid; there it is similar to the hardest rocks, and may be formed by the chisel of the statuary like a stone. The following circumstance, noticed by Bishop Watson, will show the solidity that water is capable of acquiring when divested of a large portion of caloric. It is related that at the whimsical marriage of Prince Gallitzen, in 1739, the Russians applied ice to the same purposes as stone. A house, consisting of two apartments, was built with large blocks of ice; and the icy cannon, which were fired in honor of the day, performed their office more than once without bursting.

During the severe winter of 1740, observes M. de Bomare, a palace of ice, 52 feet long, 16 wide, and 20 high, was built at Petersburgh, according to the most elegant rules of art. The river Neva afforded the ice, which was from two to three feet thick, blocks of which were cut and embellished with various ornaments. When built up, the different parts were colored by sprinkling them over with water of various tints. Six cannons, made of and mounted with ice, with wheels of the same matter, were placed before the palace; and a hempen bullet was driven by one of these cannons, in the presence of the whole court, through a board two inches thick, at the distance of sixty paces. Cowper remarks,—

> "No forest fell,
> Imperial mistress of the fur-clad Russ,
> When thou wouldst build—no quarry sent its stores
> T' enrich thy walls; but thou didst hew the floods,
> And make thy marble of the glassy wave.
> Silently as a dream the fabric rose,
> Ice upon ice; the well-adjusted parts
> Were soon conjoin'd; nor other cement ask'd
> Than water interfused to make them one.
> Lamps gracefully disposed, and of all hues,
> Illumin'd ev'ry side. Long wavy wreaths

> Of flowers, that feared no enemy but warmth,
> Blush'd on the pannels, which were once a stream,
> And soon to slide into a stream again."

In the most northern part of the Russian territory, the cold is sometimes sufficient to freeze mercury, or 72 degrees below the freezing point of water.* It is so intense in some seasons, that the poor inhabitants cannot venture out of their miserable huts but at the hazard of their lives.

> "There, through the prison of unbounded wilds,
> Barr'd by the hand of nature from escape,
> Wide roams the Russian exile. Nought around
> Strikes his sad eye but deserts lost in snow,
> And heavy loaded groves, and solid floods,
> That stretch athwart the solitary vast
> Their icy horrors to the frozen main."

In Iceland and Germany the thermometer frequently falls to zero, which is 32 degrees below the freezing point. At Hudson's Bay it has been known to sink even 50 degrees lower. When stones or metals, which have been exposed to such degrees of cold, are touched by the tongue, or the softer parts of the human body, they absorb the heat from those parts with such rapidity, that the flesh becomes instantly frozen and mortified, and the principle of life in them is extinguished. Some French academicians, who made a journey to the northern end of the Baltic, and wintered under the polar circle, found it necessary to use all possible precautions to secure themselves from the dreadful cold which prevailed. They prevented, as much as possible, the entrance of the external air into their apartments; and if at any time they had occasion to open a window or a door, the humidity of their breath, confined in the air of the house, was condensed and frozen into a shower of snow; their lungs, when they ventured to breathe the cold air, felt as if they were torn asunder; and they often heard the rending of the timber around them by the expansive power of the frost on the fluid in its pores. In this terrible cold the thermometer fell to 33 below zero.† The most intense cold ever known in the neighborhood of London was on December 25th, 1796, when the thermometer indicated 2 below zero.

The ice at each pole of the earth forms an immense cupola, the arch of which extends some thousand miles over the continents; the thickness of which, beyond the 60th degree of latitude, is several hundred feet. Navigators have assigned to detached masses, which are met with floating at sea, an elevation of from 1,500 to

* "Frosts often occasion a scantiness of water in our fountains and wells. This is sometimes erroneously accounted for by supposing that the water freezes in the bowels of the earth. But this, as Dr. Robison remarks, is a great mistake: the most intense cold of a Siberian winter would not freeze the ground two feet deep; but a very moderate frost will consolidate the whole surface of a country, and make it impervious to the air; especially if the frost have been preceded by rain, which has soaked the surface. When this happens, the water which was flittering through the ground is all arrested, and kept suspended in its capillary tubes by the pressure of the air." Haüy's Nat. Phil. p. 198.

† "Dr. Black's Lectures, vol. i. p. 69.

1,800 feet.* There can be no doubt but that the thickness of these cupolas of ice is much greater nearer the poles; for astronomy sometimes presents in the heavens so vast an image of them, that the rotundity of the earth seems to be considerably affected thereby. Captain Cook could never approach nearer the south pole, where there is no land, than the 70th degree of latitude; that is, no nearer than 1,500 miles; and it was only under the favor of a bay, that he was permitted to advance even so far.† All the results of observations made by navigators, concur in proving that the temperature of the sea decreases according to the depth; and that the deepest gulfs are continually covered with ice, even under the equator. From a late memoir by M. Perron, some say, there is reason to believe that these mountains of ice at the poles, which have hitherto impeded the progress of European navigators, have been detached from the depths of the sea to float at the surface.‡

When water is converted into ice, it is lighter§ than when in a fluid state, which is a circumstance of great importance. Galileo was the first who observed this. Ice consequently floats upon water, its specific gravity being to that of water as eight to nine. This rarefaction seems to be owing to the air-bubbles produced in water by freezing; and which, being considerably larger in proportion to the water frozen, render the body so much specifically lighter: these air-bubbles, during their production, acquire a great expansive power, so as to burst the containing vessels though ever so strong.

[The specific weight of ice is known to be less than that of water. Our author assigns a reason not entirely satisfactory. We must admit that the freezing of the upper stratum of water, although it may *include* the air which was in the water frozen, yet, *it does not expel the air from the subjacent volumes of water.* Hence the air in the water below will balance the effects of the air included in the ice.

It is a singular fact, and is regarded as a deviation from the general rule, that water *expands* in volume in proportion as its temperature is *reduced below* 40° Fahrenheit. It also expands by raising its temperature above this degree.

The *expansion* of the volume then, and not the enclosed air bubbles, is the cause of water being specifically lighter when converted into ice. But it remains to account for its expansion by a *reduction* of temperature.

This is a difficult question. It seems most probable that this expansion is owing to a peculiar arrangement of the particles of water, in the act of crystallization, i. e. *freezing.* M. Mairan found

* See Ellis's voyage to Hudson's Bay.

† St. Pierre's Studies, vol. i. pp. 129—132.

‡ See 21st volume of the Philosophical Magazine.

§ The specific gravity of water is as follows; a wine-pint measure weighs one pound; consequently a cubic foot of water weighs about 1,000 ounces, or 62½ pounds, avoirdupois. It is 816 times heavier than atmospheric air.

that the particles of water, in the act of freezing, arranged themselves constantly at an angle of 60°, and by this arrangement *increased the bulk* of the water thus crystallized.

It is obviously a mistake to attribute the "expansive power" of freezing to the force of the inclosed air-bubbles; because the reduction of temperature would reduce this supposed expansion of the inclosed air. The true cause of the expansion of ice is supposed above, in the arrangements of the particles of water in the process of crystallization.

The *power* which disposes these particles to arrange, *increases with the reduction of temperature*, until the disposing power becomes sufficiently great to force every impediment to the inclination to arrange. Hence the strongest vessels burst in the process of freezing.

The impediments may restrain the accomplishment of the arrangement of the particles for a time, but the disposing power will overcome them, if the reduction of temperature go on; and when they are overcome *suddenly*, the crystallization will take place *instantly*. Hence the sudden rending of vessels, trees, mountain rocks, &c, upon the sudden congelation of water.

Even when there is no cause to impede crystallization, it is well known that the *preparation* to crystallize, or freeze, may be observed in the liquid; the particles seeming to be *preparing* to arrange themselves; and then, at a given stage of the preparation, they take their places *suddenly*, and thus we have ice.

This consummation may be retarded, or hastened by *artificial* means. Water may be reduced to a lower temperature by being kept *still*, than when *agitated*. And if it be cooled down to the lowest possible temperature, *without congealing*, it may remain fluid at that temperature for a long time. But if the vessel be *suddenly struck;* or the surface of the water *touched with a piece of ice;* or *a large piece of cold metal be brought in contact with the outside of the vessel; the water will instantly crystallize or freeze in beautiful crystals.*

These facts establish the above theory. Because, 1. there is no increased reduction of temperature effected, by striking the vessel, touching the surface of the water with ice, or the outside of the vessel with cold metal. 2. There is every reason to conclude these things *commence the motion* in the water, which is at rest, balanced between an inclination to be at rest, and an inclination to move in arranging the particles; the motion communicated overcomes this balance in favor of the disposition to crystallize, and hence the water freezes instantly, with an expansion of volume.]

It is owing to the *expansion* of water in freezing, that rocks and trees are often split during intense frosts. According to the calculations of the Florentine academicians, a spherule of water, only one inch in diameter, expands in freezing with a force superior to the resistance of 13½ tons weight. Major Williams also attempted to prevent this expansion; but during the operation the iron plug which stopped the orifice of the bomb-shell containing the freezing water, and which was more than two pounds weight, was projected several hundred feet with great velocity; and in another experiment the shell burst. This property of water is taken advantage of in splitting slate. At Colly Western, the slate is dug from the quarries in large blocks: these are placed in an opposite direction to what they had in the quarry, and the rain is allowed to fall on them: it penetrates their fissures, and the sharp frost freezes the water, which, expanding with its usual force, splits the slate into thin layers.*

M. Mairan, in a dissertation on ice, attributes the increase of its bulk chiefly to a different arrangement of the parts of the water from which it is formed; the icy skin on the water being composed of filaments, which according to him, are found to be constantly and regularly joined at an angle of 60°; and which, by this angular disposition, occupy a greater volume than if they were parallel. He found the augmentation of the volume of water by freezing, in different trials, a 14th, an 18th, a 19th, and when the water was previously purged of air, only a 22d part: that ice, after its formation, continues to expand by cold; for, after water had been frozen to some thickness, the fluid part being let out by a hole in the bottom of the vessel, a continuance of the cold made the ice convex; and a piece of ice, which was at first only a 14th part specifically lighter than water, on being exposed some days to the frost, became a 12th part lighter. To this cause he attributes the bursting of ice on ponds.

Several philosophers have been very desirous to experience how far the expansive force of freezing water might be carried. "An iron gun of an inch thickness," says M. Haüy, "filled with water and exactly closed, having been exposed by Buot to a strong frost, was found to be burst in two places at the end of twelve hours. The Florentine philosophers were able, by means of the same cause, to burst a sphere of very thick copper; and Musschenbroek, having calculated the effort which would occasion the rupture, found that it would be capable of raising a weight of 27,720 pounds."

"Colonel E. Williams, of the Royal Artillery, when at Quebec, in the years 1794 and 1795," says Dr. O. Gregory, "made many experiments. He filled all sizes of iron bomb-shells with water, then plugged the fusee-hole close up, and exposed them to the strong freezing air of the winter in that climate; sometimes driving in the iron plugs as hard as possible with a sledge-hammer: and yet, though they weighed near three pounds, they were always forced out by a sudden expansion of the water in the act of freezing, like a ball impelled by gunpowder, sometimes to the distance of between 400 and 500 feet: and when the plugs were screwed in, or furnished with hooks and barbs, by which to lay hold of the inside of the shell, so that they could not

* Parkes's Chemical Catechism, p. 108.

possibly be forced out; in that case the shell was always split in two, though its thickness of metal was about an inch and three quarters. It is further remarkable, that through the circular crack, round about the shells where they burst, there stood out a thin film or sheet of ice, like a fin; and in the cases where the plugs were projected by freezing water, there suddenly issued from the fusee-hole a bolt of ice of the same diameter, and stood over it sometimes to the height of eight inches and a half. Hence we need not be surprised that excessive frost should cause the ice to split rocks, and other solid substances."*

It was necessary for the preservation of the world, that water should in this instance be subjected to a law different from that of other substances which change from fluid to solid. The wisdom and goodness of the great ARTIFICER of the world will manifest itself in this arrangement, if we consider what would have been the consequences had water been subject to the general law, and like other fluids, become specifically heavier by the loss of its caloric. In winter, when the atmosphere became reduced to 32°, the water on the surface of our rivers would have sunk as it froze; another sheet of water would have frozen immediately, and sunk also; the ultimate consequence of which would have been, that the beds of our rivers would have become repositories of immense masses of ice, which no subsequent summer could unbind; and the world would shortly have been converted into a frozen chaos. How admirable the wisdom, how skilful the contrivance, that by subjecting water to a law contrary to what is observed by other fluids, as it freezes it becomes specifically lighter, and, swimming upon the surface, performs an important service by preserving a vast body of caloric in the *subjacent* fluid from the effects of the surrounding cold, ready to receive its own accustomed quantity on the first change of the atmosphere?†

Owing to the distance of this globe from the sun, and to the vast mountains of ice at the poles, the atmosphere over a large portion of the earth is at times reduced to so low a temperature, that, if it were not for a wise provision of nature, all vegetable life must be destroyed. Caloric has always a tendency to equilibrium; therefore, if the temperature of the air be lowered, the earth cools in proportion: but when the atmosphere is reduced to 23°, the water which it held in solution becomes frozen, and precipitates in the form of snow on the earth, covering it as with a carpet, and thereby preventing the escape of that caloric which is necessary for the preservation of those families of vegetables that depend on it for their support and maturity. Be the air ever so cold, the ground, thus covered, is seldom reduced below 32°, but is maintained equably at that temperature for the purpose above men-

* Haüy's Natural Philosophy, vol. i. pp. 197, 198.
† Parkes's Chemical Catechism, pp. 94, 95.

tioned.* Homer has described a shower of snow, and its extensive effects, in a fine strain of poetry.

"In Winter's bleak uncomfortable reign,
A snowy inundation hides the plain:
Jove stills the winds, and bids the skies to sleep;
Then pours the silent tempest thick and deep:
And first the mountain tops are covered o'er,
Then the green fields, and then the sandy shore;
Bent with the weight the nodding woods are seen,
And one bright waste hides all the works of men:
The circling seas alone, absorbing all,
Drink the dissolving fleeces as they fall."—POPE.

Snow is furnished with the power of absorbing and combining with a large portion of oxygen, which gives it its fertilizing property. The snow melting and penetrating into the softened earth communicates to it oxygen, and this oxygen promotes the germination of seeds. The carbon of the earth combining with the oxygen, is converted into carbonic acid, and thereby acquires more solubility; while the water contributes to excite that activity which had been rendered dormant in the roots by the cold. It is this property of carbon which deprives water of the superabundant oxygen that would render it prejudicial to health, and unfit for the purposes of life. Thus what would otherwise be injurious to us is improved by the ground, and gives at the same time power and activity to the mould. How multiplied are those means which infinite wisdom and goodness employ for the preservation of the productions of Nature !†

Ice at 32° must absorb 140° of caloric before it can become a fluid; or such a quantity as would raise a body of water of equal bulk with itself from 32° to 172°. For instance: "Take any quantity by weight of ice or snow at 32°, and mix it with an equal weight of water heated exactly to 172°. The snow instantly melts, and the temperature of the mixture is still only at *thirty-two* degrees. Here the water is cooled 140°, while the temperature of the snow is not increased at all; so that 140° of caloric have disappeared. They must have combined with the snow; but they have only melted it, without increasing its temperature. Hence it follows irresistibly that ice, when converted into water, absorbs and combines with 140° of caloric. Water then, after being cooled down to 32°, cannot freeze till it has parted with 140° of caloric; and ice, after being heated to 32°, (which is the exact freezing point, cannot melt till it has absorbed 140° more of caloric. This is the cause of the extreme slowness of these operations. There can be no doubt, then, but water owes its fluidity to its latent caloric, and that its caloric of fluidity is 140°.‡ And all this arrangement in nature, connected with the operation of these

* Parkes's Chemical Catechism, p. 92.
† Driessen on the Nature of Snow.
‡ Thomson's Chemistry, vol. i, p. 365.

elements, is immediately under the control and direction of the infinitely wise and almighty Creator of the universe. "He sendeth forth his commandment upon earth: his word runneth very swiftly. 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? He sendeth out his word, and melteth them: he causeth his wind to blow, and the waters flow."

Drops of rain, falling through a cold region of the atmosphere, are frozen and converted into hail; and thus the *hail* is produced by *rain*. When it begins to fall, it is *rain;* when it is falling, it is converted into *hail;* so that it is literally true, that *it rains hail.* The further a hail-stone falls, the larger it generally is; because, in its descent, meeting with innumerable particles of water, they become attached to it, are also frozen, and thus its bulk is continually increasing till it reaches the earth.* A storm of hail fell near Liverpool, in Lancashire, in the year 1795, which greatly damaged the vegetation, broke windows, &c, &c. Many of the stones measured five inches in circumference. Dr. Halley mentions a similar storm of hail in Lancashire, Cheshire, &c, April 29, 1697, that for sixty miles in length, and two miles in breadth, did immense damage, by splitting trees, killing fowls and all small animals, knocking down men and horses, &c, &c. Mezeray, in his History of France, says, that in Italy, in 1510, there was for some time a horrible darkness, thicker than that of night; after which the clouds broke into thunder and lightning, and there fell a shower of hail-stones which destroyed all the beasts, birds, and even fish of the country. It was attended with a strong smell of sulphur, and the stones were of a blueish color, some of them weighing one hundred pounds weight. The Almighty says to Job—"Hast thou seen the treasures of the hail, which I have reserved against the time of trouble, against the day of battle and war." While God has such artillery at his command, how soon may he desolate a country, or a world!†

The aqueous fluid is in continual circulation. The constant *round* which it travels, says Dr. Paley, and by which, (without suffering either adulteration or waste,) it is continually offering itself to the wants of the habitable globe, is much to be admired. From the sea are exhaled, by the heat of the sun, into the air, those vapors which are there condensed into clouds: these clouds are dissolved into rain and dew, or into snow and hail, which are but rain congealed, by the coldness of the air, and descend in showers, which, penetrating into the crevices of the hills, supply the springs: which springs flow in little streams into the valleys;

* "The English word *hail*, in Latin *grando*, in Greek χαλαζα, gives us no information about the nature of the thing: but, if we take the word ברד BeReD in Hebrew, it resolves itself into ב-רד, which signifies *in descensu*, and so describes to us the physiological formation of hail: which, as philosophers agree, is first formed into drops of rain, and, *as it falls*, is frozen into hail." Jones's Letter on the Use of the Hebrew Language.

† Dr. Clarke on Exod. ix, 18.

and there uniting, become rivers, which rivers, in return, feed the ocean. So there is an incessant circulation of the same fluid; and not one drop probably more or less now than there was at the creation. A particle of water takes its departure from the surface of the sea, in order to discharge certain important offices to the earth: and, having executed the service which was assigned to it, returns to the bosom which it left.* Thus, as one of the greatest of naturalists says, "All the rivers run into the sea; yet the sea is not full: unto the place from whence the rivers come, thither they return again."

Water, when taken up by the atmosphere, is not in an aqueous state, but is converted into vapor by the efficiency of heat, and then combines with more than five times the quantity of caloric than is required to bring ice-cold water to a boiling heat, and occupies a space 800 times greater than it does when in the form of water. A large portion of the matter of heat combining chemically with water, renders it specifically *lighter;* which is the cause of its rising and mixing with the atmosphere. The waters on the face of the earth would be dissipated in vapor by a small degree of heat, if we had no atmosphere. Under the pressure of the atmosphere water boils at 212°, but in vacuo it boils when heated only to 67°. On the contrary, if additional pressure be given to water by a Papin's digester, it may be heated to 400°, without producing ebullition. However long we boil a fluid, in an open vessel, we cannot make it in the smallest degree hotter than the boiling point.† When arrived at this point, the vapor absorbs the heat, and carries it off as fast as it is generated. When water is received into the atmosphere, if the air be warm, it becomes so far changed by its union with the matter of heat as to be perfectly invisible. In this state it occupies a space 1,400 times greater than its ordinary liquid state.

After vapor has remained some time in the atmosphere, it

* See Dr. Paley's Natural Theology, p. 407.

† There are hot spouting springs of water in Iceland, of which a traveller says, "Near Laugervatan, a small lake about two days' journey distant from Mount Hecla, we beheld the steam of the hot springs rising in eight different places, one of which continually threw up into the air a column of water from eighteen to twenty-four feet high. The water was extremely hot, so that a piece of mutton and some salmon trouts were almost boiled to pieces in it in six minutes.

At Gyser, not far from Skallholt, one of the Episcopal sees in Iceland, within the circumference of three English miles, forty or fifty boiling springs are seen together; and the largest, which is in the middle, particularly engaged our attention the whole of the day that we spent here. The aperture through which the water arose is nineteen feet in diameter; and round the top is a basin nine feet higher than the conduit. Here the water does not spout continually, but only by intervals several times a day; and, as I was informed by the Icelanders, in wet weather higher than at other times.

On the day we were there the water spouted ten different times, between the hours of six and eleven in the morning, each time to the height of fifty or sixty feet. Before, the water had not risen above the margin of the pipe; but now it began by degrees to fill the upper basin, and at last to run over. Our guides told us that the water would soon spout up much higher than it had done.

Soon after four o'clock we observed that the earth began to tremble in three different places; as well as the top of a mountain which was about three hundred fathoms distant from the mouth of the spring. We also frequently heard a subterraneous noise, like the discharge of a cannon; and immediately afterwards a column of water spouted from the opening, which at a great height divided itself into several rays, and according to our observation was ninety-two feet high. Our great surprise at this uncommon force of the air and fire was increased, when many stones which we had flung into the aperture were thrown up again with the spouting water." *Troil.*

becomes in a measure condensed; and the particles of water of which it is composed unite, and form hollow vesicles, which accumulate together and produce clouds. How this is effected, those who have attentively considered the subject are not agreed. Dr. Thomson, after well investigating the matter, concludes, from all the facts, that "the formation of clouds and rain cannot be accounted for by a single principle with which we are acquainted." It is, however, says Mr. Parkes, probable that *electricity* alone is the primary cause. Saussure conjectures that it is the electrical fluid which surrounds these vesicles, and prevents them from dissolving in the air. And the idea of the formation of clouds by the agency of electricity was mentioned by Volta, and also by Dr. Franklin.

[It is allowed by all, that clouds are formed by the aqueous vapors which are held suspended, or in solution, by the atmosphere. It is not a settled question, whether the air holds these vapors in solution, or merely suspended; and thus, keeping the particles asunder, prevents their condensation.

This aqueous vapor is *invisible* when perfectly in union with the air. When it begins to separate from the air, it becomes visible by condensation, in the form of *clouds*, *mists*, and *fogs*. When it is perfectly separated and sufficiently condensed it becomes *rain*, and when the temperature is sufficiently low to freeze the condensed drops, they become *snow*, or *hail*.

The above process is quite intelligible, but the *agent* of this condensation is, perhaps, inexplicable. It is impossible to solve all the phenomena of the formation of clouds, by supposing the vapors condensed by a reduction of temperature, produced by the warmer volumes of clouds rising into the regions of colder ones. For we know the natural tendency of the warmer strata of air, from the neighborhood of the earth, is to rise, with its watery particles, to colder regions. Hence there would be a constant condensation, which would seem to require a constant deposition of rain, or mist; or, at least, a constant accumulation of clouds.

Again: On this theory, the nights would be cloudy and rainy: as the vapors raised during the day would be condensed by the superior coldness of the night succeeding. Moreover, it is well known that great rains fall in very warm weather, and when a *rise* of temperature is observed.

These, and other considerations, have induced many persons to have recourse to *electricity* to solve this difficult question, and various observations seem to countenance the idea that it may be the remote agent of the formation of clouds, by producing a sudden rarefaction of the air, which would, of course, produce a sudden reduction of temperature; the consequence of which would be a rapid condensation of the watery particles in combination with the air. This condensation would form clouds, and if sufficiently rapid and extensive, a fall of rain would ensue.

This supposition is much strengthened by a fact of common observation, viz: *when clouds are impending over us, but no rain* *falling, a sudden shower comes down instantly upon a flash of lightning.* In this case it is so obvious that the lightning had an immediate agency, that none can doubt, who ever observed the phenomenon.

The *electrified* state of *clouds*, *fogs*, and *mists*, is considered strong proof in favor of this theory. Clouds are almost always highly charged with electricity, and sometimes so highly charged as to become *luminous*, and very destructive.

On the 11th of August, 1772, about midnight, a bright cloud was observed covering a mountain in the district of Cheribon, in the island of Java, at the same time several reports were heard like those of a gun. The people who dwelt upon the upper parts of the mountain not being able to fly fast enough, a great part of the cloud, almost three leagues in circumference, detached itself under them, and was seen at a distance rising and falling like the waves of the sea, and emitting globes of fire so luminous, that the night became as clear as day. The effects of it were astonishing; every thing was destroyed for seven leagues round; the houses were demolished; plantations were buried in the earth, and 2,140 people lost their lives. ***Ency. Brit.*** *Article*, CLOUDS.

In another case, October 29th, 1757, in the island of Malta, a little after midnight, there was seen to the South west of the city Melita, a great black cloud, which, as it approached, changed its color, till at last it became like a flame of fire mixed with smoke. A dreadful noise was heard on its approach, which alarmed the whole city. It passed over the port, and came first on an English ship, which in an instant was torn to pieces, and nothing left but the hulk; part of the masts, sails, and cordage were carried to a considerable distance along with the cloud. The small craft were sunk instantly. It demolished a part of the city, and passed over to Sicily, but did no injury there as it was previously exhausted. Several hundred were killed. ***Ency. Brit.*** *Article*, CLOUD.]

The principle of evaporation is the primary cause of all rain, mist, dew, &c. The ocean loses many millions of gallons of water hourly by evaporation. The Mediterranean alone is said to lose more by it, than it receives from the Nile, the Tiber, the Rhone, the Po, and all the other rivers that fall into it. When Dr. Halley made his celestial observations upon the tops of the mountains at St. Helena, he found that the quantity of vapor which fell there (even when the sky was clear) was so great, that his observations were thereby much impeded: his glasses were so covered with water through the condensation of the vapors, that he was obliged to wipe them every ten minutes. In order to determine, with some degree of accuracy, how much water would be raised in vapor in any space of time, he took a vessel of water salted to the same degree with that of sea-water, in which he placed a thermometer, and by means of a pan of coals brought the water to the same degree of heat as would be produced by the sun in summer: he then affixed the vessel of water with the thermoneter in it, to one end of a pair of scales, and exactly counterpoised it with weights on the other. Then, at the end of two hours, he found by the alteration in the weight of the vessel, that a sixtieth part of an inch in the depth of the water was gone off in vapor; and therefore, in twelve hours, one-tenth of an inch would have gone off. From this experiment the Doctor calculates (in as accurate a manner as the subject will admit of) the quantity of water raised by evaporation from the Mediterranean Sea, to be at least five thousand two hundred and eighty millions of tons of water in a day; and from the river Thames twenty millions three hundred thousand tons per day, on the average.

This water is conveyed by the winds to every part of the continents: these it fertilizes in the form of rain, and afterwards supplies the rivers, which flow again into the sea. In our climate, evaporation is found to be about four times as much from the vernal to the autumnal equinox, as from the autumnal to the vernal. Heat facilitates all solutions; and the greater the difference between the temperature of the air and the evaporating surface, the greater will be the evaporation. Bishop Watson found that, even when there had been no rain for a considerable time, and the earth had been dried by the parching heat of summer, an acre of ground dispersed into the air above 1,600 gallons of water in the space of twelve hours of a summer's day. A little reflection would convince any one of the importance of the principle of evaporation. Innumerable instances of its use might be adduced: suffice to add, that without it neither grass nor corn could be sufficiently void of moisture to lay up for use. Our clothes when washed could not be dried; neither could a variety of the most common operations, which conduce much to our comfort and convenience, be performed without it.

It is evident that water exists in the atmosphere in abundance, even in the driest seasons, and under the clearest sky. By the experiments of Saussure, it appears, that a cubic foot of atmospheric air will hold eleven grains of water in solution. From this property of the air we derive many advantages. It has a tendency to preserve every thing on the face of the earth in a proper degree of moisture. It appears, from the experiments of some aëronauts, that the air is much drier in the higher regions than it is near the surface of the earth.

When two opposite currents of air meet, of different temperatures, the vapors are sometimes condensed thereby, and rain ensues. It may be remarked, that if the temperature of our atmosphere had been 212, or upwards, rain could never have fallen on the earth; for the water taken up by evaporation would have been converted into a *permanently* elastic fluid. Such is the necessity of rain, that it *alone* not only affords a proper degree of moisture to the vegetable creation, but is of service in bringing the soils into a fit state to perform their office. Dry earth of itself is ineffective; but when *moistened* it has the property of decomposing atmospheric air, and of conveying its oxygen to the roots of those plants which vegetate within it. We are indebted to Humboldt for the knowledge of this fact. It is impossible ever to contemplate the various ways in which the different operations of nature are made to correct and balance each other, without being struck with the infinite comprehension of the Divine Mind, which could thus foresee the tendency of every law which it was about to establish. How many cases are there in which the slightest oversight would have produced the destruction of the world!

The effects of vapor have furnished a new moving force to mechanics, says Haüy, which it required no ordinary genius to have created, and to have measured its energy. This science, during a long time, had only employed water as a moving force, by availing itself of its natural course, or by judiciously managing its fall, so as to subject it to the operation of machines which is regulated by an impulsion continually renewed. The experiments made upon the force of water reduced to vapor, gave birth to the idea of applying that vapor so much the more advantageously to the same purpose, because independently of its great energy, it may be transported wherever it is called for by the interests of commerce and industry.

The execution of steam-engines has had, like that of all other machines, its different epochs, to which successively corresponded new degrees of perfection. To diminish, as far as possible, the quantity of vaporisation requisite for the effect in contemplation, and to make a moderate use of the combustible; to combine with this chief economy that of substance and of workmanship, by contracting the dimensions of the pieces without diminishing their utility; to prevent explosions, by the wisest precautions adopted in the management of an agent whose power becomes destructive when it is not limited: these are in general the objects which have fixed the attention of engineers, and have excited among them a laudable kind of rivalship.*

In no invention, either for ingenuity or utility, has modern genius been more conspicuous than in the invention of the steam-engine. The amazing power wielded by man, by this means, is just matter of astonishment and wonder. In no part of the kingdom have these stupendous machines been brought to greater perfection, either in size or principle, than in the mining counties of Cornwall and Devon. The largest ever built has lately been

* Savary, Newcomen, Cawley, Watt, and Boulton, Englishmen; and Betancourt and the brothers Perrier, Frenchmen; are names well known in the history of steam-engines. And those persons who wish to acquaint themselves with the principles and manner of operation of this most important class of machines, says Dr. O. Gregory, may be referred to the following work:—The Repertory of Arts and Manufactures, the Philosophical Journal, and the Philosophical Magazine, in various places; the second volume of Mr. Brewster's edition of Ferguson's Select Lectures, the second volume of Gregory's Mechanics, and the second volume of Prony's treatise entitled Nouvelle Architecture Hydraulique.

erected at Chacewater mine, in the county of Cornwall, by Mr. S. Moyle, of that place, and is for size and efficiency, as well as neatness, without a parallel. This stupendous machine is equal to 1,010 horses; it works day and night in pumping dry a mine of 100 fathoms deep, and of a large extent: and the quantity of water pumped out in one minute, and the column consequently lifted, is greater than any other machine of the kind ever erected. The whole reflects the greatest credit on the abilities of the engineer, and forms an interesting object to all those who are curious in mechanism, or who may visit the mines of Cornwall.*

A very ingenious naturalist suggests the idea, that subterraneous fire, and steam generated from it, are the true and real causes of earthquakes. And he thinks the elasticity of steam and its expansive force, are every way capable of producing the stupendous effects attributed to earthquakes, when it is considered that this expansive force of steam is to that of gunpowder as 140 to 5. He also apprehends that subterraneous fire must, at different times, have existed universally in the bowels of the earth, and that in union with water, or by the expansive power of steam, it has produced the immense continents, as well as the mountains of our globe.† There are, in the Memoirs of the Paris Academy of Sciences for the year 1707, some observations communicated by Vauban, from which it results that 140 pounds of water converted into vapor, would produce an explosion capable of blowing up a mass of 77,000 pounds, while 140 pounds of powder could only produce a similar effect upon a mass of 30,000.

Water would be the purest of all drinks, says Sturm, were it an absolutely simple body; but on the other hand, its medicinal virtue would be reduced to nothing. If we consider the manner in which water nourishes plants, it is easy to presume that it communicates the nutritious juices which it contains, to men and animals in the same way. Water is not very nutritive by itself, but being very subtile, it dissolves the nutritious parts of aliments, is a vehicle for them, and carries them along into the minutest vessels. It is consequently the most wholesome drink; and is essentially necessary to men and animals; and its salutary effects are felt, where all other liquids are found hurtful to health. "The water of Egypt," says the Abbé Mascrier, "is so delicious, that one would not wish the heat to be less, or to be delivered from the sensation of thirst. The Turks find it so exquisite, that they excite themselves to drink of it by eating *salt*. It is a common saying among them, that if Mahomed had drank of it, he would have besought God that he might never die, in order to have had this continual gratification. When the Egyptians undertake the pilgrimage of Mecca, or go out of their country on any other account, they speak

* Plymouth Chronicle.

† Whitehurst's Inquiry into the Original State and Formation of the Earth.

of nothing but the pleasure they shall have, at their return, in drinking of the waters of the Nile. There is no gratification to be compared to this: it surpasses, in their esteem, that of seeing their relations and families. All those who have tasted of this water, allow that they never met with the like in any other place. When a person drinks of it for the first time, he can scarcely be persuaded that it is not a water prepared by art: for it has something in it inexpressibly agreeable and pleasing to the taste; and it should have the same rank among *waters*, that *champaigne* has among *wines*. But its most valuable quality is, that it is exceedingly salutary. It never incommodes, let it be drank in what quantity it may: this is so true, that it is no uncommon thing to see some persons drink three buckets full of it in a day, without the least inconvenience! When I pass such encomiums on the water of Egypt, it is right to observe, that I speak only of that of the *Nile*, which indeed is the only water, drinkable, for their *well-water* is detestable and unwholesome. *Fountains* are so rare, that they are a kind of prodigy in that country; and as to *rain-water*, that is out of the question, as scarcely any falls in Egypt."

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HAVING attended to the situation and properties of water in the world of nature, we shall now show that by this element is represented the blessings of Divine grace in the moral or spiritual world. God is the *fountain of living waters*, ever-living, all-sufficient, and incessantly flowing; like waters, arising and issuing from a spring, which continue during the whole year: not like waters that proceed only from some excess of rain, such as land-floods, or those flowing down from hills, which in the winter season run in torrents, but in the heat of summer are dried up and fail. Such uncertain waters are well expressed by Job—"My brethren have dealt deceitfully as a brook, and as the stream of brooks they pass away; which are blackish by reason of the ice, and wherein the snow is hid: what time they wax warm they vanish: when it is hot they are consumed out of their place. The paths of their way are turned aside; they go to nothing, and perish. The troops of Tema looked, the companies of Sheba waited for them. They are confounded because they had hoped; they came thither, and were ashamed." He alludes to those merchants who travelled in companies or caravans, with beasts of burden, through the deserts of Arabia; who, having in the winter observed and marked out in certain places on the road great pools of water, or copious streams locked up in the valleys by severe frosts; so that, when travelling the same road in summer, they expected finding water there still to refresh themselves and their thirsty camels; but, to their great grief and consternation, instead of pools or brooks of water, found heaps of dry sand, occasioned by intense heat. But God is a fountain which sends forth streams of blessings in all seasons, and never fails. The *living waters* which proceed from him as their fountain, are not stagnant, or dead, but running, like those that issue from springs which are never dry, and possess the most refreshing and invigorating properties.

The element of water is used for washing and purifying the body; so the operation of Divine grace on the soul removes its moral defilement. All the purifications by water under the law, were outward expressions of this inward cleansing. Thus those important words by the prophet Ezekiel, "I will sprinkle clean water upon you, and ye shall be clean; from all your filthiness, and from all your idols, will I cleanse you: a new heart also will I give you, and a new spirit will I put within you." Accordingly the Psalmist says, "Thou shalt wash me, and I shall be whiter than snow." He also prays, "Create in me a clean heart, oh God; and renew a right spirit within me." As purity is necessary for enjoying communion with God in all his instituted ordinances, he says, "I will wash mine hands in innocency: so will I compass thine altar, oh Lord." Similar language is used in the New Testament. Our Lord said to Peter, "If I wash thee not, thou hast no part in me." The apostle Paul, after mentioning several immoral characters to the Christians at Corinth, says, "And such were some of you: but ye are washed, but ye are sanctified, but ye are justified in the name of the Lord Jesus, and by the Spirit of our God."

Our Lord gave himself for us, not only that he might redeem us from all iniquity, but also that he might purify us unto himself a peculiar people. This cleansing, washing, and purifying the soul from sin, is, in the Holy Scripture, attributed to the virtual efficacy of his blood. "The blood of Jesus Christ his Son cleanseth us from all sin." "Unto him that loved us, and washed us from our sins in his own blood." The primary effect of his blood is the expiation of sin; and, as a consequence thereof, the remission of it. "This is my blood which is shed for the remission of sins." "In whom we have redemption through his blood, the forgiveness of sins." Now by the blood of Christ in these places we are to understand his sufferings, which were completed in the shedding of his blood on the cross.

## *Section* II.—The Earth.

Surface of the Earth—Mountains—Fertility of Plants—Dissemination of Seeds—Preservation of Plants—Adaptation to different Climates—Number of vegetables—Succession of vegetables—Remarkable Trees—Sensitive Plants—Kitchen vegetables—Garden flowers—Religious Improvement.

The dry land and the seas constitute what is called the *terraqueous globe;* what proportion the superficies of the sea bears to that of the land, cannot be easily ascertained; but, as one observes, the earth and the water exist in a most judicious proportion to each other. According to the most exact calculations, the surface of the earth is 199,512,595 square miles; and that of the sea is to the land as three to one. There is no certain measurement of the proportion of land and water which the parts within the polar circles contain. The superficies of the sea appearing so large, may lead some persons to suppose, that the proportions between the land and water are not wisely adjusted; and that had there been less sea and more dry land, this would have been more adapted to the accommodation and service of mankind. As such a supposition as this tends to arraign the wisdom of God, so it proceeds from ignorance of natural philosophy. For, as Dr. Keill asserts, "if there were but half the sea that now is, there would be also only half the quantity of vapors; and, consequently, we could have no more than half so many rivers as there now are, to supply not only all the dry land we have at present, but half as much more; for the quantity of vapors which are raised, bears a proportion to the surface whence they are raised, as well as the heat which raised them. The wise Creator so prudently ordered it, that the sea should be large enough to supply vapors sufficient for all the land, which it would not do if it were less than it now is."* The Scriptures speak of God as making all things in number, weight, and measure; as proceeding in his works with the greatest exactness. "He hath measured the waters in the hollow of his hand, and meted out heaven with a span, and comprehended the dust of the earth in a measure, and weighed the mountains in scales, and the hills in a balance." Those who wish to see this further illustrated, would do well to consult Ray's "Wisdom of God manifested in the works of the Creation," and his "Physico-theological Discourses."

The stately mountains, that lift their lofty heads above the clouds, serve for very beneficial purposes. Does the bold atheist call them blemishes, and irregularities in the formation of the earth? Surely he never considered how necessary they are, for arresting the clouds in their flight, and conveying their waters through imperceptible channels, till they meet in some common receptacle, whence they

* Examination of Dr. Burnet's Theory of the Earth, pp. 92, 93.

burst out in springs to fertilize the lower grounds, and afford refreshing streams for man and beast. "This," says Mr. Halley, "seems to be the design of the hills, that their ridges, being placed through the midst of the continents, might serve as it were for alembics, to distil fresh water for the use of man and beast; and that their heights might give a descent to those streams to run gently, like so many veins of the microcosm, to be more beneficial to the creation." They are, says Mr. Ray, "for the generation and maintenance of rivers and fountains, which—on the hypothesis that all proceed from rain water—could not subsist without them, or but rarely. So we should have only torrents, which would fail in summer, or in any dry season, and nothing to trust to, but stagnating water, reserved in pools and cisterns. The great inconvenience resulting from this I need not take pains to show. I say that fountains and rivers would be but rare, were there no mountains. For the whole dry land being but one continued mountain, and ascending all along from the sea to the mid-land, as is undeniably proved by the descent of rivers even in plain countries; the water sinking into the earth, may run under ground, and, according as the vein leads it, break out in the side of this mountain, though the place, as to outward appearance, be a plain. There are huge ridges and extended chains of mountains directed for the most part to run east and west; by which means they give admittance and passage to the vapors, brought in by the winds from the Atlantic and Pacific oceans; but stop and inhibit their excursions to the north and south, either condensing them on their sides into water, by a kind of external distillation; or by straitening and constipating them, compelling them to gather into drops, or descend down in the rain."

After the waters had subsided, the land appeared, dry and fit for vegetation. "And God said, Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself upon the earth: and it was so. And the earth brought forth grass, and herb yielding seed after his kind, and the tree yielding fruit, whose seed was in itself, after his kind." Here we rise to organized and vegetative bodies. At the Divine command, herbs, plants, trees, and all the almost endless varieties of the vegetable world, bearing their several seeds and fruits, according to their different kinds, immediately began to appear. Thus before God formed any living creature to dwell upon the earth, he provided abundantly for its sustenance. "Now as God delights to manifest himself in the little as well as the great," says a celebrated commentator, "he has shown his consummate wisdom in every part of the vegetable creation. Who can account for, or comprehend, the structure of a single tree or plant? The roots, the stem, the woody fibres, the bark, the rind, the air-vessels, the sap-vessels, the leaves, the flowers, and the fruits, are so many mysteries. All the skill, wisdom, and power of men and angels, could not produce a single grain of wheat!"

Dr. Hales, in his Statistical Essays, has observed, that the substances of vegetables appear, by a chemical analysis, to be composed of sulphur, volatile salt, water, and earth, which are all endued with mutually attracting powers; and also of a large portion of air, which has a wonderful power of strongly attracting in a fixed state, or of repelling in an elastic state, with a power which is superior to great compressive forces.* By the infinite combinations, action, and reaction of these principles, all the operations in animal and vegetable bodies are effected. These active aërial principles are very serviceable in carrying on the work of vegetation to its perfection and maturity; not only in helping, by their elasticity, to distend each ductile part, but, also, by enlivening and invigorating their sap, where, mixing with the other mutually attracting principles, they are, by gentle heat and motion, set at liberty to assimilate into the nourishment of the respective parts. The sum of the attracting powers of these mutually acting and re-acting principles, is, while in this nutritive state, superior to their repelling power; by which the work of nutrition is gradually advanced by the nearer and nearer union of these principles from a less to a greater degree of consistency, till they are advanced to that viscid, ductile state, whence the several parts of vegetables are formed; and are, at length, firmly compacted into hard substances, by the flying off of the watery diluting vehicle: but when they are again disunited by the watery particles, their repelling power is thereby become superior to their attracting power, and the union of the parts of vegetables is so thoroughly dissolved, that putrefaction commences.

God has endued the vegetable creation with the astonishing power of multiplying itself by seeds, slips, roots, &c. ad infinitum: it contains in itself all the rudiments of the future plants through their endless generations. The celebrated Linnæus, in an "oration concerning the augmentation of the habitable earth," which proceeds on the supposition of the existence of a sexual system in the vegetable world, shows how from one plant of each species the immense number of individuals now existing might arise. He gives some instances of the surprising fertility of certain plants; as, of the elecampane, one plant of which produced 3,000 seeds; of spelt, 2,000; of the sun-flower, 4,000; of the poppy, 3,200; of tobacco, 40,320: and one grain of Turkey-corn produces 2,000 others! But supposing any annual plant producing yearly only two seeds, even of these, after 20 years, there would be 1,048,576

* The substances of which vegetables are composed, now amount to fifteen in number; but almost the whole of vegetable substances are composed of four ingredients, namely, carbon, hydrogen, oxygen, and azote. Of these, the last, namely, azote, forms but a small proportion even of those vegetable substances of which it is a constituent part, while, into many, it does not enter at all.—Contemplative Philosopher, vol. i. p. 150.

individuals. For they would increase yearly in a double proportion, *viz.* 2, 4, 8, 16, 32, &c. The seed of the *elm*, as a learned author, observes, affords a remarkable instance of the prolific power with which the vegetable creation is endued, to multiply its different species. "This tree produces one thousand five hundred and eighty-four millions of seeds; and each of these seeds has the power of producing the same number. How astonishing is this produce! At first one seed is deposited in the earth; from this one a tree springs, which in the course of its vegetative life produces one thousand five hundred and eighty-four millions of seeds. This is the first generation. The second generation will amount to two trillions, five hundred and ten thousand and fifty-six billions. The third generation will amount to fourteen thousand six hundred and fifty-eight quadrillions, seven hundred and twenty-seven thousand and forty trillions! And the fourth generation from these would amount to fifty one sextillions, four hundred and eighty-one thousand three hundred and eighty-one quintillions, one hundred and twenty-three thousand one hundred and thirty-six quadrillions! Sums too immense for the human mind to conceive; and when we allow the most confined space in which a tree can grow, it appears that the seeds of the third generation from one elm would be many myriads of times more than sufficient to stock the whole superficies of all the planets in the solar system!"

While many plants and trees may be propagated by branches, buds, suckers, and leaves fixed in the ground; so concerning the dissemination of seeds after they come to maturity, the Author of nature has wisely provided in various ways; this being absolutely necessary, since without it no crop could follow. The stalks and stems favor this purpose; for these raise the fruit above the ground, so that the winds, shaking them to and fro, widely disperse the ripe seeds. The pericarpium, a pellicle or thin membrane encompassing the fruit or grain of a plant, is generally shut at the top, that the seeds may not fall before they are shaken out by stormy winds. Wings are given to many seeds, by the help of which they fly far from the mother plant, and frequently spread over a large tract of country. These wings consist either of down, as in most of the composite-flowered plants; or of a membrane, as in birch, alder, ash, &c. Several kinds of fruits are endued with a remarkable elasticity, by the force of which the ripe pericarpies throw the seeds to a great distance; as wood-sorrel, spurge, phyllanthus, and dittany. Other seeds or pericarpies are rough, or provided with hooks, as hounds-tongue, agrimony, &c; so that they are apt to stick to animals which pass by them, and by this means are carried to their holes, where they are both sown and manured. Berries, as well as other pericarpies, are by nature allotted for aliment to animals; but, with this condition, that while they eat the pulp, they shall sow the seeds: for when they feed on it, they either disperse them at the same time, or, if they swallow them, they are returned unhurt. The misleto always grows on other trees, because the thrush eating its seeds, casts them forth with its dung. The cross-bill living on fircones, and the haw-finch feeding on pinecones, sow many of their seeds.

The structure of plants contributes essentially both to their own preservation, and that of others. But the wisdom of the Creator appears very remarkable in the manner of the growth of trees. For as their roots descend deeper than those of other plants, provision is thereby made that they shall not rob them too much of nourishment;* and what is still more, a stem, not above a span in diameter, often shoots its branches very high; these bear perhaps many thousand buds, each of which is a plant, with its leaves, flowers, and stipulæ. Now if all these grew on the plain, they would take up a thousand times as much space as trees do; and, in this case, there would scarcely be room in all the earth for so many plants as at present trees alone afford. Besides, plants that shoot up in this way are more easily preserved from cattle by a natural defence: their leaves also, falling in autumn, cover the plants growing about them against the rigor of the winter; and, in the summer, they afford a pleasing shade, not only to animals, but to plants, against the intense heat of the sun. We may add, that trees, like all other vegetables, imbibe water from the earth: which does not circulate again to the root, but being dispersed like small rain, by the transpiration of the leaves, moistens the plants that grow around. Many plants and shrubs are armed with thorns, as the buckthorn, sloe, carduus, cotton-thistle, &c: these serve to keep off animals, which otherwise would destroy their fruit. At the same time, they cover many other plants, especially of the annual kind, under their branches. Nay it has frequently been observed on commons where furze grows, that wherever a bush was left untouched for some years by the inhabitants a tree has sprung up, being secured by the prickles of that shrub from the bite of cattle. So that while adjacent grounds are robbed of plants by voracious animals, some may be preserved to ripen flowers and

* Of the efficacy of water in vegetation, we have on record some remarkable instances. That vegetables will grow in woollen cloth, moss, and in other insoluble media, besides soils, provided they be supplied with water, has been repeatedly shown since the days of Van Helmont and Boyle: but the experiments of a modern author, says Mr. Parkes, from their apparent correctness, seem more highly interesting and conclusive.

Seeds of plants were sown in pure river-sand, in litharge, in flowers of sulphur, and even among metal, or common leaden shot; and in every instance nothing employed for their nourishment but distilled water. The plants throve, and passed through all the usual gradations of growth to perfect maturity. The author then proceeded to gather the entire produce, the roots, stems, leaves, pods, seeds, &c. These were accurately weighed, dried, and again weighed, then submitted to distillation, incineration, lixivation, and the other ordinary means used in a careful analysis. Thus he obtained from these vegetables all the materials peculiar to each individual species, precisely as if it had been cultivated in a natural soil—viz. the various earths, the alkalies, acids, metals, carbon, sulphur, phosphorus, nitrogen, &c. He concludes this very important paper nearly in these extraordinary words: "Oxygen and hydrogen, with the assistance of solar light, appear to be the only elementary substances employed in the constitution of the whole universe; and Nature, in her simple progress, works the most infinitely diversified effects by the slightest modifications in the means she employs."—See Recherches sur la Force assimilatrice dans les Végétaux, par M. Henri Braconnot, **Annales de Chimie**, Fev. et Mars, 1808.

fruit, and stock the surrounding parts with seeds which otherwise would be quite extirpated. All herbs cover the ground with their leaves, and by their shade hinder it from being totally deprived of that moisture which is necessary to their nourishment. Mosses, which adorn the most barren places, do, at the same time, preserve lesser plants when they begin to shoot, from cold and drought; as is evident in gardens, where plants are preserved in the same way. They also hinder the fermenting earth from forcing the roots of plants upwards in the spring; like what happens annually to trunks of trees, and other things put into the ground. Hence very few mosses grow in warm climates, the same necessity not existing in those places.

The great Author of all things intended that the whole earth should be covered with plants, and that no place should be void or barren. But since all countries have not the same changes of seasons, and every soil is not equally adapted to every plant; therefore, that no place should be without some, he gave to each of them such a nature as might be chiefly accommodated to their own climate: so that some of them can bear intense cold, others an equal degree of heat; some delight in dry ground, others in moist, &c. Hence plants grow where the seasons of the year and the soil are friendly to their constitution. Grasses, the most common of all plants, can bear almost any temperature of air: in this the good providence of the Creator particularly appears; for all over the globe they are necessary for the nourishment of cattle. The same is observed in relation to our most common grains. Thus neither the scorching sun, nor the pinching cold, hinders any country from having vegetables. Nor is there any soil which does not bring forth many kinds of plants. Deserts and sandy places are adorned with trees and plants.

If we connect the vast fecundity of vegetables with their number, how bountiful will the great Author of nature appear! Solomon had a comprehensive knowledge of the different species of plants, for he "spake of trees, from the cedar-tree that is in Lebanon even unto the hyssop that springeth out of the wall;" but his writings on this subject, not being quoted by any ancient author, nor the least fragment remaining, are entirely lost. Theophrastus, a Greek philosopher, who succeeded Aristotle in his school at Athens, where his name became so celebrated that he was attended by two thousand pupils, wrote a work entitled "The History of Plants," in which above 500 different plants are described. Dioscorides, a Grecian by birth, but under the Roman empire, a physician and botanist in the time of Nero, being near 300 years posterior to Theophrastus, describes about 600 plants. Pliny the elder,* in his voluminous work entitled "The History of the

* He was born at Verona of an illustrious family; and at the foot of Vesuvius, while attempting to ascertain the cause of an extraordinary cloud issuing therefrom, was, by the sulphureous exhalation from the burning lava, suffocated, A. D. 79.

World," gives descriptions of above 1,000 different species of plants. Hieronymus Bock, or Bouc, a German, generally known by the name of *Tragus*, in 1532, published a History of Plants, in which he describes 800 species.

From later botanical researches, we learn, that the bountiful Creator has enriched the earth with about 20,000 different species of vegetables. The following statement of the progress of botanical knowledge has recently been given to the public. Messrs. Humboldt and Boupland, the celebrated travellers, have collected in their five years' travels through South America, 3,800 species of plants, of which upwards of 3,000 were new, and absolutely unknown before to the botanists of Europe. We are at present acquainted altogether with 44,000 species of plants; while the whole number mentioned by the Greeks, Romans, and Arabians, does not exceed 1,400. It is worth remarking, that the vegetable productions of the new world seem to have been in an inverse ratio, both in point of number and luxuriance, to those of the animal kingdom. In North America, for instance, the number of lofty trees is far greater than in Europe. In the former country, there are found 137 species of trees, whose trunks exceed the height of 30 feet; while in Europe there are scarcely 45 species. But it is singular there are no firs to be found on any part of the mountains of South America, between the tropics, though they are very abundant in North America. The reason why Magnolias, and other equinoxial plants, appear so far north in America, is, that as far as lat. 48 deg. the summers are 9 degrees (of Fahrenheit) hotter than in the corresponding European latitudes. The winters, however, are more than proportionably colder. At Philadelphia the summer is as hot as at Rome; while the winter corresponds with that of Vienna. At Quebec, the summer is warmer than at Paris; the winter colder than at St. Petersburgh. Beyond Lake Superior, and at Hudson's Bay, it is said that the earth is perpetually frozen at the depth of three feet from the surface, which prevents the inhabitants from digging wells. The same thing happens in Siberia, on the banks of the Lena; while in South America there are cities at a greater height than the highest summit of the Pyrenees, and houses more elevated than the Peak of Teneriffe, the region, in Europe, of perpetual congelation. To this we may add, that Linnæus, the celebrated botanist, divided all plants into classes, the classes into orders, the orders into genera, and the genera into species: and the species, we are told, amount perhaps to 40,000, or 50,000, or more!

The fertility of the earth has been continued from the creation, through every successive period, to the present time. Plants spring up, grow, flourish, ripen their fruit, wither, and at last, having finished their course, die, and return to the dust again, from whence they first took their rise. Thus black mould, which covers the earth, is generally owing to dead vegetables. For all roots descend into the sand by their branches, and after a plant has lost its stem, the root remains; but this too rots at last, and changes into mould. Thus this kind of earth is mixed with sand, by the arrangement of nature, nearly in the same way as dung thrown on fields is wrought into the earth by the industry of the husbandman. But the earth offers again to plants from its bosom what it has thus received. For when seeds are committed to the earth, they draw to themselves, accommodate to their nature, and turn into plants, the more subtile parts of this mould by the co-operation of the sun, air, and rain; so that the tallest tree is, properly speaking, nothing but mould wonderfully compounded with air and water, and modified by a virtue communicated to a small seed by the Creator. From these plants, when they die, just the same kind of mould is formed as gave birth to them originally; whence fertility remains continually uninterrupted. Whereas the earth could not make good its annual consumption, unless it were constantly recruited by new supplies.

That the Author of nature had so constituted the world that none of the elements should be subject to destruction, might have been supposed by the ancients; but, till the present advanced state of the science of chemistry, no proof of this interesting fact could have been adduced. Of the indestructibility of matter it may be remarked, that provision has been made even for the restoration of the fallen leaves of vegetables, which rot on the ground, and, to a careless observer, would appear to be lost for ever. Berthollet has shown by experiment, that whenever the soil becomes charged with such matter, the oxygen of the atmosphere combines with it, and converts it into carbonic acid gas. The consequence of this is, that this same carbon in process of time is absorbed by a new race of vegetables, which it clothes with a new foliage, and which is itself destined to undergo similar putrefaction and renovation to the end of time.

The selection of a few remarkable trees and plants will serve to impress the reader with a sense of the wisdom and power of God, as displayed in the vegetable kingdom. As rivers and brooks are very seldom found in deserts and sandy places, many of the trees growing there distil water; and, by that means, afford great comfort both to man and beast. Thus the *Tillandsia*, which is a parasitical plant, growing on the tops of trees in the deserts of America, has its leaves turned at the base into the shape of a pitcher, with the extremity expanded; in these the rain is collected, and preserved for the use of men, beasts, and birds. The water-tree in Ceylon produces cylindrical bladders, covered with a lid; into these is secreted a most pure and refreshing water. There is a kind of cuckow-pint in New France, of which, if a person break a branch, it will afford him a pint of excellent water. How wise, how beneficial is the adaptation of plants to the inhabitants of those countries where they grow!

On the top of a rock, in one of the Canary Islands, says Glass, in his History, grows the *Fountain Tree*, called, in the language of the ancient inhabitants, *Garse*, (sacred or holy tree,) which for many years has been preserved sound, entire, and fresh. Its leaves constantly distil such a quantity of water as is sufficient to furnish drink to every living creature in Hierro; nature having provided this remedy for the drought of the island. It is situated about a league and a half form the sea. Nobody knows of what species it is, only that it is called *Til*. It is distinct from other trees, and stands by itself. The circumference of its trunk is about twelve spans, the diameter four, and in height from the ground to the top of the highest branch forty spans: the circumference of all the branches together, is one hundred and twenty feet. The branches are thick and extended; the lowest commence an ell from the ground. Its fruit resembles the acorn, and tastes something like the kernel of a pine-apple, but is softer and more aromatic. The leaves of this tree resemble those of the laurel, but are larger, wider, and more curved; they come forth in perpetual succession, so that the tree always remains green. On the north side of the trunk, are two large tanks, or cisterns, of rough stone, or rather one cistern divided, each half being twenty feet square, and sixteen spans in depth. One of these contains water for the drinking of the inhabitants; and the other that which they use for their cattle, washing, and such like purposes. Every morning, near this part of the island, a cloud or mist arises from the sea, which the south and easterly winds force against the fore-mentioned steep cliff, so that the cloud, having no vent but by the gutter, gradually ascends it, and from thence advances slowly to the extremity of the valley, where it is stopped and checked by the front of the rock, which terminates the valley, and then rests upon the thick leaves and wide-spreading branches of the tree, from whence it distils in drops, during the remainder of the day, until it is at length exhausted, in the same manner that we see water drip from the leaves of trees after a heavy shower of rain. This tree yields most water in those years when the Levant or easterly winds have prevailed for a continuance, for by these winds only the clouds or mists are drawn hither from the sea. A person lives on the spot near where this tree grows, who is appointed by the council to take care of it, and its water; and is allowed a house to live in, with a certain salary. He every day distributes to each family of the district, seven pots or vessels full of water, besides what he gives to the principal people in the island.

In Cockburn's Voyages we find the following account of the *Dropping Tree*, near the mountains of Vera Paz, in America. "On the morning of the fourth day we came out on a large plain where were numbers of fine deer, and in the middle stood a tree of an unusual size, spreading its branches over a vast compass of ground. Curiosity led us up to it; we had perceived, at some distance, the ground about it to be wet, at which we began to be somewhat surprised, as well knowing there had no rain fallen for near six months past, according to the certain course of the season in that latitude; that it was impossible to be occasioned by the fall of dew on the tree, we were convinced, by the sun having power to exhale all moisture of that nature a few minutes after his rising. At last, to our great amazement, as well as joy, we saw water dropping, or, as it were, distilling fast from the end of every leaf of this wonderful (nor had it been amiss, if I had said miraculous) tree; at least it was so with respect to us, who had been laboring four days through extreme heat without receiving the least moisture, and were now almost expiring for the want of it. We could not help looking on this as liquor sent from heaven to comfort us under our great extremity. We catched what we could of it in our hands, and drank very plentifully of it, liking it so well, that we could hardly prevail with ourselves to give it over. A matter of this nature could not but excite us to make the strictest observations concerning it; and accordingly we staid under the tree near three hours: we found that we could not clasp its body by five times. We observed the soil where it grew to be very stony; and upon the nicest inquiry we could afterwards make, both of the natives of the country, and the Spanish inhabitants, we could not learn that there was any such tree known throughout New Spain, nor perhaps all America over."

The *Tallow Tree*, mentioned by Du Halde in his History of China, grows in great plenty in that country, producing a substance much like our tallow, and serving for the same purposes. It is about the height of a cherry tree; its leaves are in form of a heart, of a deep shining red color, and its bark very smooth. Its fruit is enclosed in a kind of pod or cover, like a chesnut, and consists of three round white grains, of the size and form of a small nut, each having its peculiar capsule, and within that a little stone. This stone is encompassed with a white pulp, which has all the properties of true tallow, as to consistence, color, and even smell; and accordingly the Chinese make their candles of it, which doubtless would be as good as those in Europe, if they knew how to purify this vegetable as we do the animal tallow, and make their wicks as fine. All the preparation they give it, is to melt it down, and mix a little oil with it, to make it softer and more pliant. It is true, their candles made of it yield a thicker smoke, and give a dimmer light than those of ours; but these defects are owing in a great measure to the wicks, which are not of cotton, but only a little rod or switch of dry light wood, covered with the pith of a rush, wound round it, which, being very porous, serves to filtrate the minute parts of the tallow, attracted by the burning stick, and which by this means is kept burning.

The *Tea Tree* is a native of China, of very slow growth; it has a black, woody, irregular, branched root, and rises to a fathom high, or rather more. Its leaves are very thick set, without any regularity, and are, in substance, like those of the morella cherry tree; but, when young, they resemble, except in color, the spindle tree, with red berries, called *euonymus*. The larger leaves are about two inches long, and one broad. The method of gathering them is one by one, lest they should be torn. The first gathering begins at the middle of the first moon, immediately before the vernal equinox; these leaves are scarcely full opened, being only of two or three days growth; but they are accounted the best, fetch the best price, and are called the flower of the tea; but, by the Chinese, *veui boui*, or bohea tea. The second gathering begins about a month after, and the last gathering is in June; the leaves of the gatherings are sorted into three several classes, according to their size and goodness, and sold accordingly. After the leaves are gathered, they are the same day carried to the work-house, and roasted over a slow fire in an iron pan; and, that they may be thoroughly and equally dried, the roaster keeps them continually stirring with his hands, then takes them out, with a shovel like a fan, and commits them to the rollers, who roll them with the palms of their hands in small parcels, till they are equally cooled, and the sharp yellow and greenish juice is quite discharged. They are then poured upon a mat, and sorted a second time into different classes according to their goodness, and those that are less curled or burnt are taken out.—It is said that the Dutch were the first importers of tea into Europe, about the year 1606, for which they exchanged dried sage with the Chinese: and though the English did certainly about the same time gain a knowledge of this plant, we do not find that the government took any cognizance of it till the Restoration, when in 1660, a duty of eight-pence per gallon was laid on the liquor made, and sold in all coffee-houses.

The *Coffee Tree* is a native of the Indies, grows surprisingly quick, and its body is naturally of an upright form; its leaves are something like those of the common bay, but curl at the end and hang downwards. The blossoms first appear in July, when they show themselves in bunches at the joints, near the ends of the branches; they are much like the flowers of the jessamine, but have the addition of some yellow *apices*, which are loose on the top of the blossom, and a *style* which shoots out near half an inch above it. The fruit appears about October, which hangs on the tree till the next July before it is ripe: it is then gathered and prepared for the market, or for propagating other plants. Coffee is, perhaps, one of the greatest blessings, among those that are not really necessaries of life, that Providence has granted to mankind;

and, considering its beneficial qualities as well as its agreeable properties, it should be ranked among the most elegant plants, in foliage, blossom, and fruit. It is a wholesome, pleasant, and cheap beverage, and of great use in many disorders. The origin of the use of coffee is stated to be as follows. A prior of a monastery in the part of Arabia where this berry grows, having remarked that the goats which eat of it became extremely brisk and alert, resolved to try the experiment on his monks, of whom he so continually complained for their lethargic propensities. The experiment turned out successful; and, it is said, it was owing to this circumstance that the use of this Arabian berry came to be so universal.

The *Banian Tree* is a native of several parts of the East Indies. It has a woody stem, branching to a great height and vast extent, with heart-shaped entire leaves, ending in acute points. Of this tree the following lines of Milton contain a description equally beautiful and just.

> "There soon they chose
> The fig tree; not that tree for fruit renown'd,
> But such as at this day to Indians known
> In Malabar or Decan, spreads her arms,
> Branching so broad and long, that in the ground
> The bended twigs take root and daughters grow
> About the mother tree, a pillar'd shade,
> High over arch'd and echoing walks between;
> There oft the Indian herdsman, shunning heat,
> Shelters in cool, and tends his pasturing herds
> At loop-holes cut through thickest shade."

The banian tree, or Indian fig, is perhaps the most beautiful of nature's productions in that genial climate, where her luxuriance is displayed with the greatest profusion and variety. Some of these trees, as they are continually increasing, and, contrary to most other things in animal and vegetable life, seem to be exempted from decay, grow to an amazing size. Every branch projecting from the main body throws out its own roots, at first in small tender fibres, several yards from the ground; these continually grow thicker till they reach the surface; and there striking in, they increase to large trunks, and become parent trees, shooting out new branches from the top; these at length suspend their roots, which, swelling into trunks, produce other branches: thus continuing in a state of progression as long as the earth, the first parent of them all, contributes her sustenance. The Hindoos are peculiarly fond of this tree; they view it as an emblem of the Deity, from its long duration, outstretching arms, and overshadowing beneficence; they almost pay it divine honors, and

> "Find a fane in every sacred grove."

Near these trees the most esteemed pagodas are generally erected; under their shade the brahmins spend their lives in religious solitude; and the natives of all casts and tribes are fond of recreating in the cool recesses, beautiful walks, and lovely vistas of this umbrageous canopy, impervious to the hottest beams of a tropical sun.

A description of a tree in the island of Java, called the *Upas*, or Poison Tree, is given to the public by a surgeon belonging to the Dutch East India Company, of the name of Foersch, who was stationed at Batavia, in the year 1774. Surprising as this account may be, it is accompanied by so many public facts, and names of persons and places, that it is somewhat difficult to conceive it fabulous. The Upas grows about seven leagues from Batavia, in a plain surrounded by rocky mountains, the whole of which plain, containing a circle of ten or twelve miles round the tree, is totally barren. Nothing that breathes or vegetates can live within its influence. The bird that flies over it drops down dead. The beast that wanders into it expires. The whole dreadful area is covered with sand, over which lie scattered loose flints and whitened bones, Thus,

> "Fierce in dread silence on the blasted heath,
> Fell Upas sits!"

This tree may be called the emperor's great military magazine. In a solution of the poisonous gum which exudes from it, his arrows and offensive weapons are dipped; the procuring, therefore, of this poisonous gum, is a matter of as much attention as of difficulty. Criminals are only employed in this dreadful service. Of these, several every year are sent with a promise of pardon and reward if they procure it. Hooded in leather cases, with glass eyelet-holes, and secured as much as possible from the foul effluvia of the air they are to breathe, they undertake this melancholy journey, travelling always with the wind. About one in ten escapes, and brings away a little box of this direful commodity!

Every one skilled in natural history knows, that the mimosæ, or sensitive plants, close their leaves, and bend their joints, on the least touch. This is truly astonishing: but hitherto no end or design of nature has appeared from these motions; they soon recover themselves, and the leaves are expanded as before. Dionæ Muscipula, or Venus's Fly Trap, is a newly discovered sensitive plant; and shows that nature may have some view towards its nourishment, in forming the upper joint of its leaf like a machine to catch food. Upon the middle of this lies the bait for the unhappy insect that becomes its prey. Many minute red glands, that cover its inner surface, and which, perhaps, discharge some sweet liquor, tempt the poor animal to taste them; and the instant these tender plants are irritated by its feet, the two lobes rise up, grasp it fast, lock the two rows of spines together, and squeeze it to death. Further, lest the strong efforts for life, in the creature thus taken, should serve to disengage it, three small erect spines are fixed near the middle of each lobe among the glands, that effectually put an end to all its struggles. Nor do the lobes ever open again, while the dead animal continues there. But it is nevertheless certain that the plant cannot distinguish between an animal and a mineral substance; for if we introduce a straw, or a pin, between the lobes, it will grasp it full as fast as if it were an insect. This plant grows in America, in wet shady places, and flowers in July and August. The largest leaves are about three inches long, and an inch and a half across the lobes: the glands of those exposed to the sun are of a beautiful red color; but those in the shade are pale, and inclining to green. The roots are squamous, sending forth few fibres, and are perennial. The leaves are numerous, inclining to bend downwards, and are placed in a circular order; they are jointed and succulent; the lower joint, which is a kind of stalk, is flat, longish, two-edged, and inclining to heart-shaped. In some varieties, they are serrated on the edges near the top. The upper joint consists of two lobes, each lobe is of a semi-oval form, with their margins furnished with stiff hairs, like eye-brows, which embrace or lock in each other when they are inwardly irritated. The upper surfaces of these lobes are covered with small red glands, each of which appears, when highly magnified, like a compressed arbutus berry. Among the glands, about the middle of each lobe, are three very small erect spines. When the lobes enclose any substance, they never open again while it continues there. If it can be shoved out, so as not to strain the lobes, they expand again; but if force is used to open them, so strong has nature formed the spring of their fibres, that one of the lobes will generally snap off, rather than yield. The stalk is about six inches high, round, smooth, and without leaves, ending in a spike of flowers. The flowers are milk-white, and stand on foot stalks, at the bottom of which is a little painted bractea, or flower-leaf.

There is not an article in botany more admirable than a contrivance, visible in many plants, to take advantage of good weather, and to protect themselves against bad. They open and close their flowers and leaves in different circumstances; some close before sun-set, some after; some open to receive rain, some close to avoid it. The petals of many flowers expand in the sun; but contract at night, or on the approach of rain. After the seeds are fecundated, the petals no longer contract. All the trefoils may serve as a barometer to the husbandman; they always contract their leaves on an impending storm. Some plants follow the sun, others turn from it. Many plants, on the sun's recess, vary the position of their leaves, which is styled, the *sleep of plants*. A singular plant was lately discovered in Bengal. Its leaves are in continual motion all day long; but when night approaches, they fall down from an erect posture to rest.*

A plant has a power of directing its roots for procuring food.

* The *Tabacum*, or common Tobacco plant, was first discovered in America, by the Spaniards, about the year 1560, and by them imported into Europe. It had been used by the inhabitants of America long before; and was called by the inhabitants of the islands, *yoli*, and by those of the

The red whortle-berry, a low evergreen plant, grows naturally on the tops of our highest hills, among stones and gravel. This shrub was planted in an edging to a rich border, under a fruit wall. In two or three years it over-ran the adjoining deep-laid gravel walk, and seemed to fly from the border, in which not a runner appeared. An effort to come at food, in a bad situation, is extremely remarkable, in the following instance. Among the ruins of New Abbey, formerly a monastery in Galloway, there grows on the top of a wall, a plane tree, about twenty feet high. Straitened for nourishment in that barren situation, it several years ago directed roots down the side of the wall, till they reached the ground ten feet below; and now the nourishment it afforded to those roots during the time of their descending, is amply repaid, having every year, since that time, made vigorous shoots. From the top of the wall to the surface of the earth these roots have not thrown out a single fibre, but are now united in a single root.

Plants, when forced from their natural position, are endowed with the power to restore themselves. A hop-plant, twisting round a stick, directs its course from south to west, as the sun does. Untwist it, and tie it in the opposite direction, it dies. Leave it loose in the wrong direction, it recovers its natural direction in a single night. Twist the branch of a tree, so as to invert its leaves, and fix it in that position, if left in any degree loose, it untwists itself gradually, till the leaves be restored to their natural position. What better can an animal do for its welfare? A root of a tree meeting with a ditch in its progress, is laid open to the air. What follows? It alters its course, like a rational being, dips into the ground, surrounds the ditch, rises on the opposite side to its wonted distance from the surface, and then proceeds in its original direction. Lay a wet sponge near a root laid open to the air; the root will direct its course to the sponge. Change the place of the sponge; the root varies its direction. Thrust a pole into the ground at a moderate distance from a climbing plant; the plant directs its course to the pole, lays hold of it, and rises on it to its natural height. A honeysuckle proceeds in its course till it be too long for supporting its weight; and then strengthens itself by shooting into a spiral. If it meet with another plant of the same kind, they coalesce for mutual support, the one screwing to the

continent, *patur*. It was sent into Spain from Tabaco, a province of Yucatan, where it was first discovered, and from whence it takes its common name. Sir Walter Raleigh is generally said to have been the first that introduced it into England, about the year 1585, in the reign of Queen Elizabeth, and who taught his countrymen how to smoke it. The following anecdote is related of him. He having imitated the Indians in smoking this plant, at length so much delighted in it, that he was unwilling to disuse it on his return to England; and therefore supplied himself with several hogsheads, which he placed in his own study, and generally indulged himself with smoking secretly two or three pipes a day. He had a simple man, who waited at his study door, to bring him up daily a tankard of old ale and nutmeg, and he always laid aside his pipe when he heard him approaching. One day, being earnestly engaged in reading some book which amused him, the man abruptly entered, and, surprised at seeing his master enveloped in smoke, (a sight perfectly new to him) the smoke ascending in thick vapors from his mouth and the bowl of the tobacco-pipe, immediately threw the ale in his master's face, ran down stairs, and alarmed the family with repeated exclamations, that his master was on fire in the inside, and that if they did not make haste, before they could get up stairs, he would be burned to ashes.

right, the other to the left. The claspers of briony shoot into a spiral, and lay hold of whatever comes in their way for support. If, after completing a spiral of three rounds, they meet with nothing, they try again, by altering their course.

By comparing these and other instances of seeming voluntary motion in plants, with that share of life wherewith some of the inferior kind of animals are endowed, we can scarce hesitate at ascribing the superiority to the former: that is, putting sensation out of the question. Muscles, for instance, are fixed to one place as much as plants are; nor have they any power of motion, besides that of opening and shutting their shells; and in this respect, they have no superiority over the motion of the sensitive plant: nor does their action discover more sagacity, or even so much, as the roots of the plane tree, mentioned by Lord Kames.*

Beckmann's History of Inventions and Discoveries presents us with an interesting account of Kitchen Vegetables and Garden Flowers, collected from numerous authorities; some parts of which I shall now transcribe, and incorporate with information derived from other sources.

Our foreign kitchen vegetables have, for the most part, been procured from the southern countries, but chiefly from Italy; and the number of them has rapidly increased, in the course of the last two centuries. Many of them require laborious attention to make them thrive in our climate. On the other hand, some grow so readily, and increase so much without culture, even in the open fields, that they have become like indigenous weeds, as is the case with hops, which at present abound in our hedges. Some plants, however, both indigenous and foreign, which were formerly raised by art and used at the table, are no longer cultivated, because we have become acquainted with others more beneficial.

Among many which were formerly cultivated, but at present are no longer esteemed, are the following. Winter-cresses, *erysimum barbarea;* common alexander, *smyrnium olosatrum,* which in the seventeenth century was used instead of celery; bulbous chærophyllum, the roots of which are still brought to market at Vienna, where they are boiled and eaten as salad. Rampion, *phyteuma spicata,* was formerly used in like manner. The earth nut, the tuberous roots of the *lathyrus tuberosus,* which grows wild in many parts of Germany, is still cultivated in Holland and in some districts on the Rhine. Rocket, *brassica eruca,* in Italian, *ruchette,* the young leaves of which were eaten by our forefathers as salad, and is still retained in Italy. And there are several others either but imperfectly known or little regarded.

Among the kitchen vegetables of which no certain traces are to be found in the works of the ancients, is spinage, *spinacea oleracea.* Its native country is unknown; but the name is new, and

* Taylor on remarkable Trees, Plants, and Shrubs.

certainly derived from the nature of its prickly seeds. As far as I know, it first occurs in the year 1351, among the food used by the monks on fast-days; and at that time it was written *spinagium* or *spinachium*.

The ancients were acquainted with curled cabbages, and even with some of those kinds which we call *broccoli*. Under this term is understood all those species, the numerous young flower heads of which, particularly in spring and autumn, can be used like cauliflowers. The broccoli used at present was however first brought from Italy to France, together with the name, about the end of the sixteenth century.

Our cauliflower, about the same time, was first brought from the Levant to Italy; and in the end of the seventeenth century was transplanted thence to Germany. For a long time the seeds were procured annually from Cyprus, Candia, and Constantinople, by the Venetians and Genoese, who sent them to every part of Europe, because at that time the art of raising seed was not understood. The seeds of cauliflowers were brought from Italy to Antwerp, where no seed was raised, or such only as produced degenerate plants. Prosper Alpinus, in the year 1588, found abundance of this vegetable in Egypt, and from his account there is reason to conjecture it was then very little known in Europe. Conrad Gesner seems not to have been acquainted with it; at any rate it is not mentioned by him in a list of the cabbage kind of plants. Even in the time of Bauhin, it must have belonged to those vegetables which were scarce; because he has been so particular in naming the garden in which he saw it. Von Hohberg, who wrote about 1682, says that cauliflower, a few years before, had been brought to Germany for the first time.—It would be difficult to define all the species of the cabbage kind, the leaves and flowers of which were used by the ancients as food; but it would be a task still more arduous to determine those that have esculent roots.

Potatoes were first imported into Europe, in the year 1565, by Hawkins, from Santa-Fe, New Mexico, Spanish America. They were planted for the first time in Ireland, by Sir Walter Raliegh, who had an estate in that kingdom. The natural history of the potatoe was so little understood, that a total ignorance which part of the plant was the proper food, had nearly ruined any further attention towards its cultivation. For perceiving green apples appear on the stems, these were first supposed to be the fruit; but on being boiled, and finding them unpalatable, or rather nauseous, Raliegh was disgusted with his acquisition, nor thought any more of cultivating this plant. Accident, however, discovered the real fruit, owing to the ground being turned over, through necessity, that very season; and to his surprise, a plentiful crop was found under ground, which being boiled, proved nourishing to the stomach, and grateful to the taste. On its utility being known, its cultivation became general through Ireland. It found its way to this kingdom, and was first planted on the western coast, in consequence of a vessel containing some potatoes, being wrecked at the village of Formby, in Lancashire ; a place still famed for this excellent vegetable.

Asparagus was first planted in England in the year 1662, in the reign of Charles II. Artichokes were first introduced about the same time. Cos lettuces were originally brought from the island of Cos, near Rhodes, in the Mediterranean. Turnips were brought into this country from Hanover. In the time of Henry VIII, several kinds of fruits and plants were cultivated in England, as apricots, and a fine gooseberry from Flanders ; also salads, carrots, and other edible roots. These vegetables were before this period imported from Holland and Flanders. So that Queen Catherine, to procure a salad, had to dispatch a messenger to fetch it from those countries. Fruit seems to have been scarce in the time of Henry VII. In an original manuscript, signed by himself, and kept in the Remembrance office, it appears that apples were not less than one or two shillings each, and that a red one cost two shillings. The great plenty and variety of vegetables displayed upon modern tables, through every month in the year, evidently shows what superior blessings we enjoy, in this respect, compared with those of our forefathers.

Some of the flowers introduced into our gardens, and now cultivated either on account of their beauty, or the pleasantness of their smell, have been procured from plants which grew wild, and which have been changed, or, according to the opinion of florists, improved by the art of the gardener. The greater part of them however came originally from distant countries, where they grow in as great perfection as ours, without the assistance of man. It is probable that the modern taste for flowers came from Persia to Constantinople, and was imported thence to Europe for the first time, in the sixteenth century. At any rate, many of the productions of our flower-gardens were conveyed to us by that channel. Clusius and his friends, in particular, contributed very much to excite this taste ; and the new plants brought from both the Indies by travellers who frequently visited these countries, tended to increase it. That period also produced some skilful gardeners, who carried on a considerable trade in the roots and seeds of flowers ; and these likewise assisted to render it more general. Among these were John and Vespasian Robin, gardeners to Henry IV, of France, and Emanuel Sweert, gardener to the emperor Rodolphus II, from whom the botanists of that time procured many rarities, as appears from different passages of their works.

Simon de Tovar, a Spanish physician, brought the tuberose to Europe before the year 1594 from the East Indies, where it grows wild in Java and Ceylon, and sent some roots of it to Barnard Paludanus, who first made this flower publicly known, in his annotations on Linschoten's voyage. The full tuberoses were first procured from seed by one Le Cour, at Leyden, who kept them scarce for some years, by destroying the roots. The propagation of them in most countries is attended with difficulties; but in Italy, Sicily, and Spain, it requires no trouble; and at present the Genoese send a great many roots to England, Holland, and Germany. The oldest botanists classed them among the hyacinths, and their modern name *polianthes tuberose* was given them by Linnæus in his Hortus Cliffortianus.

The auricula, *primula auricula*, grows wild among the long moss covered with snow, on the confines of Switzerland and Steyermark, whence it was brought to our gardens, where, by art and accident, it has produced more varieties than any other species of flower. I do not know who first transplanted it from its native soil. Pluche says only that some roots were pulled up by Walloon merchants, and carried to Brussels. However, this is certain, that it was first cultivated with care by the Flemings, who were very successful in propagating it. In the time of Clusius, most of the varieties of the auricula were scarce.

The common fritillary, or chequered lily, *fritillaria meleagris*, was first observed in some parts of France, Hungary, Italy, and other warm countries, and introduced into gardens about the middle of the sixteenth century. At first it was called *lilium variegatum;* but Noel Capperon, an apothecary at Orleans, who collected a great many scarce plants, gave it the name of *fritillaria*, because the red or reddish-brown spots of the flower form regular squares. It was first called *meleagris* by Dodonæus, because the feathers of that fowl are variegated almost in the same manner.

The roots of the magnificent crown imperial, *fritillaria imperialis*, were about the middle of the sixteenth century brought from Persia to Constantinople, and were carried thence to the Emperor's garden at Vienna, from which they were dispersed all over Europe. This flower was first known by the Persian name *tusac*, until the Italians gave it that of *corona imperialis*, or crown imperial. It has been imagined that the figure of it is to be found represented on the coins of Herod, and that, on this account, it has been considered as the lily so much celebrated in the Scripture.

The Persian lily, *fritillaria Persica*, which is nearly related to it, was made known almost about the same time. The bulbs or roots were brought from Susa to Constantinople, and for that reason it was formerly called *lilium Susianum*.

African and French marigolds, *tagetes erecta* and *patula*, are indigenous in South America, and were known to botanists under the name of *caryophillus Indicus*, from which is derived the

French appellation *œillet d' Inde*. Cordus calls them, from their native country, *tanacetum Peruvianum*.

Among the most beautiful ornaments of our gardens, is the bella-donna lily, *amaryllis formosissima*, the flower of which, composed of six petals, is of a deep red color, and in a strong light, or when the sun shines upon it, has an agreeable yellow lustre like gold. The first roots of it ever seen in Europe were procured in 1593, on board a ship which had returned from South America, by Simon de Tovar, a physician at Seville. In the year following, he sent a description of this flower to Clusius; and as he had at the same time transmitted some roots to Bernard Paludanus, and count d'Aremberg, the former sent a dried flower, and the latter an accurate drawing of it, to Clusius, who published it in 1601. One of the Robins gave, in 1608, a larger and more correct figure, which was afterwards copied by Bry, Parkinson, and Rudbeck; but a complete description, with a good engraving, was published in 1742, by Linnæus, who in 1737 gave to that genus the name by which they are known at present. Tovar received it from South America, where it was found by Plumier and Barrere, and at a later period by Thiery de Menonville. At first it was classed with the narcissus, and it was afterwards called *lilio-narcissus*, because its flower resembled that of the lily, and its roots those of the narcissus. It was named *flos-Jacobæus*, because some imagined that they discovered in it a likeness to the badge of the knights of the order of St. James in Spain, whose founder, in the fourteenth century, could not indeed have been acquainted with this beautiful amaryllis.

Another species of this genus is the Guernsey lily, *amaryllis Sarniensis*, which in the magnificence of its flower is not inferior to the former. This plant was brought from Japan, where it was found by Kæmpfer, and also by Thunberg, during his travels some years ago in that country. It was first cultivated in the beginning of the seventeenth century, in the garden of John Morin, at Paris, where it flowered, for the first time, on the 7th of October, 1634. It was then made known by Jacob Cornutus, under the name of *narcissus Japonicus flore rutilo*. After this it was again noticed by John Ray, an Englishman, in 1665, who called it the *Guernsey lily*, which name it still very properly bears. A ship returning from Japan was wrecked on the coast of Guernsey, and a number of the bulbs of this plant, which were on board, being cast on shore, took root in that sandy soil. As they soon increased, and produced beautiful flowers, they were observed by the inhabitants, and engaged the attention of Mr. Hatton, the governor's son, whose botanical knowledge is highly spoken of by Ray, and who sent roots of them to several of his friends who were fond of cultivating curious plants. Of this elegant flower Dr. Douglass gave a description and figure in a small treatise published in 1725, which is quoted by Linnæus in his Bibliotheca, but not by Haller.

Of the numerous genus of the ranunculus, florists, to speak in a botanical sense, have obtained a thousand different kinds; for, according to the manner in which they are distinguished by gardeners, the varieties increase almost every summer.

The principal part of them, however, and those most esteemed, were brought to us from the Levant. Some were carried from that part of the world so early as in the time of the crusades; but most of them have been introduced into Europe from Constantinople since the end of the sixteenth century, particularly the Persian ranunculus, the varieties of which, if I am not mistaken, hold at present the first rank. Clusius describes both the single and the full flowers as new rarities. This flower was in the highest repute during the time of Mahomet IV. His Grand Vizir, Cara Mustapha, well known by his hatred against the Christians and the siege of Vienna, in 1683, wishing to turn the Sultan's thoughts to some milder amusement than that of the chase, for which he had a strong passion, diverted his attention to flowers; and, as he remarked that the Emperor preferred the ranunculus to all others, he wrote to the different Pachas throughout the whole kingdom to send him seeds or roots of the most beautiful kinds. The Pachas of Candia, Cyprus, Aleppo, and Rhodes, paid most regard to this request; and the elegant flowers which they transmitted to court were shut up in the seraglio as unfortunate offerings to the voluptuousness of the Sultan, till some of them, by the force of money, were at length freed from their imprisonment. The ambassadors from the European courts, in particular, made it their business to procure roots of as many kinds as they could, which they sent to their different sovereigns. Marseilles, which at that period carried on the greatest trade to the Levant, received on this account these flowers very early; and a person there, of the name of Malaval is said to have contributed very much to disperse them all over Europe.

Some of our most common flowering shrubs have been long introduced into the gardens: the bay-tree has been cultivated more than two centuries; it is mentioned by Tusser, in the list of garden plants inserted in his work called, "Five Hundred Points of Good Husbandry," printed in 1573. The laurel was introduced by Cole, a merchant at Hampstead, some years before 1629, when Parkinson published his Paradisus Terrestris, and at that time we had in our gardens oranges, myrtles of three sorts, lauristinus, cypress, phyllyrea, alaternus, arbuttus; a cactus, brought from Bermuda, and the passion-flower, which last had flowered here, and showed a remarkable peculiarity, by rising from the ground near a month sooner, if a seedling plant, than if it grew from roots brought from Virginia.

### *Crust of the Earth.*

[In the preceding section the Author has noticed the *superficies* of the earth principally; as its inequalities because of seas, lakes, rivers, mountains, vallies, &c. The *rocky*, and *earthy* masses and strata, which cover the nucleus of our globe, are scarcely mentioned at all. Whether the *central* parts of the earth be solid, soft, or hollow, and filled with gaseous matter, is not the subject of enquiry here: but the *composition* and *arrangement* of the *solid crust* of the planet come under consideration.

As it regards the composition of the crust of the earth considered principally, it consists of *metallic oxides.* The bases of the different earths are well known to be *metals.* The metal called ***Silicon***, is the base of silex or flint—***Aluminum*** is the metallic base of pure clay—***Calcium***, of lime—***Magnesium***, of magnesia—***Potasium***, of potash, &c. Iron, also, enters largely into the composition; and soda, whose metallic base is *sodium*, forms a considerable portion.

These bases, at their creation, existed in an *uncombined* state, as did all the elementary substances. When they entered into combination with *oxygen* they became *earths*, which are simple metallic oxides, which readily combine with the *acids*, in which combination they are generally seen, though not always, at the earth's surface; as carbonate of lime, or common limestone; the composition of which is *calcium*, *oxygen*, and *carbonic acid.*

Rocks of the *silicious* family are not considered *earthy salts*, though, occasionally, they may contain a small per cent. of acid. They are called *earthy compounds.* ***Granite*** is an instance; composed of *feldspar*, *quartz*, and *mica.* Gneiss, and mica slate are of similar composition, though in different proportions, and under different arrangements.

It will readily occur to the reader that there are some other earths, and other substances also, as the acids, and gases, which enter into the composition of the earth's crust, though in small proportions, and, therefore, are not considered *principal* ingredients, and hence not noticed in this general sketch.

The rocky, or stony substances, composed of the above elements, under the influence of chemical affinities, and other principles, are found in *crystalline*, *stratified*, *amorphous*, and *aggregate masses.* The *position*, *structure*, and *contents* of these masses will develope the *natural history of the solid crust of our Earth.*

In order to facilitate this development, the rocks have been divided, according to their age into,

1. ***Primitive Rocks.*** These were deposited *first*, as is evident from their position, being the lowest of all the rocks. Their name indicates their relative age.

2. ***Transition Rocks.*** These rocks are deposited immediately above the primitive, of course subsequently to them. They are called *transition* rocks, because they were deposited as the earth was *passing* from an uninhabitable to a habitable state, as is evident from the fact that ***they contain the first traces of organized being imbedded in them.***

3. *Secondary Rocks.* These are deposited next in succession to the transition rocks, and mark a *third* grand geological epoch, by being almost altogether a *mechanical* deposition, and lie *horizontally* when *in situ*, and contain an increase of organic remains, both in quantity and variety.

4. *Tertiary Rocks.* These derive their name from their succession to the secondary, and of course mark the *fourth* geological epoch in the history of the arrangement of the earth's crust, which completed its redemptiom from the abyss of waters, and fitted it for the habitation of man.

This division of the rocks designates the *order of time* in which they were successively deposited, as is evident from their position.

Considering these rocks *in situ*, they may be reckoned *general formations*, extended all around the globe in concentric circles, as the coats of an onion around its centre, in the order above stated, beginning with the primitive rocks.

It is, however, well known that *fractures* and *dislocations* prevail to a great extent, the result of violence subsequently to the deposition of these rocks, removing large portions of them *out of place.* But this circumstance need not interrupt the grand *natural* order of the construction of the earth's crust.

There is also a class of stony substances which follow no general laws, either in regard to *position*, *form*, or *age*. These are volcanic and igneous productions of every kind; as basalt, lava, &c. These shall be mentioned subsequently.

In the above remarks we have an *outline* of the structure of the crust of the earth; but in order to have a more satisfactory development, the principal and distinctive features of the leading rock formations must be stated in order.

### *Primitive Rocks.*

1. *This class occupies the lowest position as a class*, yet the individual rocks of this class have a general order of position among themselves. Granite is lowest; then Gneiss—Mica Slate—Clay Slate—Primitive Limestone—Porphyry—Sienite—and Greenstone.

*These rocks are sometimes observed alternating with each other, and sometimes passing into each other.* But these circumstances do not effect the general order. When the formations are *undisturbed*, in penetrating them we should come to granite last; and it is universally the lowest of all observed rock formations.

2. *This class is generally, indeed we may say, universally, crystalline in its structure.* Each integrant particle is not a *perfect crystal;* but throughout the mass there is a partial crystallization, such as would be the result of an effort to crystallize perfectly, under a great pressure; in which case the particles would mutually interfere with each other.

The very fact of this crystallization implies *first;* a prevailing state of *unagitated solution* of the crystallizing materials: *secondly:* that their crystallization was the effect of *chemical action.*

3. *The primitive rocks contain no fragments, either angular, or rounded by attrition, imbedded in them;* simply because no rocks

preceded them, and of course could not be broken up. It is, however, to be carefully observed, that perfect crystals of different kinds are found imbedded in primitive rocks. When they prevail to a great extent they constitute *porphyritic rocks.* It is evident that these crystals must have been formed before the consolidation of the including rock, and must have been suspended in the solution which formed the rock upon crystallization.

4. *The primitive rocks contain no traces of organized bodies.* This is an universal characteristic, and proves incontestibly that they were formed *previous to the existence of organized beings.*

5. *The primitive rocks are usually inclined at a high angle to the horizon, and frequently are vertical.* This seems to be the result of crystallization, as mechanical deposition would place them *horizontally*, having the general bearing of the curve of the earth.

6. The principal primitive rocks are granite, gneiss, and mica slate.

They are composed of the same materials, in different proportions; viz; feldspar, quartz, and mica. These three minerals constitute granite, when feldspar is the *base*, and the quartz is embedded in a crystalline state, and the mica interspersed generally. They constitute gneiss, when the feldspar *decreases*, and the mica *increases*, and is arranged in layers. They compose mica slate, when the feldspar almost *disappears*, and the mica and quartz are intimately united.

7. Though the primitive rocks occupy the lowest position *in situ*, yet they sometimes form, not only the *summits* of lofty mountains, but sometimes the *mountain mass* itself, and appear at the surface. In these cases it is evident that they have been *upheaved* by a force acting beneath, and forcing them through the superincumbent rocks, which were rent, and glided down the sides of the rising mass of primitive rocks, leaving them bare and visible at the summit. In this case the rocks which were uppermost before the mountain mass began to rise, would be found at the *foot* of the mountain; and the rocks which were next to the uppermost, would be found immediately above them, reclining on the side of the mountain; and thus *ascending through the ages of the rocks to the summit of the mountain, where we find the primitive rock formations constituting its apex.*

This phenomena of primitive rocks forming the apices of mountains may be explained differently. The primitive rocks, and other classes in succession, *may have been deposited in mountain masses*, and the upper rocks being *softer* and more *exposed*, have yielded to the ravages of the elements, and to the demolishing force of the deluge, and thus laid the primitive rocks bare. The *first* seems to be the most probable supposition.

8. It is beyond a doubt, that in some instances, an upheaving force has operated, and elevated the granitic summits of mountains; and so powerful was the upheaving force that the blocks of granite have broke at the apex of the elevation, and some of them hang over perpendicularly in awful grandeur; and others have rolled down the sides far into the plains below.

This theory of the formations of some of the principal mountains would be firmly established in every mind, if every one could have an opportunity of inspecting them without prejudice. The primitive rocks would be seen shooting up from the centre of the mountain, into lofty pyramidal elevations, resembling, sometimes, lofty spires, or cupolas; and sometimes the summit is rounded off as a dome. The rocks are in a *verticle* position, which proves they could not have been *deposited there* from a state of quiet repose.

Sometimes two summits project from the same common base, having an intervening valley or depression between them. In this case, the rocks which lay uppermost before the mass was upheaved, upon upheaving, broke and glided down the sides, on which they depend in magnificent drapery; but the portion of them which was situated *between* the uprising summits, not being able to escape, is found in the valley which is formed between the peaks.

In some instances, as the mass is elevating itself it bears up upon it a large mass of the over-laying rock, which forms the apex of the mountain, crowning it as a stately castle crowns the summit of the hill on which it is built. In this case the crowning mass is entirely different, and perfectly distinct from the subjacent materials. *For some further remarks on the structure, and formation of mountains, and mountain masses, and the deluge, see Theory of the Earth, end of Sect. 2, chap.* iv.

9. As there was a rapid and irresistible chemical action, at a very high temperature, going on during this first great geological period, and the whole globe in almost omnipotent fermentation, there is no difficulty in accounting for the irregularities, contortions, dislocations and fractures which we observe in the earth. This whole process was anterior to the existence of organized being.

*Transition Rocks.*

1. *This class was deposited subsequently to the primitive rocks, and after they had consolidated.* This is evident from the fact that, in their natural order, they *overlay* the primitive, which could not be the case, unless they were deposited subsequently, any more than the roof of the house could be put on before the foundation was laid.

2. *Their structure is evidently the result both of chemical action, and mechanical deposition.* These principles appear to have acted sometimes conjointly; and at other times to have alternated. Hence the crystallization is more imperfect than in the primitive, and occasionally seems to disappear.

3. *From the complex action under which they were deposited, they are generally, neither verticle nor horizontal, but inclined about between these two positions.*

4. *They were deposited as the primitive chaotic ocean was subsiding, and the elevations of the new-born earth had recently emerged.* Hence they are found next to the summits of the primitive mountains, *on their flanks.*

5. *The transition rocks contain some fragments of all the primitive class.* This would be the natural consequence of the summits of primitive rock formations being exposed to the fury of the elements; which would rend portions of them, and thus deposit the fragments mechanically in the floods subsiding below on the flanks of the mountains.

6. *In these rocks we meet with the first traces of organized being.* (SILLIMAN.) This fact is irresistible proof that these rocks were deposited *subsequently* to the existence of the enclosed remains. The probability is, that the animals and vegetables found in transition rocks, were created at the *commencement* of the transition period, and their remains deposited as the rocks were successively deposited.

It is remarkable that these organized beings belonged to genera now extinct. They were of an inferior class, having neither the delicacy, complexity, or sensibility of those which we now see. They were crude, and gross, corresponding to the condition of the earth at the time of their existence.

It is also evident that they lived, and died, and were inhumed in the same places; as they present, generally, no marks of violence, and their most delicate parts are well preserved.

These organic remains occupy vast districts of country, and constitute, principally, large masses of marbles, sometimes many hundreds of feet in the interior of mountains. They are identified with the rock, and frequently impart to it its beauty.

7. The reader will readily perceive that this class of rocks marks the *commencement* of *sensitive* existence. And it would seem, from an examination of fossil remains generally, that the creation of animals and vegetables was *progressive*, produced with structures and functions adapted to the condition of the globe, at the time of their creation.

### *Secondary Rocks.*

1. *These rocks are so called, because they are the second great deposit, after the grand foundation of the primitive rocks were laid.* Of course they point out the *third* great geological period.

2. *Their position is horizontal, corresponding to the general curve of the earth.* This regards their natural position. They are found, under particular circumstances, inclined to the horizon. They occupy a lower position on the sides of mountains, resting on the transition class, which is immediately subjacent *in natural order.*

3. *This class is much less chemical, indeed very little so, in its structure.* It is the result of mechanical deposition, after the chemical action had nearly ceased in the great primitive and retiring abyss.

4. *These rocks abound more in fragments of other rocks, and in the remains of organized beings, than the preceding class.* This would be natural, as a greater extent of the earth's surface would be exposed to the elements, and thus the destruction would be greater: and as the condition of the earth was better for sustaining sensitive beings, these would of course be more abundant both in *kind* and *number.*

It is also well ascertained, from the fossil remains found in this class of rocks, that during their deposition, there existed many species of animals and plants which do not now exist: that many of the animals were *monsters* of incredible size and voracity; of such hugeness, grossness, and ferocity as were suitable to the then prevailing condition of the earth.

The researches of the last ten or fifteen years, in England, have brought to light the skeletons of animals, approaching the *lizard* *genus,* from *sixty to seventy feet long!!* They are abundant in England, and occasionally found on the continent. Who can say, but that the other genera of animals then existing, were also as much more vast, and misshapen than their present existing types? A single glance at the *geological reminiscences* of this ancient period must convince any observer, that the vegetable, and specially the animal genera then existing were really astonishing both in *size, shape,* and *nature.*

It becomes a question of some interest, whether these huge animals ceased to exist, having found their graves in this secondary class of rocks, before the existence of man?

There are many reasons which induce a supposition they did cease to exist. Man could scarcely have been safe in the land of these wonderful creatures. Moreover, it is probable their constitutions were adapted to the condition of the world at this period, which we suppose to have been more gross in its air, and water, and more ardent in its climate; as it had not yet settled, and dried; and the waters had not yet sufficiently subsided, to render the earth the abode of the more delicate land-animals, birds, and specially man. It is probable the earth was marshy, with numerous inland lakes, to a considerable extent; the waters still somewhat turbid; the air gross and moist; and the temperature still very high. Such a state of the planet would suit the constitutions of such monsters as the *ichthyosaurus,* and *plesiosaurus,* which would perish as the condition of the globe became more pure, and its temperature reduced.

### *Tertiary Rocks.*

1. *These rocks were deposited as the earth was actually, and finally redeemed from water, and became fit for the abode of the more delicate and gentle land-animals and birds.* Hence, it is very rare, if ever, the fossil remains of animals which live wholly on land, are found below this class of rocks. But man's companion animals are found, as elephants, deer, horse, sheep, &c.

2. This class is not so extensively spread as the preceding classes. It includes the *diluvial* and *alluvial* formations, and indicate an alternation of fresh and sea waters in its deposition. This class covers the low countries as they slope from primitive districts towards the sea. Such grand vallies are called *diluvial,* because deposited chiefly by the great primitive ocean, as it retired through its last stages to its resting beds. The deposites at the mouths of rivers, or any other deposites from causes now in operation, are called *alluvial.*

3. Some of the principal members of this class are: 1. Argillaceous, and sandy depositions from the sea. 2. Marl, and gypsum, from fresh water. 3. Sand, and sandstone, with or without shells, from sea water. 4. Limestone, and silicious millstone grit, from fresh water.

### *Conclusion.*

From what has been said above we may clearly deduce the following particulars.

1. The crust of the earth is constructed of four great general classes of rocks; the *primitive* at the foundation; the *transition,* lay-

ing immediately over the primitive; the *secondary* immediately above these; and the *tertiary* at the surface. In this arrangement we consider the rocks in their natural position.

2. The *position*, *structure*, and *organic remains* of these classes, clearly point out a grand geological epoch, corresponding to the time of the deposition of each class, and thus indicate their relative ages. They indicate also the successive conditions of the globe as it passed from its gross chaotic state, to a state suitable for the habitation of man, and his companion animals.

3. *The natural history of the* PRIMITIVE WORLD, *as deduced from* GEOLOGICAL FACTS, CORRESPONDS *expressly in the* ORDER *and* NATURE OF THE EVENTS, WITH THE ACCOUNT GIVEN BY MOSES.

4. The gradual retiring of the primitive chaotic ocean, would give sufficient time for the production of those immense beds of marine animals which are found in the most solid and elevated mountains. During the prevalence of the sea, these beds would form at the bottom, and when it retired they would consolidate, with the mineral deposites, into rocks.

In this case the process is supposed to go on in a *quiet* ocean, peaceably retiring,, and leaving the deposition in layers. But we must not suppose the waters were always still, and peacefully retiring. If so, there could not have been such distinct and different deposites, in which different substances sometimes alternate. Moreover, in this case there would have been but one deposition, which would have been regular and continuous, changing its character simply by almost imperceptible degrees, and extending all round the globe, as the globe was at first wholly immersed in water. But this is not the case. There is every reason to believe there were violent agitations, earthquakes, volcanos, tempests, deluges, &c, *occasionally*, during the subsidence of the primitive waters. Hence the *dislocations*, *contortions*, *protrusions of lower rocks through upper ones*, and the *upheaving of the bottom of the seas in various places into ridges, and mountains*, producing a tremendous *deflux of waters* frequently, which would wash out channels and vallies, and carry off fragments of rocks, &c, into the waters below.

Hence it is evident that the elevations on the earth's surface have been *partly* caused by subterranean force upheaving them; and *partly* by currents of water wearing away channels, defiles, vallies, &c.

The natural result of upheaving, *in mass*, the bed of the ocean, would be to protrude a body in which were embedded the marine exuviæ throughout the whole depth of the marine deposites. Hence mountain masses are sometimes composed of limestone, in which are found immense quantities of sea shells, throughout the mass, and entering intimately into the composition of the rock. This, without doubt, is the true origin of these marine mountain remains.

Some have been disposed to attribute them to the *deluge* in the days of Noah; but this is impossible for two reasons. 1. The deluge did not continue a sufficient length of time to allow these animals to be produced in such quantities, or to bury them so deeply in the earth. 2. The *rising* waters could not have carried them to their present places; because, in that case they would be found at the *surface* of the earth, or near it *exclusively;* whereas they are found buried thousands of feet in mountains, and embedded in solid rocks. They could not have been *transported* by the waters, because they would have suffered violence, and been fractured, and compressed; which is not generally the case. They are found perfectly preserved, though of such delicate structure as would seem to have been destroyed by the least violence. Hence it is evident they are buried where they lived and died in perfect tranquillity.

It is true, there are instances in which the *position* and *nature* of the animals clearly prove that they were inhumed by some *sudden* catastrophe. For instance: when we see the fossil remains of delicate, and very active fish so placed as to indicate they were *caught*, we are convinced they perished *suddenly*. But this case is always *local*, and may have been produced by an earthquake, or volcanic action.

That the primitive chaotic ocean occupied the earth a long time, *generally* in a state of tranquillity, though occasionally, strongly agitated, and rising into overwhelming deluges and gradually retired, is evident also, from the fact, that the most delicate *plants, leaves,* and *flowers* are found inhumed, as the marine animals above, *in a state of perfect preservation.*

All the above phenomena took place prior to the creation of man.

*Appendix.*

There is another class of rocky substances which obey no settled laws, and, therefore, are noticed here in an appendix: *They are rocks and substances of evident igneous origin:* as *basalt, obsidium, lavas of all textures,* and *trap* rocks *frequently,* perhaps generally. These have one common origin: they are also of similar composition generally; and in this approach the composition of primitive rocks. They have been evidently *ejected from the bowels of the earth in a melted state.* They are found in almost all countries; and in some cases form mountains, and cover the surfaces of large districts to an astonishing depth: as in the north of Ireland, more than 500 feet thick, and over an area of 800 square miles. (URE.)

Being *protruded* from beneath in a melted state they are found injected through the superincumbent rocks in *shafts* or *veins* of various sizes, from several inches to several feet. Sometimes being unable to rend the solid rocks above they are injected *between their strata.* They are generally somewhat crystalline in structure, because deposited on the same principles as granite, when undisturbed. From their *position, superficial extent,* and *quantity,* we infer they are the products of all ages, and of immense igneous action, seated at an unknown distance beneath the surface of the earth. Hence we may have some idea of the vast amount of igneous action which operated in the early ages of our planet. It must have been violently shaken from the centre to the surface.]

We may well ask, in the language of a German philosopher, Who can enumerate all the blessings which the vegetable kingdom affords? It is at least manifest that all the arrangements of Providence, in this respect, have for their grand object the advantage of the creatures. God has provided for the wants of each individual. He has assigned to each that plant, which is most proper for its nourishment and support. There is not a plant on the earth, but what has its particular destination and use. What sentiments of veneration and gratitude should we feel, at the sight of lawns, gardens, fields, and meadows! Here his beneficent care has collected all that is necessary for the comfort and preservation of the inhabitants of the earth. Here, oh God! thou openest thy hand, and satisfiest the desire of every living creature! Here every herb, ear of corn, flower, and tree, proclaims thy goodness! How closely might our modern geologists walk with God, if, like a Boyle, and a Ray, every new discovery led them to an increasing admiration of Divine wisdom and omnipotent power!* for

> "Philosophy, baptiz'd
> In the pure fountain of eternal love,
> Has eyes indeed; and viewing all she sees
> As meant to indicate a God to man,
> Gives him his praise, and forfeits not her own."

To meet God in the immensity of his works, and trace him in the operations of his hand, gives expansion to intellect, opens new sources of enjoyment, and greatly exalts the character of man. The sacred writers conduct us to the *forest*, and, after selecting particular trees, press on our attention their emblematical uses.

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## *Section* III.—Minerals.

Gold—Silver—Platina—Mercury—Copper—Iron—Tin—Lead—Nickel—Zinc—Palladium—Bismuth—Antimony—Tellurium—Arsenic—Cobalt—Manganese—Tungsten—Molybdenum—Uranium—Titanium—Chromium—Columbium or Tantalium—Cerium—Oxmium—Rodium—Iridium—Religious Improvement.

Some parts of the earth's surface are barren and unfruitful, yielding no pleasant herb for cattle, nor vegetable for the service of man. But the bowels of the earth in such places are commonly stored with rich mines, and useful minerals. Without these what could we do in the field, the house, the market, or crossing the seas? Surely, the infinitely wise Architect has not made any thing in vain! It is deserving of notice, says Mr. Parkes, that if minerals had been placed on the *surface* of the globe, they would have occupied the greatest part of the earth, and prevented its cultivation. Their being deposited *below*, is a proof of management and design worthy of that Being who could furnish so great a variety of this class of bodies.

* Evangelical Magazine, January, 1814.

There are twenty-seven distinct metals, which possess properties very different and distinct from each other. For a knowledge of most of these, we are indebted to the more perfect modes of analysis, which modern chemistry has afforded. The ancients were acquainted with only seven. The properties of these were tolerably well known to the early chemists, who acquired their knowledge from the alchemists. Metals are divided into two classes, by modern chemists. The one contains the malleable, and the other the brittle metals. This last class is sometimes subdivided into those which are easily, and those which are difficultly fused. The malleable metals are eleven, namely, Gold, Silver, Platina, Mercury, Copper, Iron, Tin, Lead, Nickel, Zinc, and Palladium. The brittle metals are Bismuth, Antimony, Tellurium, Arsenic, Cobalt, Manganese, Tungsten, Molybdenum, Uranium, Titanium, Chromium, Columbium or Tantalium, Cerium, Oxmium, Rodium, and Iridium.

*Gold* is the heaviest of all metals excepting platina; it is neither very elastic nor hard; but so malleable and ductile, that it may be drawn into very fine wire, or beaten into leaves so thin as to be carried away by the slightest wind. Dr. Black has calculated, that it would take fourteen millions of films of gold, such as is on some fine gilt wire, to make the thickness of one inch : whereas fourteen million leaves of common printing paper make near three quarters of a mile. According to Fourcroy, the ductility of gold is such, that one ounce of it is sufficient to gild a silver wire more than thirteen hundred miles long. Such is the tenacity of gold, that a wire 1–16th of an inch in diameter will support a weight of 500 pounds without breaking. Gold may be known from all other metals by its bright yellow color, and its weight. Its specific gravity is 19.3; when heavier, it must be combined with platina; when lighter, and of a deep yellow color, it is alloyed with copper; and if of a pale color, with silver.

Arabia had formerly its gold mines. The gold of Ophir, so often mentioned in Scripture, must be that which was procured in Arabia, on the coast of the Red Sea. We are assured by Sanchoniathon, and by Herodotus, quoted by Eusebius, that the Phœnicians carried on a considerable traffic in gold, even before the days of Job, who thus speaks of it, "Then shalt thou lay up gold as dust, and the gold of Ophir as stones of the brooks." Gold is found in Peru, as well as in several other parts of the world. It generally occurs in a metallic state, and most commonly in the form of grains. It frequently is met with in the ores of other metals, but is chiefly found in the warmer regions of the earth. It abounds in the sands of many African rivers, in South America, and in India. Several rivers in France contain gold in their sands. It has also been discovered in Hungary, Sweden, Norway and Ireland. Near Pamplona, in South America, single laborers have collected upwards of £200 worth of wash-gold in a day. In the province of Sonora, the Spaniards discovered a plain, fourteen leagues in extent, in which they found wash-gold at the depth of only 16 inches; the grains were of such a size that some of them weighed 72 ounces, and in such quantities, that in a short time, with a few laborers, they collected 1,000 marks, (equal in value to £31,219 10*s.* sterling,) even without taking time to wash the earth which had been dug. They found one grain which weighed 132 ounces; this is deposited in the royal cabinet at Madrid, and is worth £500.* The native gold found in Ireland was in grains, from the smallest size to upwards of two ounces. Only two grains were found of greater weight, one of which weighed 5, and the other 22 ounces.† Gold mines were formerly worked in Scotland; and indeed now, grains of this metal are often found in brooks after a great flood. It has been said, that at the nuptials of James V, covered dishes filled with coins of *Scotch gold* were presented to the guests by way of dessert. Standard gold of Great Britain is twenty-two parts pure gold, and two parts copper; it is therefore called gold of "twenty-two carots fine." Some have thought that Moses made use of sulphuret of potass to render the calf of gold adored by the Israelites soluble in water. Stahl wrote a long dissertation to prove that this was the case.

*Silver* is a heavy, sonorous, brilliant, white metal; exceedingly ductile, and of great malleability and tenacity. It possesses these latter properties in so great a degree, that it may be beaten into leaves much thinner than any paper, or drawn into wire as fine as a hair without breaking. Fifty square inches of silver leaf weigh not more than a grain. The specific gravity of silver is 10.500. When perfectly pure, it is a very soft metal. To know when it is pure, heat it in a common fire, or in the flame of a candle: if it be alloyed, it will become tarnished; but if it be pure, it will remain perfectly white. Our standard silver is formed with fifteen parts pure silver, and one part copper.

Silver is found in various parts of the world in a metallic state; also in the states of a sulphuret, a salt, and an oxide. Native silver is found chiefly in the mines of Potosi. Sulphuret of silver occurs in the silver mines of Germany, Hungary, Saxony and Siberia. Oxides of silver are also common in some of the silver mines in Germany. Silver has lately been found in a copper-mine in Cornwall.‡ Most of our lead mines also afford it. particularly some in Scotland. In the county of Antrim, in Ireland, there is a mine so rich, that every thirty pounds of lead ore is said to produce one pound of silver. By the silver which was produced from the lead mines in Cardiganshire, Sir Hugh Middleton is said to have cleared two thousand pounds a month, and that this ena-

* Dr. Black, ii. 694. † Phil. Trans. for 1796.
‡ See Mr. Hitchen's Paper, in Phil. Trans. vol. xci. p. 159.

bled him to undertake the great work of bringing the New River from Ware to London.

Silver was used in commerce eleven hundred years before the foundation of Rome. Moses, says, "And Abraham weighed to Ephron the silver, which he had named in the audience of the sons of Heth, four hundred shekels of silver, current money with the merchant." At this period silver was not coined, but being only in bars, or ingots, in commerce was always weighed. In the museum of the Academy of Sciences at St. Petersburgh, is a piece of *native* silver from China of such firmness, that coins have been struck from it without its having passed through the crucible.*

*Platina*, the heaviest of all metals, is nearly as white as silver, and difficultly fusible, though by great labor may be rendered malleable, so as to be wrought into utensils like other metals. It will resist the strongest heat of our fires without melting, and, like iron, is capable of being welded when properly heated. It is found in grains, in a metallic state, at St. Domingo: and also at Santa Fe, in Peru, in the language of whose inhabitants it means *little silver*. It has recently been discovered in an ore of silver found in Estremadura, existing in its metallic form. This metal was first introduced into England by Charles Wood, who brought it from Jamaica in the year 1741. It has been drawn into wire less than the two thousandth part of an inch in diameter. The specific gravity of hammered platina is 23.66, which is more than double that of lead.

*Mercury*, in the temperature of our atmosphere, is a fluid metal, having the appearance of melted silver: in this state it is neither ductile nor malleable; very volatile when heated; extremely divisible; and is the heaviest of all metals except platina and gold. We see it always in a fluid state, because it is so fusible that a small portion of caloric will keep it in a state of fluidity; but when submitted to a sufficient degree of cold, is similar to other metals, and may be beaten into plates. It has been determined, that at 39 degrees below zero of Fahrenheit's thermometer is the point at which the congelation of mercury takes place. In the winter of 1799, Mr. Pepys froze 56 pounds of it into a solid and malleable mass. At Hudson's Bay, frozen mercury has lately been reduced to sheets as thin as paper, by beating it upon an anvil that had previously been reduced to the same temperature. It is a substance so volatile that it may be distilled like water; and is sometimes purified in this way from mixture with other metals, being often adulterated with lead and bismuth. It is also so elastic when in a state of vapor, that it is capable of bursting the strongest vessels. According to Mr. Biddle, its specific gravity at 47 degrees above zero is 13.545; but when frozen into a solid at 40 below zero, 15.612.

* Storch's Picture of Petersburgh, p. 330.

This metal is brought to Europe from the East Indies and Peru; but is found in greater abundance at Almaden in Spain, where it is extracted from the ore by distillation. The quicksilver mine of Guanca Velica, in Peru, is 170 fathoms in circumference, and 480 deep. In this profound abyss are streets, squares, and a chapel where religious mysteries on all festival occasions are celebrated. Millions of flambeaux are continually burning to enlighten this subterranean abode. This mine generally affects those who work in it with convulsions. Notwithstanding this, the unfortunate victims of an insatiable avarice are crowded all together, and plunged *naked* into this abyss. Tyranny has invented this refinement in cruelty, to render it impossible for any thing to escape its restless vigilance.

> "Thus in the dark Peruvian mine confin'd,
> Lost to the cheerful commerce of mankind,
> The groaning captive wastes his life away,
> For ever exil'd from the realms of day;
> While, all forlorn and sad, he pines in vain
> For scenes he never shall possess again."

Mercury is raised in such abundance in Spain, that in the year 1717 there remained above 1,200 tons of it in the magazines at Almaden, after the necessary quantity had been exported to Peru for the use of the silver mines there. The quicksilver mines of Idria, a town in the circle of Lower Austria, have been wrought constantly for 300 years, and are thought on the average to yield above 100 tons of quicksilver annually. Mercury is found also in Hungary and China; it occurs most commonly in argillaceous schistus, lime-stones, and sand-stones. It is likewise found in Sweden, amalgamated with silver, and frequently combined with sulphur. Running mercury is seen in globules, in some earths and stones in America, and is collected from the clefts of rocks. Cinnabar, or sulphuret of mercury, is also generally found in those countries which produce the fluid metal.*

*Copper* is of a red color, very sonorous and elastic, and the most ductile of all metals, except gold. A wire 1-10th of an inch will support near 300 pounds. Its specific gravity is 8.66. It will not burn so easily as iron; which is evident from its not striking fire by collision. Copper-mines have been worked in China, Japan, Sumatra, and in the north of Africa. Native copper is generally found in Siberia, Sweden, Hungary, and some parts of France. Copper is found in several parts of England and Wales, particularly in Cornwall, and the Isles of Man and Anglesea. The copper pyrites found in Cornwall are *sulphuret* of copper. Anglesea

* Several salts are formed by art with this metal for medicinal purposes. One of the most valuable is *calomel*, which is made by triturating fluid mercury with corrosive sublimate, and then submitting the mixture to sublimation. As this medicine is much used in private families, and as dreadful consequences might ensue if it were improperly prepared, it ought to be generally known, says Mr. Parkes, that if it be not perfectly insipid to the taste, and indissoluble by long boiling in water, it contains a portion of oxymuriate of mercury, or corrosive sublimate, and consequently is poisonous.

formerly yielded more than twenty thousand tons of copper annually: the vein of metal was originally more than seventy feet thick. Copper mines have not been worked in England above 160 years. Before that period, whenever the workmen met with copper ore in the tin mines of Cornwall, they threw it aside as useless, no English miner at that time knowing how to reduce it to a metallic state. To chemical science, therefore, we are indebted for such an ample supply of this valuable metal. It is asserted, that a large copper mine has been worked for some time in the state of New-Jersey in America, and that the ore raised there is brought to this country to be smelted. Native oxides of copper are found in Cornwall and in South America. Carbonate of copper occurs as a natural production in two varieties, called *malachite* and *mountain green*. Sulphate of copper, of a very rich quality, is also found in the state of Connecticut. The stream in its course destroys vegetation; and where it settles in places near the spring, large lumps of metallic salt are collected. Bishop Watson relates, that the waters which issue from the copper mines in the county of Wicklow, in Ireland, are so impregnated with sulphate of copper, that one of the workmen having accidentally left a shovel in this water, found it some weeks after so incrusted with copper, that he imagined it was changed into copper. The proprietors of the mines, in pursuance of this hint, made proper receptacles for the water, and now find these streams of as much interest to them as the mines. When miners wish to know whether an ore contains copper, they drop a little nitric acid upon it; after a short time they dip a feather into the acid, and then wipe it over the polished blade of a knife; and if there be the smallest quantity of copper in it, the copper will be precipitated on the knife.* A mass of *native* copper has been found in a valley in the Brazils, containing 2,666 pounds weight. The description of it in the Memoirs of the Royal Academy of Sciences at Lisbon is said to be very interesting, as the largest specimen ever found before this weighs only ten pounds. In the museum of the Academy of Sciences at St. Petersburgh, is a piece of native malleable copper of extraordinary magnitude, found on the copper island lying to the east of Kamschatka.† The Romans were acquainted with this metal; for the only money used by that people, till the 485th year of their city, was made of it, when silver began to be coined. In Sweden, houses are covered with copper.‡

* Monthly Review, Appendix, vol. xxvii. N. S. p. 551.

† Storch's Picture of Petersburgh, p. 319.

‡ In domestic economy, the necessity of keeping copper vessels always clean is generally acknowledged; but it may not perhaps be so well known, that fat and oily substances, and vegetable acids, do not attack copper while *hot*; and, therefore, if no liquor be ever suffered to grow *cold* in these utensils, they may be used for every culinary purpose with perfect safety.—Dr. Percival gives an account of a young lady who amused herself, while her hair was dressing, with eating samphire pickle impregnated with copper. She soon complained of pain in the stomach, and in five days vomiting commenced, which was incessant for two days. After this her stomach became prodigiously distended: and in nine days after eating the pickle, death relieved her from her sufferings. Medical Transactions, vol. iii, p. 80.

*Iron* is of a livid blueish color, and one of the hardest and most elastic of all metals. When dissolved, it has a nauseous styptic taste, and being strongly rubbed emits a peculiar smell. It is attracted by the magnet, and has the property of becoming itself magnetic. It is fused with great difficulty, but gives fire by collision with flint. An iron wire only one-tenth of an inch in diameter, will carry a weight of 450 pounds without breaking; and a wire of tempered steel, of the same size, will carry one of about 900 pounds. Iron becomes softer by heat, and has capability of being welded to another piece of the same metal so as to form one entire mass; and this may be done without melting either of the pieces. No other metal, except platina, possesses this singular property, which renders it most suitable for every common purpose. Its specific gravity varies from 7.6. to 7.8.

This valuable metal is plentifully diffused throughout nature, pervading almost every thing, so as to be detected even in plants and animal fluids, and is the chief cause of color in earths and stones. It is found in large masses, and in various states, in the bowels of the earth. In the museum of the Academy of Sciences at Petersburgh is a mass of native iron twelve hundred pounds weight. In the northern parts of the world whole mountains are formed of iron ore, and many of these ores are magnetic. Of the English ores, the common Lancashire hematite produces the best iron. This metal is found in solution in many natural springs, and gives the character to all our chalybeate waters: besides which, there are some springs which contain iron in combination with sulphuric acid. These are called vitriolated waters. There are several in this land; but those at Chadwell near London, and at Swansea in Glamorganshire, are probably the most important.

As this metal possesses so many properties, exists in so many different states, and is capable of being applied to such a variety of excellent purposes, it is certainly the most useful of all the products of the mineral kingdom. It was used in the time of Moses, in whose writings Canaan is mentioned as "a land whose stones were iron." The Greeks understood the method of tempering it. Homer, in the ninth book of his Odyssey, describes the fire-brand driven into the eye of Polyphemus, as hissing like hot iron immersed in water. The advantages which we derive from the magnetic property of iron are incalculable. To this we are indebted for the *mariner's compass*, by which man is enabled to traverse the ocean, open a friendly or commercial intercourse with every quarter of the globe, and to steer his course with the utmost accuracy.

> "Tall navies hence their doubtful way explore,
> And ev'ry product waft from ev'ry shore;
> Hence meagre want expell'd, and sanguine strife,
> For the mild charms of cultivated life."

Iron may be moulded by the hammer into any form, and united into as many parts as the workman pleases, without rivets or solder. Were it not for this peculiar quality, many works of great importance could never have been executed. A most stupendous fabric, achieved by means of welded iron is the Chinese bridge of chains. hung over a dreadful precipice in the neighborhood of Kingtung, to connect two high mountains. The chains are twenty-one in number, stretched over the valley, and bound together by other cross chains, so as to form a perfect road from the summit of one immense mountain to that of the other.

Some idea of the extent and importance of the iron trade may be conceived from the following account, abridged from Malkin's Scenery, &c, of South Wales. "Merthyr Tydvill was a very inconsiderable village till the year 1755, when the late Mr. Bacon obtained a lease of the iron and coal-mines of a district at least eight miles long, and four wide, for 99 years. Since then these mines have been leased by him to four distinct companies, and produce to the heirs of Mr. Bacon a clear annual income of ten thousand pounds. The part occupied by Mr. Crawshay contains now the largest set of iron works in the kingdom. He constantly employs more than two thousand workmen, and pays weekly for wages, coal, and other expenses of the works, twenty-five thousand pounds. The number of smelting furnaces belonging to the different companies at Merthyr is about sixteen. Around each of these furnaces are erected forges and rolling-mills, for converting pig into plate and bar-iron. These works have conferred so much importance on the neighborhood, that the obscure village of Merthyr Tydvill has become the largest town in Wales, and contains more than twelve thousand inhabitants."

*Tin* is white, a little elastic, and so exceedingly soft and ductile, that it may be beaten out into leaves thinner than paper. It is much more combustible than many of the metals; and is soluble in all the mineral acids. Its specific gravity is 7.291, or about 516 pounds to the cubic foot. This metal is found in Germany, Saxony, South America, the East Indies, and in England, chiefly in Cornwall and Devonshire. It must have been known very early, as it is mentioned in the books of Moses. Homer in his Iliad mentions the use of tin.

Pliny says, that the Romans learned the method of tinning their culinary vessels from the Gauls. They used tin to alloy copper, for making those elastic plates which they employ in shooting darts from their warlike machines. The addition of tin to copper renders that metal more fluid, and disposes it to assume all the impressions of the mould. It was probably with a view to this, that it was used by the ancient Romans in their coinage. Many of the imperial *large brass*, as they are called, are found to consist of copper and tin alone. Antique coins frequently occur, made by forgers in the different reigns, in imitation of the silver currency, which contain a very large proportion of tin. There are coins of Nero which are of a most debased and brittle brass.

According to Aristotle, the tin mines of Cornwall were known and worked in his time. Diodorus Siculus, who wrote about forty years before the Christian era, gives an account of working these mines: he says, that their produce was conveyed to Gaul, and thence to different parts of Italy. The miners of Cornwall were so celebrated for their knowledge of working metals, that, about the middle of the seventeenth century, the renowned Becher, a physician of Spire, and tutor of Stahl, came over to this country on purpose to visit them; and it is reported of him, that, when he had seen them, he exclaimed, He who was a *teacher* at home, was a *learner* when he came there. About 3,000 tons of tin are furnished annually in Cornwall, two-fifths of which are usually exported to India by the East India Company. There are two kinds of tin known in commerce, namely, *block* tin, and *grain* tin. Block tin is procured from the common tin ore, and usually cast in blocks of about 320 pounds weight. It is taken to the proper offices to be assayed, where it receives the impression of a lion rampant, being the arms of the Duke of Cornwall, pays a duty of four shillings per hundred weight to the Duke, and then becomes legally salable. Grain tin is found in small particles, in what is called the *stream tin ore*. It appears to have been washed from its original bed in remote ages. This kind of tin owes its superiority, not only to the purity of the ore, but to the care with which it is washed and refined.

*Lead* is of a blueish white color, scarcely sonorous, unelastic, and, being the softest of all metals, yields readily to the hammer. It generally contains a small quantity of silver. An alloy of this metal with tin forms pewter, and in different proportions soft solder. Its specific gravity is 11.35. Lead ore is very abundant in Scotland, the western parts of Northumberland and Durham, Derbyshire, and many other parts of the world. The lead found in these counties occurs on the estates of Colonel Beaumont, and of those of the late Lord Derwentwater: the last of these were forfeited to Government, and are now in the possession of Greenwich Hospital. Lead was known in the time of Moses, and was in common use among the ancients. The Romans sheathed the bottoms of their ships with it, fastened by nails made with bronze. During the first century, at Rome, it was twenty-four times the price it is now in Europe; whereas tin was only eight times its present price.

*Nickel* is white, ductile and malleable, but of difficult fusion. It is attracted by the magnet, and has itself the property of attracting iron: but as the nickel of commerce always contains iron, this may disguise its properties, and prevent its nature being exactly known. Richter, in his Annales de Chimie, asserts, that this metal, in its pure state, is nearly as brilliant as silver, and more attractable by the loadstone than iron; that it is not liable to be altered by the atmosphere; and that its specific gravity when forged is 8.666. The ore of nickel is procured from various parts of Germany, and is often found with cobalt. It is chiefly used in China; and it is said, that the manufacturers of Birmingham combine it with iron, and melt it with brass, with great advantage.

*Zinc* possesses but a small degree of malleability and ductility, except under certain circumstances. When broken, it appears of a shining bluish white; and when exposed to the air, becomes covered with a pellicle which reflects various colors. If beaten out into thin leaves, it will take fire from the flame of a common taper. Its filings are mixed with gunpowder, to produce those brilliant stars and spangles which are seen in the best artificial fire-works. It is also one of the metals employed to form Galvanic batteries. It is the most combustible metal we have. It will decompose water without the assistance of heat. Next to manganese, it has the strongest affinity for oxygen of all the metals. Its specific gravity is 6.861. Its nature is such, that it seems to form the link between brittle and malleable metals. Some mineralogists consider zinc to be the most abundant metal in nature, excepting iron. Calamine, or lapis calaminaris, which is a native oxide of zinc, combined with carbonic acid, is found both in masses and in a crystallized state, and is generally combined with a large portion of silex. Zinc is also found in an ore called *blend*, in which state it is mineralized by sulphur. The miners call it Black Jack—a mineral employed till lately in Wales for mending the roads. Zinc is generally called by our artists *spelter;* and in England and elsewhere it is extracted from calamine, and other ores, by distillation. This metal abounds in China, where it is used for current coin, and for that purpose is employed in the utmost purity. These coins have frequently Tartar characters on one side, and Chinese on the other. They have generally a square hole in the centre, that they may be carried on strings, and more readily counted.

*Antimony* is of a dusky white color, brilliant, brittle, and destitute of ductility. Though seemingly hard, it may be cut with a knife. Its specifiic gravity, according to Bergman, is 6.86. It is procured from an ore which is found chiefly in Hungary and Norway. Native antimony, alloyed with a small portion of silver and iron, has been found in Sweden. And it is said, that it has been found in the state of Connecticut, in America, nearly in a pure metallic form. There are five distinct ores of antimony, but the grey is the only one found in sufficient quantity for the manufacturer; it is a sulphuret of antimony. Perhaps we have no metal more valuable as a medicine than this, or one which is applied in such various ways.

*Bismuth* is of a yellowish white color, lamellated texture, and moderately hard, but not malleable. It is so brittle that it breaks readily under the hammer, and may be reduced to powder. It has the singular property of *expanding* as it cools. Hence, probably, its use in the metallic composition for printers' types; as from this expansive property are obtained the most perfect impressions of the moulds in which the letters are cast. In manufactories this metal is known to the workmen by the name of *tin glass*. It is one of the metals which will inflame when suspended in oxymuriatic acid gas. It is generally found with cobalt in the cobaltic ores of Saxony and England. Native bismuth, and sulphuret of bismuth, are found on the continent; and a sulphuret of bismuth has been discovered in Cornwall; but this is not an abundant metal. If 8 parts of bismuth, 5 of lead, and 3 of tin, be melted together, the mixed metal will fuse at a heat no greater than 212°. Tea-spoons made of this alloy are sold in London, to surprise those who are unacquainted with their nature. They have the appearance of common tea-spoons, but melt as soon as they are put into hot tea.

*Arsenic*, when reduced to its pure metallic state, is a friable brilliant metal, of a bluish white color, easily tarnishing, or oxidizing, by exposure to the air. In all its states it is extremely poisonous. It may be known by the smell of garlic, and by the white fumes which it exhales when thrown upon a piece of red-hot coal. Its specific gravity is 8.310. It is found in Bohemia, Hungary, Saxony, and other places on the continent; and in combination with acids, sulphur, or oxygen. The arsenic of commerce is prepared in Saxony, in the operation of roasting the cobalt ores for the manufacture of zaffre. The reverberatory furnace in which the ores are roasted terminates in a long horizontal chimney; and in this chimney the arsenical vapors are condensed, forming a crust, which at stated times is cleared off by criminals, who are condemned to this work.

*Cobalt* is a whitish-grey, brittle metal, nearly resembling fine hardened steel; is difficult of fusion, but obedient to the magnet. According to Bergman, its specific gravity is about 7.700; though Tassaert makes it 8.538. Formerly all our cobalt came from Saxony. The cobalt ores of Hesse produce a nett profit of £14,000 a year, as stated in Born's Travels; though once they were used for no other purpose than to repair the roads. But now cobalt is found abundantly in the Mendip hills in Somersetshire, and in a mine near Penzance in Cornwall. Zaffre is now made from the cobalt ores found in these hills. Had it not been for the rapid promulgation of chemical science in these kingdoms, this important metal might have lain in the bowels of the earth undiscovered for ages yet to come. Formerly miners not only threw cobalt aside as useless, but they considered it so troublesome when they found it among other ores, that, as stated in Beckmann's History of

Inventions, a prayer was used in the German church, that God would preserve miners from *cobalt* and from *spirits*. It is now very valuable to the manufacturers of porcelain.

*Manganese* is of a dark grey color, brilliant, very brittle, of considerable hardness, and difficult fusibility. Its specific gravity has been estimated by Bergman at 6.850, and by Hielm 7.00. It is never found native. It was first procured in its pure metallic form by Kaim and Gahn between 1770 and 1775. It abounds in America, and in various parts of the continent. The manganese which is used in England, is obtained in a state of black oxide from Somersetshire and Devon. It is found either in the state of an oxide or a salt. But the discovery of mines of it in this country is a new acquisition, owing to the spirit of chemical research. Dr. William Dyce, of Aberdeen, has lately communicated to the Society for the Promotion of Arts, &c, the discovery of a mine of great extent, and very fine quality, in the vicinity of that town: for which the gold medal of the Society was sent him. Professor Beattie, of the same place, has also discovered manganese in his neighborhood, on the river Don, of good quality. Scheele discovered this metal in the ashes of burnt vegetables. Proust has lately announced the discovery of a native sulphuret of manganese. That from the Bristol and the Mendip hills generally contains lead.

*Tungsten* is a heavy metal, but its properties are not much known. It is procured from a mineral found in Sweden, and from an ore called *wolfram*, found in Cornwall, Germany, &c. It has been used in France for making vegetable lakes; but is not used here. Though it has been recommended as a proper basis for colors, it shows in some instances a strange fugacious disposition. Its specific gravity is 17.60.

The same may be said of the other metals, their properties not being much known. *Molybdenum* was first procured in a metallic state by Hielm, in the year 1782; and, it is believed, has been employed in some processes of dyeing in Germany. As the ore may be had in great plenty, it will probably, some time hence, come into general use here. At present it is not used in any of the arts. Its specific gravity is 8.61. *Uranium* was discovered by Klaproth in 1789, in a mineral called pechblend; and has since been found combined with carbonic acid, in the common green mica. *Titanium* was first noticed in the year 1781, by Mr. Macgregor, in a greyish black sand, found in the vale of Menachan in Cornwall; but has since been discovered by Klaproth in several other minerals. An ore of it occurs in Transylvania, which very much resembles yellow sand. This metal has been used in France for painting porcelain. *Tellurium* was discovered by Klaproth in the year 1798, in a particular kind of gold ore. It has hitherto been found in quantities too small to allow of its being employed in the arts. Its specific gravity is only 6.115. *Chromium* received its name from a property it has of imparting a lively color to a variety of other bodies. The emerald is colored by an oxide of this metal. *Columbium* was discovered in a mineral sent from Massachusetts in North America. *Tantalium* was found in an ore from Swedish Lapland: but Dr. Woollaston has lately discovered that this and columbium are identically the same metal. *Cerium* had not been seen in a metallic form till Sir Humphrey Davy procured it from some oxide discovered by Hissinger and Berzelius in 1804. Its scarcity will prevent its being applied to any useful purpose.

The metals are simple substances, distinguishable from all other bodies by their lustre, great specific gravity, perfect opacity, and superior power of conducting electricity. They are the great agents by which we are enabled to explore the bowels of the earth, and examine the recesses of nature. Their uses are so multiplied, that they are become of prime importance in every occupation of life.

The reason why one metal possesses such opposite and specific differences from those of another, is not to be attributed to chance, but must certainly be the effect of consummate wisdom and contrivance. These metals differ so much from each other in their degrees of hardness, lustre, color, elasticity, fusibility, weight, malleability, ductility, and tenacity, that the Author of nature appears to have had in view all the necessities of man coming within the range of their operation.*

[It is now generally admitted that there are FORTY *distinct metals.* Some of these metals are the *bases* of the *alkalis, alkaline earths,* and *earths.* And as *this* class of metals is but little known to the great mass of readers, some remarks will be acceptable: they are recommended to his special attention, as they form the base of the only satisfactory theory of *volcanos* and *earthquakes.* The number of metals in this class are *twelve.*

1. The bases of the three alkalis, *potash, soda,* and *lithia.*

The base of *potash* is POTASIUM. This metal was discovered in 1807 by Sir H. Davy. Its texture is crystalline; color and lustre similar to mercury. It is solid at the ordinary temperature of the atmosphere; somewhat fluid at 70°, melts at 150°. Its affinity for oxygen is so great that it oxidizes rapidly in the air; and decomposes water instantly upon contact, emitting heat, flame, and light, as it swims on the surface of the water, being the *lighter* substance. In these cases it oxidizes and becomes potash, by abstracting oxygen from the air and water.

The base of *soda* is SODIUM. This metal was discovered by the same chemist the same year. It has the strong metallic lustre of silver. It fuses at 200°, and evaporates at a full red heat. It decomposes both air and water, but not so rapidly as potasium. When thrown on water it effervesces strongly; and inflames with light,

* The materials forming nearly the whole of this Section have been selected and arranged from the *seventh* Edition of Parkes's *Chemical Catechism*: a work of peculiar interest, and which was confidently recommended to the Author by a physician and chemist of distinguished celebrity.

when thrown on boiling water. In these cases soda results, which is the *oxide of sodium. This metal is the base of common salt.*

The base of *lithia* is LITHIUM. This metal was discovered in Sweden in 1818, by Arfwedson. It is of a white color, like sodium; but oxidizes so rapidly as not to be kept in its pure metallic state. Its peculiar properties are, therefore, not so certainly known. Its alkaline quality is well ascertained, when in combination with oxygen, in which form it commonly appears.

2. The bases of the four alkaline earths, *baryta, strontia, lime* and *magnesia.*

The base of *baryta* is BARIUM. This metal was discovered by Sir H. Davy, in 1808. It is of a dark gray color, very heavy, and attracts oxygen very strongly from the air, and from water, with effervescence, caused by the escape of hydrogen gas, and thus becomes an oxide which is the pure earth baryta, of a white color, and very heavy. Its intimate properties are not yet well known.

The base of *strontia* is STRONTIUM. This metal is very much like barium, in color, weight, and power of decomposing air and water, and thus becoming an oxide, which is the earth strontia. Yet it is satisfactorily distinguished from barium.

The base of *lime* is CALCIUM. This metal was satisfactorily obtained first by Sir H. Davy. It is of a whiter color than the two last mentioned metals; and like them decomposes the air and water, and thus becomes lime, which is an *oxide of calcium.* The *base* of common *limestone is,* of course, *a metal.*

The base of *magnesia* is MAGNESIUM. This metal was discovered by Sir H. Davy, but in very small quantities; sufficient, however, to determine its strong affinity for oxygen, so as to decompose water, and thus oxidize, and become the earth magnesia, which is a metallic oxide. The base of common magnesia is, of course, a metal.

3. The bases of the five earths, *alumina, glucina, yttria, zirconia,* and *silica.*

The base of *alumina* is ALUMINIUM. The existence of this metal was pretty satisfactorily ascertained by Sir H. Davy, and subsequently *established* by Wöhler. It is very difficult to obtain it, as the preparation is attended with intense heat and light. When obtained it is generally in small scales of a metallic lustre. It requires a great heat to fuse it; and when heated to redness in the open air, it burns with a bright light, and the product is an *oxide of aluminium,* which is *pure clay,* of a white color, and quite hard.

This oxide, or pure clay, is very abundant in the compostion of the earth, though generally very much adulterated. It is found in all countries and used for making bricks, porcelain ware, pipes, &c. When pure it sometimes crystallizes. Hence it is capable of forming some of the most beautiful *gems:* as the sapphire and ruby, which are pure crystallized clay. *Clay, then, has a metallic base.*

The base of *glucina* is GLUCINIUM. Glucina was first discovered by Vauquelin in 1798, and by *analogy* its base was *supposed* to be metallic, which has since been confirmed by Dr. Wöhler, who has obtained the base in the form of a metal. *An. de ch. et de ph. Sept.* 1828, *as quoted by **Dr. Bache, Turner's Chem.** p.* 303.

The base of *yttria* is YTTRIUM. This metal was obtained in a separate state by Dr. Wöhler, (See last quoted authority,) though its existence was inferred by Godolin who discovered the earth which is an oxide of this metal.

The base of *zirconia* is ZIRCONIUM. The earth was discovered by Klaproth in 1789, and its metallic base clearly established by Berzelius 1824.

The base of *silica* is SILICIUM. There exists some doubts among chemists whether this base is indeed a *metal;* but there is no doubt but that it is *combustible*, and that the earth silica, (or silex,) is an *oxide*. From *analogy* it would be inferred this base is metallic, and the *evidence* preponderates on this side. This oxide, or earth, is very abundant. It is more commonly called *silex*: It is the base of the whole class of primitive rocks, and almost altogether constitutes quartz, flint, &c.

The reader is now desired to recollect that this class of metals constitutes the *bases of the alkalis, and earths;* which are simply *metallic oxides* or a combination of oxygen with the metals. Recollect also that *all these metals are inflammable*, and some of them simply upon exposure to air and water. Now as the earths at the surface of our goble are the results of *chemical action*, in which the oxygen combined with the metals, it is beyond a doubt that these substances were created in their elementary and uncombined state; and that the act of combining would produce an inconceivable amount of heat, so as to fuse completely the whole mass of our earth; and in this state of fusion the oxides would commence forming at the *surface chiefly;* and thus by oxidizing the metals would form the earths, rocks, &c, which constitute, principally, the *crust* of our globe. When this crust became sufficiently thick it would protect the *interior* parts of the earth from oxidation, by preventing the access of air and water; and they would of course remain in a pure metallic state. But, (as is most probable,) if the materials, being promiscuously mixed throughout the mass at the commencement of the chemical action, should oxidize throughout, then the indurating of the crust, by cooling, would inclose the *interior* parts *in a state of fusion*, and in that state they remain to the present time. Nor is this astonishing when we recollect the *earths* are almost perfect *non-conductors of caloric:* of course it could not escape at all through the *crust* of the earth, formed of many strata of earths, in the shape of rocks, which, taken together, may be about eight miles thick.

If, by any concussion, or by percolation, water, or air should reach these metals in the interior, or these fused masses of matter, the consequence would be *decomposition*, and the production of a great amount of gas, and heat, which operating conjointly, first produce earthquakes by struggling to escape from the caverns in which they are generated; and when they find a passage, they would break forth into volcanos. This is the only true and satisfactory theory of earthquakes and volcanos.

It may be added, that this action would naturally bring to its aid the astonishing powers of electricity and galvanism.

The *forty* metals mentioned above, may be classed scientifically into *two* classes.

1. *The bases of the alkalis, alkaline earths, and earths.* These are twelve: potasium, sodium, and lithium; bases of the alkalis—barium, strontium, calcium, and magnesia; bases of the alkaline earths—aluminium, glucinium, yttrium, zirconium, and silicium; bases of the earths.

2. Metals, the oxides of which are neither alkalis, or earths. These are *twenty-eight* in number, and may be set down in the following order: gold, silver, iron, copper, mercury, lead, tin, antimony, zinc, bismuth, arsenic, cobalt, platinum, nickel, manganese, tungsten, tellurium, molybdenum, uranium, titanium, chromium, columbium, palladium, rhodium, iridium, osmium, cereum, and cadmium.

Not only the *first* class of metals are *combustible*, but the *last* also. *All* the metals are now well known to be combustible bodies, *and may be made to burn as really as wood.*]

*Gems* are of a higher order than metals, of a more refined nature, and consist of two classes, the pellucid and semi-pellucid. Those of the first class are bright, elegant, and beautiful fossils, naturally and essentially compound, ever found in small detached masses, extremely hard, and of great lustre. Those composing the second class are stones naturally and essentially compound, not inflammable nor soluble in water, found in detached masses, and composed of crystalline matter debased by earth: however, they are but slightly debased, are of great beauty and brightness, of a moderate degree of transparency, and usually found in small masses.

The knowledge of the gems depends principally on observing their hardness and color. Their *hardness* is commonly allowed to stand in the following order: the diamond, ruby, sapphire, jacinth, emerald, amethyst, garnet, carneol, chalcedony, onyx, jasper, agate, porphyry, and marble. This difference, however, is not regular and constant, but frequently varies. In point of *color*, the diamond is valued for its transparency, the ruby for its deep red, the sapphire for its blue, the emerald for its green, the jacinth for its orange, the amethyst for its purple, the carneol for its carnation, the onyx for its tawny, the jasper, agate, and porphyry, for their vermillion, green, and variegated colors, and the garnet for its transparent blood-red.

There is not a unity of opinion concerning the cause of this difference. "Their colors," says Cronstedt, "are commonly supposed to depend upon metallic vapors; but may they not more justly be supposed to arise from a phlogiston united with a metallic or some other earth? because we find that metallic earths which are perfectly well calcined give no color to any glass; and that the manganese, on the other hand, gives more color than can be ascribed to the small quantity of metal which is to be extracted from it." M. Magellan is of opinion, that their color is owing chiefly to the mixture of iron which enters their composition ; but approves the sentiment of Cronstedt, that phlogiston has a share in their production, it being well known that the calces of iron when dephlogisticated, produce the red and yellow colors of marble, and when phlogisticated to a certain degree produce the blue or green colors.

With regard to the texture of gems, M. Magellan observes, that all of them are foliated or laminated, and of various degrees of hardness. Whenever the edges of these laminæ are sensible to the eye, they have a fibrous appearance, and reflect various shades of color, which change successively according to their angular position to the eye. These are called by the French *chatorantes ;* and what is a blemish in their transparency, often enhances their value on account of their scarcity. But when the substance of a gem is composed of a broken texture, consisting of various sets of laminæ differently inclined to each other, it emits at the same time various irradiations of different colors, which succeed one another according to their angle of position. This kind of gems has obtained the name of *opals*, which are valued in proportion to the brilliancy, beauty, and variety of their colors. Their crystallization, no doubt, depends on the same cause which produces that of salts, earths, and metals: but as to the particular configuration of each species of gems, we can hardly depend upon any individual form as a criterion to ascertain each kind; and when we have attended with the utmost care to all that has been written on the subject, we are at last obliged to appeal to chemical analysis, because it very often assumes various forms.*

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The rich treasures of the earth are within it, observes a worthy author, so that they cannot be discovered and brought to the surface without the labor of man; yet they are not placed so deep, as to render his exertion ineffectual. Thus nothing but what is comparatively worthless is to be found by the indolent on the surface of life. Every thing valuable must be obtained by diligent research and sedulous effort. All wisdom, science, art and experience, are bidden at a proper depth for the exercise of intellect, and they who bend their attention to any of these objects shall not be disappointed in their pursuit.

The treasures of wisdom, which are displayed in the redemption of mankind by Jesus Christ, and recorded in the Divine Oracles, do not lie upon the surface of the letter, for every superficial reader to observe them : therefore our Lord says, " Search the Scriptures." The word ερευνατε, compounded of ερεω, *I seek*, and ευνη, *a bed*, is, says St. Chrysostom, " a metaphor taken from those who dig deep and search for metals in the bowels of the earth. They look for the bed where the metal lies, and break every clod, and sift and examine the whole, in order to discover the ore." In Leigh's

* See Encyclopædia Britannica.

Critica Sacra, we meet with these observations, illustrative of the Greek word—" *Search ;* that is, shake and sift them, as the word signifies : search narrowly, till the true force and meaning of every sentence, yea, of every word and syllable, nay, of every letter and yod therein, be known and understood. Confer place with place; the scope of one place with that of another; things going before with things coming after : compare word with word, letter with letter, and search it thoroughly."

The Holy Scriptures contain the most invaluable treasures, a complete collection of doctrines, precepts, and promises, necessary to everlasting happiness. In this respect they have a peculiar advantange above all the writings of the most distinguished philosophers in the heathen world. The Bible presents an exact model of religion, for the instruction and common benefit of mankind. Here we have, in a narrow compass, all the things necessary to be known, believed, and practised, in order to our salvation ; for it is, " a lamp to our feet, and a light to our path." We are taught the knowledge of the only living and true God, his spiritual nature, adorable perfections, and endearing relations to his rational creatures : so that the meanest Christian who can read, may arrive at more true and just notions of him, than the wisest heathen sages could attain, who as the Apostle intimates, did only grope after him in the dark.—We are informed how Adam was created, how he fell, and what is the consequence of his transgression to all his posterity : the most celebrated heathens were not able to account for the origin of moral evil, as affecting the human race. The glorious plan of redemption by Jesus Christ is set before us, in its commencement, progress, and completion ; which is the highest display of the moral perfections of God, and attended with the most beneficial advantages to man.—The rules of duty, all the agenda of religion, or things to be done, are plainly stated, and properly enforced. Promises, containing pardon, adoption, sanctification, and eternal life, are every where interspersed, and are " yea, and amen, in Christ."

Our obligation to search the Scriptures, and by that means acquaint ourselves with their valuable contents, appears from the *necessity* and *design* of committing them to writing. St. Paul says, "All scripture is given by inspiration of God, and is profitable for doctrine, for reproof, for correction, for instruction in righteousness : that the man of God may be perfect, thoroughly furnished unto all good works." But how can they contribute to these important ends without being read ? What effect could the mere writing of them have on mankind, to inform the judgment and regulate the life ? How could Christian motives have proper influence, if the Sacred Volume were neglected ? Is it not an insult to common sense, to assert that the Scriptures were written for our instruction and admonition, but it is not necessary to peruse them to learn what they teach? To have a Bible, and not to read it, for direction in the way of truth and holiness, would not be attended with any peculiar advantage. Precious metals, deposited in the earth, must be procured to be rendered beneficial. The Holy Scriptures contain the revelation of God to mankind, declare his will with certainty, and are the prescribed means of salvation: the Apostle says, "they are able to make us wise unto salvation, through faith that is in Christ Jesus."

# CHAPTER V.

## FOURTH DAY.

### *Section* I.—The Sun.

Signs—Names—Nature—Motions—Form—Magnitude—Distance—Suspension—Idolatrous worship of the Sun—The Sun an Emblem of Christ.

On the *fourth day*, "God said, Let there be lights in the firmament of the heaven to divide the day from the night, and let them be for signs, and for seasons, and for days, and years: and let them be for lights in the firmament of the heaven to give light upon the earth: and it was so. And God made two great lights; the greater light to rule the day, and the lesser light to rule the night: he made the stars also. And God set them in the firmament of the heaven, to give light upon the earth, and to rule over the day and over the night, and to divide the light from the darkness." The light which had hitherto been scattered and confused, was now collected and formed into several luminaries, and so rendered more glorious and of greater utility.

A sensible and pious author observes, that not only the two great lights, which were made after a special manner to rule the day and the night, but, in general, all the lights in the firmament of the heaven, are said to be for signs and for seasons; or, as some render the words, "for signs of the seasons." And indeed this seems to be the meaning of the inspired writer. As for the manner of expression, "for signs and for seasons," it is very common in the Hebrew, as well as in many other languages, and is a figurative way of speech, expressing those things disjunctively, which must by the understanding be joined together. First, these lights are said to be *for signs*, and then the things are mentioned which they are to signify, namely, the *seasons*, the *days*, and the *years:* whereas, if we understand the word *signs* in an indefinite sense, and not confined to what follows, we are through the whole text left in great uncertainty; seeing that there are *signs* appointed *in* *the heaven* for some purpose or other, but not knowing for what. Besides, if we must take all the parts of the text disjunctively, then "the lights in the firmament" must be taken for *seasons*, and for *days*, and for *years*, as well as for *signs*. But we know, that the celestial bodies are not themselves *seasons*, and *days*, and *years*, but only *signs* of them, by such particular motions and aspects, as God, according to the laws of nature, has ordained them. Neither can I see reason to believe, that every motion or position of the heavenly bodies has a special signification in it: though serving in general to display the wisdom and power of God, in their regular courses. The sun, indeed, which is called the *greater light*, is said *to rule the day*, as it is by the appearance of his light, increasing and decreasing, that we measure the length of the day; and the moon likewise *to rule the night*, partly on the like account. Thus likewise the sun's course (if we may so call it) is a determining sign of the beginning and ending of the year, and of its various seasons. And in general, the sun, the moon, and the other lights, are necessary signs of the seasons of sowing, reaping, planting, and are useful in navigation, as well as other arts.

Costard, in his History of Astronomy, makes some critical remarks on the name of this greater light. He says, The sun is, by the Greeks, called Ἥλιος: which is nothing more than the Hebrew word אל *El*, modelled after the Greek manner of pronunciation, and signifies *Lord*; the first idolatrous worship being paid to this planet. In the Hebrew language it is called שמש *Shemesh*, and in the Chaldee שמשא *Shimsha*, from שמש *Shamesh*, to *minister*, on account of its administering light and heat to this world. From this property of communicating heat, it is also called חמה *Hammah*. By the Phœnician idolaters it seems to have been called בעל *Baal*, or בעל שמים *Baal-Shamim*, the *Lord of Heaven*. And on account of the supposed swiftness of its diurnal motion from east to west, it had a chariot dedicated to it at Sidon, an ancient town of Phœnicia. Such a chariot is still seen on the coins of that place. This superstition was likewise imitated by the idolatrous Jews: for we read of *the horses which the kings of* Judah *had given*, or dedicated, *to the sun*. By the Chaldeans it seems to have been called בל *Bel*, and by the Assyrians פל *Pul*; and, with the addition, sometimes of אב *ab*, or אף *ap*, i. e. *father*, אף־פל *Ap-Pul*, or *Father-Lord*; from whence the Greeks formed their Ἀπολλων, another name given by them to the sun. The name of this luminary, among the Romans, was *sol*; given more probably, on account of his scorching heat in the summer, or from his determining the length of the year by his course, than because he appeared *solus*, *alone*, according to the derivation given by Macrobius.

The *nature* of the sun is a subject which has not only excited the most diligent inquiry among men of scientific knowledge, but the opinions concerning it have passed through a variety of vicissitudes. The sun being evidently the source of light and heat, was by the ancients considered to be a globe of fire. But Dr. Herschell's discoveries, by means of his immensely large telescopes, tend to prove, that what we call the *sun* is only the *atmosphere* of that luminary: "that this atmosphère consists of various *elastic fluids*, which are more or less transparent; that as the clouds surrounding our earth are probably decompositions of some of the elastic fluids belonging to the atmosphere itself, so we may suppose that in the vast atmosphere of the sun similar decompositions may take place, but with this difference, that the decompositions of the elastic fluids of the sun are of a *phosphoric* nature, and are attended by lucid appearances, by giving out light." The body of the sun this celebrated astronomer considers as hidden generally from us, by means of this luminous atmosphere; that what are called *maculæ*, or *spots* on the sun, are real openings in this atmosphere, through which the *opaque body* of the sun beoomes visible; that this atmosphere itself is not *fiery* nor *hot*, but is the instrument which God designed to act on the caloric or latent heat; and that heat is only produced by the solar light acting on and combining with the caloric or matter of fire contained in the air, and other substances which are heated by it.

This indefatigable investigator of the heavenly phenomena shows, by many substantial proofs, drawn from natural philosophy, that *heat* is produced by the sun's rays only when they act on a calorific medium; and that they cause the production of heat by uniting with the matter of fire which is contained in the substances that are heated,—as the collision of flint and steel will inflame a magazine of gunpowder, by uniting with its latent fire, and bring the whole into action. This point is capable of a very clear elucidation. "On the tops of mountains, and at heights to which the clouds seldom reach to shelter them from the direct rays of the sun, we always find regions of ice and snow. Now if the sun's rays themselves conveyed all the heat we find on the earth, it would of course be hottest in situations similar to the tops of mountains, where their course is least interrupted. But all those who have ascended in balloons confirm the coldness of the upper regions of the atmosphere; and, therefore, since even on the earth the heat of the situation depends on the facility with which the medium yields to the impression of the sun's rays, we have only to admit, that, on the sun itself, the fluids composing its atmosphere, and the matter on its surface, are of such a nature as not to be capable of any excessive heat from its own rays. It is also a well known fact, that the focus of the largest burning lens thrown into the air, will occasion no heat in the place where it has been kept for a considerable time, although its powers of exciting heat, when proper bodies are exposed to it, should be sufficient to melt or fuse the most refractory metals." That the sun is a luminous, and not an igneous body, has met with the general consent of modern philosophers; an opinion to which every new discovery in philosophy gives additional support.

The telescope, said to have been invented by the children of a spectacle-maker at Middleburgh, in the year 1590, but first brought to such a degree of perfection by Galileo as to make any considerable discoveries in the celestial regions, has led to the most important results in the science of astronomy. Among which are the *spots* in the sun's disk, by whose motion from west to east the sun is perceived to revolve upon his own axis in 25 days, 14 hours, 8 minutes. This revolution of the sun round his own axis is probably not the only motion which this luminary experiences. There is great reason to believe that he has another motion, either rectilinear, or round some indefinitely remote centre of attraction. In this last course, he carries along with him, through space, the entire system of planets, satellites, and comets; in the same manner in which each planet draws his satellites along with him in his motion round the sun. He communicates light and heat to at least twenty opaque bodies, which revolve round him, at different distances, in ellipses that differ but little from circles.

From the motion of the spots, which is sometimes straight and sometimes curved, we learn that the sun's axis is not perpendicular to the plane of his ecliptic, but inclined to it, or the plane of the earth's annual orbit, so as to form an angle of about 83 degrees. Christopher Scheiner, a most diligent observer of these spot's in the sun's disk, published a treatise concerning them in A. D. 1626. These spots are sometimes seen to increase to a very large size, and to continue for a considerable time. In the year 1779, there was a spot on the sun's disk which was large enough to be seen with the naked eye: it was divided into two parts, and must have been 50,000 miles in diameter: this, and other phenomena of the same kind, may be accounted for from some natural change of the atmosphere. For if some of the fluids which enter into its composition be of a shining brilliancy, while others are merely transparent, then any temporary cause removing the lucid fluid, will permit us to see the body of the sun through the transparent ones. Dr. Herschell supposes that the spots in the sun are mountains on its surface, which, considering the great attraction exerted by this luminary upon bodies placed at its surface, and the slow revolution it has about its axis, he thinks may be more than 300 miles in height, and yet not be rendered unstable by the centrifugal force.

[There appears to be a *discrepancy* between this last statement—"Dr. Herschell supposes that the spots in the sun are *mountains* on his surface;"—and the statement made a few paragraphs preceding—"that what are called *maculæ* or *spots* on the sun, Dr. Herschell thought to be *real openings* in his atmosphere, through which the opake body of the sun becomes visible." These statements must have been made at different periods of his observations on the sun, which continued about fifteen years. The last statement was, doubtless, Dr. Herschell's mature opinion.

As this seems to be a settled question among philosophers; and as it has induced the enlightened world to regard the sun as a ***habitable globe***, it will not be out of place to enlarge a little on this point.

The spots on the sun's surface has led to the conclusion above, and also to a determination of the motion of the sun around his own axis. They appear to have been observed, for the first time, in A. D. 1610, by Fabricius and Harriot; the first in Germany, the second in England. It is uncertain which noticed them first; but it is certain the discovery was *original with both.*

After the observations of these two fortunate persons were known, the attention of the scientific was directed to this phenomenon. Scheiner supposed the spots to be *planets* which revolved very near the sun. In process of unwearied observations, it was ascertained that these spots changed their positions. Sometimes two would blend together, and thus run into each other. Sometimes one large one would divide into two or three smaller ones. They were observed to dilate, and contract; and to have umbræ, or shades attending them.

From these phenomena Galileo and others supposed the solar spots were *schoria floating on the burning liquid matter,* of which they supposed the sun composed. M. de la Hire, and La Lande supposed them to be eminences which occasionally rose above the rolling tides of fire, as islands rise above the sea. All these theories were on the supposition that the sun was an igneous body, in a high state of combustion, by which means he dispenses heat and light to the surrounding planets.

Dr. WILSON, Professor of practical astronomy in the University of Glasgow, was the first to conjecture that these spots were *depressions* rather than elevations. This was about the year 1769. The Doctor rendered this conjecture very probable, by his close and lucid observations and illustrations.

These spots attracted the attention of the celebrated Dr. Herschell in 1779, who continued to observe them closely until 1794, and by means of his immensely large and powerful telescopes, he clearly established Dr. Wilson's conjectures, *that these spots are openings in the luminous surface of the sun, through which his opake body appears.*

Dr. Herschell regards the real body of the sun to be an *opake nucleus,* fit for the habitation of intellectual creatures: that he has an atmosphere suited in density and height to his own magnitude: that in the higher regions of this atmosphere there are *two* sets of clouds surrounding the sun, which are permanently and essentially luminous, being *phosphoric* in their nature. The lower set of these clouds, which are *next* the sun, are less bright, and more dense than the upper set. They are designed to serve as a *curtain* to the sun's body, to prevent a too great intensity of light at his real surface; the higher set of clouds, which are visible to us, being the principal source, or rather *agent,* of light.

It is plain from the foregoing theory, that *we* never see the real body of the sun, except when we see the spots on his surface: that what we commonly call the sun, are only those bright, luminous phosphorescent clouds, which permanently surround his body, and which give light *outwards* to the planets, and also *inwards* to his own inhabitants.

It will be obvious also to any one, that the inhabitants of the sun *cannot see* any heavenly body, as the stars, and planets; because they are inclosed by those clouds, which are impenetrable to vision. They may catch a glimpse of a passing star through these openings as we do of the sun's body.

It is highly probable (see *our* paper on light, attached to our author's chapter on the same,) that these luminous phosphoric clouds *do not actually emit light, or heat;* but only *excite* them at the surfaces of the different planets. That is: it is very probable there is a *matter of light*, or a *luminiferous ether*, diffused through all existing matter, as caloric is, which is *excited by these clouds*, and *thus* becomes *visible*, which is light, as latent caloric is excited, and becomes sensible, by becoming *free*. Indeed it is very probable *that the matter of heat and light is the same*, and that heat and light are only *different modifications* of the action of the same substance, excited in a different, or higher degree.]

The sun has two *apparent* motions, namely, the diurnal and annual. By the *former* he appears to move round the earth in twenty-four hours: and by the latter he appears to traverse that circle in the heavens, called the ecliptic, in the course of a year. These motions, are, however, only apparent: the sun does not travel round the earth in twenty four hours: he does not change his place in the heavens at different seasons of the year. His apparent motions are occasioned by the earth's real motions. The sun's apparent diurnal motion is occasioned by the earth's real rotation about its axis: and the sun's apparent annual motion is caused by the earth's real motion in her orbit, through the whole of which she travels in a little less than 365 days, and 6 hours.

The fixed stars appear every twenty-four hours to make an entire revolution about the earth. The sun makes the same apparent circuit; but the apparent diurnal motion of the sun is evidently slower than that of the fixed stars. This appearance is occasioned by the daily rotation of the earth on its axis; for while it is turning once on its axis it advances in its orbit a whole degree; therefore it must make more than a complete rotation before it can come into the same position with the sun that it had the preceding day. In the same way, as when both hands of a watch set off together at any hour, as twelve o'clock, the minute hand must travel more than the whole circle before it can overtake the hour hand: hence the difference between solar and sidereal days, which it is important to understand in explaining the equation of time.

Though the sun appears to us merely as a circular disk, yet he is a *spheroid*, higher under his equator than about his poles. The deception arises from this; that all the parts of his surface are equally luminous, and consequently there is nothing which can suggest to us, at the great distance he is from the earth, that the central parts are more prominent than the sides, although in reality, they are nearer by half a million of miles.

This luminous body is supposed to be 886,473 English miles in diameter, about 2,700,000 in circumference, in solid bulk 24,000,000 times as big as the moon, and 1,384,462 times as big as the earth, and its superficies in square miles, about 2,236,603,000,000. This *magnitude* of the sun may appear exaggerated; for our eyes can discover nothing so large as the earth which we inhabit; and as to this alone we compare the sun, so we are tempted to believe the testimony of sense rather than our reason. But what confirms this prodigious size, is his visible magnitude, notwithstanding the vastly remote point which he occupies in space. And, concerning this subject, no doubt can remain, if we admit the calculations of astronomers, which are made on principles indubitably correct.

The sun does not appear large; but this is owing to his *distance* from the earth, which is 95,513,794 miles: this is so prodigious, that a cannon-ball, which is known to move at the rate of eight miles in a minute, would be something more than twenty-two years in going from the earth to the sun. If a spectator were placed as near to any of the fixed stars as we are to our sun, he would see our sun as small as we see a common star, divested of its circumvolving planets; and in numbering the stars he would reckon it one of them. But the earth's orbit being an ellipse, the sun is not always at an equal distance from it. When he is in his apogee, that is, furthest from the earth, the sun is full two millions of miles further from us than when he is in his perigee, or nearest the earth: nevertheless, we feel greater heat than when he is in our winter. The difference of temperature between summer and winter does not depend chiefly upon our nearness to the sun, but upon the following causes. 1. In summer, the solar rays strike upon the earth more perdendicularly than in winter, and therefore they act with greater force than when they strike it obliquely. 2. The rays of the sun coming more perpendicularly in summer than in winter, have less of the atmosphere to pass through. 3. In the summer, the sun continues a longer time above the horizon than below it; and consequently there is time for the earth to accumulate a greater portion of heat than in the days of winter. We know, in the longest days, that the sun to us is above the horizon 16 hours; whereas, in the shortest days, it is not more than 8 hours visible.*

The miraculous suspension of the natural powers of the hea-

* Time's Telescope for 1815, Introduction.

venly bodies, as recorded in the book of Joshua, shows that they are upheld, controlled, and directed in their operations, by a Being who is infinitely wise and powerful. To account for this miracle, and to ascertain the *manner* in which it was wrought, has employed the pens of the ablest *divines* and *astronomers,* especially of the last two centuries. For the elucidation of this important fact, I shall transcribe the view which Dr. Adam Clarke has given of it, which he considers to be strictly philosophical, consonant to the Pythagorean, Copernican, or Newtonian system, which is the system of the universe, laid down in the writings of Moses.

He assumes, as a thoroughly demonstrated truth, that the sun is in the *centre* of the system, moving only round his own axis, and the common centre of the gravity of the planetary system, while all the planets revolve round *him*; and that his influence is the cause of the *diurnal* and *annual* revolutions of the earth.

" Joshua's address is in a poetic form in the original, and makes the two following hemistichs:

שמש בגבעון דום
וירח בעמק אילון

Shemesh, be-Gibéon dom :
Vyarcach, beëmek Aiyalon.
Sun! upon Gibéon be dumb :
And the moon on the vale of Aiyalon.

" The effect of this command is related in the following words: וידם השמש וירח עמד *vayiddom ha*-SHEMESH *ve*-YAREACH *âmad*; *And the sun was dumb, or silent, and the moon stood still.* And it is added, *And the sun stood still in the midst of heaven, and hasted not to go down about a whole day.*

" I consider, that the word דום *dom*, refers to the *withholding* or *restraining* this influence, so that the cessation of the earth's motion might immediately take place. The desire of Joshua was, that the sun might not sink below the horizon; but as *it* appeared now to be over Gibeon, and the *moon* to be over the valley of Ajalon, he prayed that they might continue in these positions till the battle should be ended; or, in other words, that the day should be miraculously lengthened out.*

" Whether Joshua had a correct philosophical notion of the true

* Dr. Robert Wittie, in his Survey of the Heavens, makes the following observations concerning this miraculous interposition of Divine providence. " We read that Joshua, in his zeal against the enemies of God and his people, in the heat of battle, called to the sun and moon to stand still, &c. The design was that the light might be lengthened, till he might destroy the army of the Amorites, and the day was accordingly prolonged, as the sun went not down for the whole day, and the moon also staid.—But why should Joshua call to the moon to stand still, as well as the sun, which could be of no use to him, while the sun was up? To this I answer with all due modesty; I do believe Joshua did call thus by inspiration, and a special impulse from God upon his spirit: for that which would make the sun stand still, would also stay the moon. He that from the hasty zealous call of this great general, shall think to form an argument to prove the philosophical notion of the sun's diurnal motion about the earth, by taking the words in a proper literal sense, may as well go on, and eke it out a little further, and then he may prove the sun to have been in the next great town, Gibeon, and the moon in the valley; but if to all men this latter shall be judged a weak inference, I dare say, to many wise men, so will the former." P. 12, 13.

system of the universe, is a subject that need not come into the present inquiry; but whether *he spoke* with strict propriety on this occasion, is a matter of importance, because he must be considered as acting *under the Divine influence*, in requesting the performance of such a stupendous miracle: and we may safely assert, that no man in his right mind would have thought of offering such a petition, had he not felt himself under some Divine afflatus. Leaving, therefore, his philosophical knowledge out of the question, he certainly spoke as if he had known that the solar influence was the cause of the earth's *rotation*, and therefore, with the strictest philosophic propriety, he requested, that that influence might be for a time restrained, that the diurnal motion of the earth might be arrested, through which alone, the sun could be kept above the horizon, and the day be prolonged. His mode of expression evidently considers the sun as the great *ruler* or *master* in the system; and all the planets, (or at least the *earth*) moving in their respective orbits at his *command*. He therefore desires him, (in the name and by the authority of his Creator) to suspend his *mandate* with respect to the earth's motion, and that of his sattellite, the moon. Had he said, *Earth, stand thou still*—the cessation of whose diurnal motion was the *effect* of his command, it could not have obeyed him; as it is not even the *secondary* cause either of its annual motion round the sun, or its diurnal motion round its own axis. Instead of doing so, he speaks to the sun, the *cause* (under God) of all these motions, as his great archetype did, when, in the storm on the sea of Tiberias, he rebuked the *wind* first, and then said to the *waves*, Peace, be still! Σιωπα, πεφιμωσο, be *silent!* be *dumb!* And the effect of this command was, a cessation of the agitation in the *sea*, because the *wind* ceased to *command* it, that is, to exert its influence upon the waters.

"The terms in this command are worthy of particular note: Joshua does not say to the sun, *Stand still*, as if he had conceived *him* to be *running his race round the earth;* but, be *silent*, or *inactive;* that is, as I understand it, *restrain thy influence;* no longer act upon the earth, to cause it to revolve round its axis; a mode of speech which is certainly consistent with the strictest astronomical knowledge: and the writer of the account, whether Joshua himself, or the author of the Book of *Jasher*, in relating the consequence of this command, is equally accurate, using a word widely different, when he speaks of the *effect*, the retention of the solar influence had on the moon: in the first case, the sun was *silent*, or *inactive*, דום *dom;* in the *latter*, the moon *stood still*, עמד *âmad*. The *standing still* of the moon, or its continuance above the horizon, would be the natural effect of the cessation of the solar influence, which obliged the earth to discontinue her diurnal rotation, which, of course, would arrest the moon; and thus both it and the sun were kept above the horizon, probably for the space of a whole day. As to the address to the *moon*, it is not conceived in the same terms as that to the *sun*, and for the most obvious philosophical reason: all that is said is simply, *and the moon on the vale of Ajalon*, which may be thus understood: 'Let the sun restrain his influence, or be inactive, as he appears now upon Gibeon, *that* the moon may continue as she appears now over the vale of Ajalon.' It is worthy of remark, that every word in this poetic address is apparently selected with the greatest caution and precision.

"At the conclusion of the 13th verse, a different expression is used when it is said, *So, the sun stood still*, it is not דום *dom*, but עמד *âmad*; ויעמד השמש *vai-yaâmod ha-shemesh*, which expression, thus varying from *that* in the command of Joshua, may be considered as implying, that in order to *restrain his influence*, which I have assumed to be the *cause* of the earth's motion, the sun himself became *inactive*, that is, ceased to revolve round his own axis; which revolution is, probably, one cause, not only of the revolution of the earth, but of all the other planetary bodies in our system, and might have effected all the planets at the time in question: but this neither could, nor did produce any disorder in nature; and the delay of a few hours in the whole planetary motions, dwindles away into an impreceptible point in the thousands of years of their revolutions. I need scarcely add, that the *command of Joshua to the sun*, is to be understood as a *prayer to God* (from whom the sun derived his being and continuance) that the effect might be what is expressed in the command; and therefore it is said, verse 14, 'that the LORD HEARKENED UNTO THE VOICE OF A MAN, *for the Lord fought for Israel*.'"

How glorious an object is the sun! too dazzling for mortal eye long to gaze on: the brightest visible emblem of its adorable Creator. This luminary rejoices to run his prescribed course, makes our day joyful, and without his reviving beams we should dwell in perpetual darkness. He, as the great source of day, distributes light and life through all nature. Seeds, in the bosom of the earth, feel his vegetative presence, and unfold themselves. By his diffusive influence he causes the vital juice to ascend in the tubes of trees, plants, and vegetables; and clothes them with their various and beautiful foilage. He nourishes the young fruits, gives them their fine tints, and brings them to maturity. At his approach, millions of insects awake into life, shine, collect themselves, and sport in his rays. Animals partake of his benefits, and without his animating beams they would sink into insensibility and death: even in caves and dens of the earth, his visitation gives life. His heat has a pleasing effect on all the juices and fluids in the human body, which, without his directive or impulsive energy, would soon become stagnant and useless. He is, by the Divine wisdom and goodness, placed at such a proper distance from us, that, were he much nearer, the blood would boil in our veins, and our bodies soon be either dissolved or calcined : or, were he at a much greater distance, we should become torpid, and presently be congealed to statues of ice. The very bowels of the earth partake of his influence, thus producing many valuable and useful metals. He penetrates the highest mountains, though composed of stones and rocks. He darts his beams even into the depths of the ocean, where the watery tribes live and play at his command.

> "—— O Sun;
> Soul of surrounding worlds! in whom best seen
> Shines out thy Maker!——
> 'Tis by thy secret, strong, attractive force,
> As with a chain indissoluble bound,
> Thy system rolls entire.——
> INFORMER of the planetary train!
> Without whose quick'ning glance their cumbrous orbs
> Were brute unlovely mass, inert, and dead,
> And not, as now, the green abodes of life!

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As the sun is the greatest visible glory in the natural world, so it is selected by the pen of Divine inspiration as the brightest emblem of the Supreme Being—"The Lord God is a sun." This great luminary has been considered by the Heathen as the representative of the Deity, and as such received religious adoration. According to Mr. Bryant's system of Ancient Mythology, the worship of fire is nearly as old as the flood, having been propagated by the posterity of Ham, in Egypt, who called themselves Ammonians, and carried this worship with them wherever they went, erecting their *puratheia*, or fire-temples, in all their settlements. It is stated, that fire was the primitive, or at least the principal object of idolatrous worship, and common to all idolaters from the first apostasy at Babel. For the original institution of this sacred fire among the Chaldeans, we must go back to Nimrod, concerning whom the Alexandrian Chronicon asserts, that "the Assyrians called Nimrod, Ninus; this man taught the Assyrians to worship fire." From the Greeks we may trace it backwards to the Ur of the Chaldeans; on which the learned Classius remarks, that "Ur is the name of a city wherein the sacred fire was conserved and worshipped by the Chaldeans, whence it was called *Ur*, which otherwise signifies *fire*." Plutarch confesses that the Romans, in the days of Numa, borrowed their worship of fire from the Greeks at Athens and Delphi. Numa built a temple of an orbicular form, to represent, as Plutarch interprets, the system of the heavens; which temple was the conservatory of a holy and perpetual fire, kindled at first by the reflections of the sun-beams, and placed in the centre of the building; the astronomy of that early period placing the sun in the centre of the world. Fire has such an affinity to light, that the same word has sometimes comprehended them both. The *Ur* of the Chaldeans was *fire;* the *Horus* of the Egyptians was *light:* and the reason is plain, because fire and light are united at the body of the sun, and by him diffused over the world. If, therefore, we consider fire as called into action by the sun, and bear in mind that the ancient Pythagoreans used the same term ΠΥΡ to denote both fire and the sun,* we shall get at the root of most of the heathen mythologic divinity.

So universal was the attachment to this fire, that Macrobius undertook to reduce the names of all the heathen deities to the one object of the sun and its attributes. He says, "The Egyptians consecrated a lion in that part of the heavens where the heat of the sun is most powerful, because that animal seems to derive his nature from the sun, excelling all other creatures in fire and force, as the sun exceeds the other lights of heaven. His eyes, likewise, are bright and fiery, as the sun with a bright and fiery aspect surveys the world. The Lybians represented their Jupiter Hammon, which was the setting sun, with the horns of a ram, with which that animal exerts its strength, as the sun acts by its rays. The worship of Egypt abundantly shows, that the bull is to be referred to the sun; which is plain from the worship of a bull at Heliopolis, the city of the sun; and of the bull Apis at Memphis, where it was an emblem of the sun; and of the other bull called Paćis, consecrated in the magnificent temple of Apollo at Hermunthis."†

Wheresoever fire was worshipped in the puratheia of antiquity after the manner of Numa, we may suppose that there the true solar system prevailed, which places the solar fire in the centre; and that this was really the universal opinion of the most ancient Heathens. This doctrine agrees with the name which they gave to the sun in his physical capacity, calling him *cor cœli*, the heart of the heaven;‡ which illustration and allusion is probably of very great antiquity, because it cannot with any propriety be applied to the more modern Ptolemaic hypothesis. The analogy is very striking; for as the heart is the centre of the animal system, so is the sun in the centre of our world: as the heart is the fountain of the blood, so is the sun the source of light and fire: as the heart is the life of the body, so is the sun the life and heat of animated nature, and the first mover of the mundane system: when the heart ceases to beat, the circuit of life is at an end; and if the sun should cease to act, a total stagnation would take place throughout the whole frame of nature. Macrobius, pursuing this analogy, says, "We have before observed, that the sun is called the fountain of the ethereal fire; therefore the sun is in the heavens, what the heart is in animals." Since the circulation of the blood has been known, this analogy has been taken up with advantage by the celebrated Hervey himself, who, first of all the moderns, explained to us with sufficient accuracy this branch of natural philosophy.

* Aristotle de Cœl. lib. ii, cap. 13.
† Macrob. Sat. lib. i, cap. 21.
‡ Macrob. in Somn. Scip. lib. i, cap. 20.

He observes, that the heart of animals is the foundation of life, the chief ruler of all things in the animal system, the sun of the microcosm, from which flows all its strength and vigor. The philosophers of antiquity called the sun the heart of the microcosm; the moderns call the heart the sun of the microcosm. There must be something very striking in the analogy which is thus convertible, and has been taken up at both ends by such different persons, at such remote periods of time.

The savage philosophy of America seems to have comprehended in it the relation, which we have already noticed, between the animal system and the frame of nature. Acosta, in his History of the Indies, reports, that in the human sacrifices of the Mexicans, the high priest pulled out the heart with his hands, which he showed smoking to the sun, to whom he offered this heat and fume of the heart, and presently he turned towards the idol, and cast the heart at his face. A very highly esteemed correspondent in Ceylon writes, There is a cast of people inhabiting this island who live wild in the woods, and worship fire as an emblem of purity; they are called Vandals, and several English officers have met a premature death by intruding near the holy fire, which is under a tamarind tree.

With the Persians fire was an object of worship from the earliest times, under the name of *Amanus*, and *Mithas;* and it is retained as such at this day by the Geberrs, Gaurs, Guebres, or Ghebers, a sect of Indian philosophers. Pottinger says, "At the city of Yezd, in Persia, which is distinguished by the appellation of the Darûb Abadut, or seat of Religion, the Guebres are permitted to have an Atush Kudu, or Fire Temple (which, they assert, has had the sacred fire in it since the days of Zoroaster), in their own compartment of the city; but for this indulgence they are indebted to the avarice, not the tolerance of the Persian government, which taxes them at twenty-five rupees each man. Hanway informs us, that the Ghebers suppose the throne of the Almighty is seated in the sun, and hence their worship of that luminary. "As to fire," says Grose, "the Ghebers place the spring-head of it in that globe of fire, the sun, by them called Mithras, or Mihir, to which they pay the highest reverence, in gratitude for the manifold benefits flowing from his ministerial omniscience. But they are so far from confounding the subordination of the servant with the majesty of the Creator, that they not only attribute no sort of sense or reasoning to the sun or fire, in any of its operations, but consider it as a purely passive blind instrument, directed and governed by the immediate impression on it of the will of God; but they do not even give that luminary, all glorious as it is, more than the second rank among his works, reserving the first for the stupendous production of the Divine power, the mind of man." The temples are generally built over subterraneous fires. Rabbi Benjamin observes, "Early in the morning, they (the Parsees or Ghebers of Ouham) go in crowds to pay their devotions to the sun, to whom upon all the altars are spheres consecrated, made by magic, resembling the circles of the sun; and, when the sun rises, these orbs seem to be inflamed, and turn round with a great noise. Every one has a censer in his hands, and offers incense to the sun."

It is not a little surprising that the descendants of faithful Abraham, taken into covenant with God, should fall under the influence of this idolatrous worship! The apostasy of the Israelites in the wilderness from the true God to the golden calf, was occasioned by a previous attachment to the sacred rites of the Egyptian idolatry. And the calves which were afterwards set up in Dan and Bethel, were probably derived from the same source. The Israelites were not only cautioned against this worship, but, if the charge of idolatry brought against an Israelite was proved by unequivooal facts and competent witnesses, it affected his life. Such was the progress of this idolatrous worship among this people at one period, that Josiah, king of Judah, took away out of the temple of the Lord the horses, and burned the chariots, which the kings, his predecessors, had consecrated to the sun. Job, in allusion to this vile worship, says, "If I beheld the sun when it shined, or the moon walking in brightness: if my heart hath been secretly enticed, or my mouth hath kissed my hand:* this also were an iniquity to be punished by the judge: for I should have denied the God that is above." Ezekiel, in a vision, saw "at the door of the temple of the Lord, between the porch and the altar, about five and twenty men, with their backs toward the temple of the Lord, and their faces toward the east: and they worshipped the sun toward the east," in imitation of the Egyptians, Persians, and other Eastern nations.

While the heathen have thus paid idolatrous worship to the sun, some persons, believing in the truth of revealed religion, have entertained strange notions concerning this luminary. It is remarkable, observes a polite writer, that whilst some of the ancients imagined the *sun* to be the seat of future blessedness, from Psal. xix, 14, "He set his tabernacle in the sun," a Mr. Swinden, among the moderns, endeavors to prove that *hell* is seated in the sun, chiefly pleading that this is the grand repository of fire; that its horrible face, viewed by a telescope, suits the description given of the burning lake; and that being in the *centre* of the system, it might be properly said that wicked men were *cast down into it*. But these are mere hypotheses, and unworthy of serious consideration.

Notwithstanding this idolatrous worship of the sun, there is a sober and religious use to be made of this luminary; for being the greatest visible glory in the natural world it is selected as the brightest emblem of the Supreme Being—"The Lord God is a sun." An object thus illustrious and useful in the regular and

* That is, in adoration; from *ad ore*, to the mouth, i. e. *hand* to the mouth.

wise economy of nature, is mentioned in the sacred volume as a metaphor fraught with truths of infinite moment, imparting wisdom to the simple, and instruction to the ignorant. He admirably represents the unity, glory, and bounty of God.

Viewing our sun in all his paramount qualities to every material object in nature, how is he eclipsed and surpassed by the Sun of Righteousness, of whose splendor, grace, and energy this is but a faint emblem, and from whom issues, in bright and gentle beams, all the light, life, joy, and hope received and enjoyed in the Christian world. The one is the most magnificent creature among the vast variety of objects which surround us, but the other is the source of all that is excellent, attractive, and beneficial, in the whole range of material causes and effects, as well as in the nature, extent, and perpetuity of the kingdom of grace. The material sun runs its course from day to day, with unwearied regularity, activity, and ardor, and thus completes its circuit according to its original destination. And did not our adorable Saviour also finish the great career of our redemption, after he had performed all those miracles, and published his own everlasting gospel, which are the sublime and interesting themes of the sacred writers, by offering himself on the consecrated altar a sacrifice for the sins of mankind? The former diffuses light, vitality, vegetation, and felicity through the whole mass of animated nature in our planetary system. And does not the other likewise dissipate the ignorance which darkens the intellectual regions, enlighten our minds in all saving knowledge, and produce in the human heart every grace and virtue?

Were our natural sun to withdraw his beams, or absent himself from the centre of our system for any given time, the planets would start out of their orbits; darkness, black as night, would instantly spread itself over the whole mass, and "chaos come again." And if the glorious Luminary of the moral world were to hide his face behind a thick cloud of gathering vengeance and judicial desertion, this would introduce into the soul alarming fears and tumultuous passions, which would exist in a state of opposition and conflict. Those who have been brought out of the darkness of ignorance, wickedness and misery, into the light of knowledge, holiness and happiness, by Christ, who is the light of the world, should be careful to walk in the light of his countenance all the days of their life. Does not the earth return the fructifying warmth of the sun, and all his genial effects, in a profusion of verdure, foliage, and flowers? Do not all the irrational tribes joyfully greet his rising every morning, and bask in his presence through the day with great delight? All the orbs which revolve round him, and are preserved and cherished in their respective spheres by his ministry, pay him perpetual homage by maintaining invariable harmony and order. And being thus taught by natural objects, what is due for the reception of so many mercies, surely it is an unquestionable duty that we guard against every thing which would prevent us doing the will of our best benefactor.

Christian believers, rich in the bloom of holiness, and ripening for the harvest of glory, are said to be "clothed with the sun." It is the gracious promise, on which all their hopes and wishes confidently rely, that the "righteous shall" ultimately "shine as the sun in the kingdom of their Father."* Thus it is written, "The path of the just is as the shining light, that shines more and more unto the perfect day." In the path of the just there is a progress from a less to a greater light: it does not only grow clearer, but increases in clearness till it is light in perfection; advancing from the break of day to the sun rising, and then to the brightness of noon-day.

"JESUS, let all thy lovers shine,
Illustrious as the sun;
And bright with borrow'd rays divine,
Their glorious circuit run.

Beyond the reach of mortals, spread
Their light where'er they go;
And heavenly influences shed,
On all the world below.

As giants, may they run their race,
Exulting in their might:
As burning luminaries, chase
The gloom of hellish night.

As the bright Sun of Righteousness,
Their healing wings display;
And let their lustre still increase
Unto the perfect day."

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## *Section* II.—THE MOON.

Names—Dimensions—Motions—Seasons—Phases—Harvest Moon—Moon's Surface—Aërial Stones—Eclipses—Moonlight—Epithets—Religious Improvement.

THE *moon* is called a *great light*, but *less* than the sun. Moses does not here speak philosophically, according to her bulk, but to the proportion of light she affords us, which is more than all the planets in the solar system and all the fixed stars put together.

"He smooth'd the rough-cast moon's imperfect mould,
And comb'd her beamy locks with sacred gold;
Be thou, said he, Queen of the mournful night,—
And as he spoke, she rose o'erclad with light,
With thousand stars attending on her train."

The moon is not a primary planet, but only a satellite, or secondary planet, attendant on our earth, round which she revolves, and along with which she is carried round the sun.

"The moon," says Dr. O. Gregory, "is a dark, or opake body, shining principally with the light she receives from the sun. If she shone by a light of her own, we should feel a sensible warmth from her rays; but it is a light reflected from the sun with which she shines, and is so exceedingly weak and languid, that the great-

* Baseley's Glory of the Heavens, pp. 73—76.

est burning glass will not collect enough to make any sensible degree of heat. This has been accounted for, and those who have gone through the computation assert that the light of the full moon is ninety thousand times less than day-light." The ancients early discovered, that the moon had no light of its own, but shone with that which it reflected from the sun. This, after Thales, was the sentiment of Anaxagoras and Empedocles, who thence accounted not only for the mildness of its splendor, but the imperceptibility of its heat, which our experiments confirm.

In the Hebrew language the moon is called ירח *Yarah*, or, more strictly speaking, says Parkhurst, the *lunar light*, or *flux of light, reflected from the moon's body*, or *orb*. That this is the true sense of the word is evident from several passages of Scripture, one of which is, "For the precious (produce) גרש ירחים *put forth by*—what? Not the *orbs* of the moon surely (for the orb is but *one*), but *by the fluxes* or *streams of light* reflected from it, which are not only *several* but *various*, according to the moon's different phases and aspects in regard to the sun and the earth. And this may lead us to the radical idea of the word ירח; for as יחר and אחר, יחד and אחד &c, are very nearly related to each other respectively, so likewise I conjecture that ירח is to ארח, in sense as well as in sound, and consequently that it signifies *to go in a track* or *in a constant customary road* or *way*; and this affords us a good descriptive name of the *lunar light*; for, *Behold*, says *Bildad* in Job, chap. xxv, 5, *even to the* ירח or lunar light ולא יאהיל *and he* (God) *hath not pitched a tent* (for it); as he has for the שמש or *solar light*. No! The *lunar* stream has a *fixed station* from whence it issues, but together with the orb which reflects it, and which like a human *traveller* moves now a quicker, now a slower pace, is continually *performing its appointed journey*, and *proceeding in a constant*, though regularly irregular *track*."

The Greeks called the moon μηνη, which may be considered as a derivative from μην. Parkhurst says, This word may be derived either from μηνη, *the moon*, by the phases of which the month is reckoned, or else it may be deduced from the Hebrew מנה *manah*, *to number*, *compute*, as being computed by the lunar phases. And it is probable that the first *computations* of time were made by the *revolutions* of the moon. It is obvious to remark, that not only these two Greek words, but also the Latin *mensis*, a month, and the English *moon*, *month*, are ultimately derived from the same Hebrew מנה. Leigh observes, that "the Hebrews call the moon and a month by the same name, because the moon is renewed every month. The Greeks also call it σεληνη, from σελας, because it every day renews its light." Parkhurst on the word σεληνη says, "The Greek etymologists, and particularly Plato, deduce it from σελας νεον, *new light*, because its light is continually renewed." But the learned Goguet says, "The Greeks gave to the *moon* the name *selene*, which comes from the Phœnician word

(לן or לון namely) which signifies *to pass the night;* whence also we may observe is plainly derived the Latin name of the moon, *luna*." From *lun* with the termination *a*, comes *luna*, and this name is given to the planet from her *changing* or appearing under different phases.

As to the *dimensions* of the moon, according to the most accurate calculations, her diameter is 2,175 miles, the circumference 6,831 miles, the surface contains 14,898,750 square miles, and its solidity 5,408,246,000 cubical ones. Her bulk is equal to about a fiftieth part of our earth, and her mean distance from the earth is about 240,000 miles.

The *motions* of the moon are most of them very irregular. The only equable motion she has, is her revolution on her own axis. The time in which she moves round her axis is about 27 days, 7 hours, 43 minutes, 5 seconds; and her revolution through an elliptical orbit is performed in the same time as her rotation on her axis, moving about 2,290 miles every hour. Her revolution round her axis exactly in the same time that she goes round the earth, is the reason she always turns the same face towards us: she has only one day and one night in the course of a month. From a long series of observations, it has been ascertained that the moon makes a complete revolution in 27 days, 7 hours, 43 minutes, 5 seconds; this is called the periodical month; but, if we refer to the time passed from new moon to new moon again, the month consists of 29 days, 12 hours, and 44 minutes, which is called the synodical month. This difference is occasioned by the earth's annual motion in its orbit. Thus, if the earth had no motion, the moon would make a complete round in 27 days, 7 hours, 43 minutes, and 5 seconds; but while the moon is describing her journey the earth has passed through nearly a twelfth part of its orbit, which the moon must also describe before the two bodies come again into the same position that they before held with respect to the sun: this takes up so much more time as to make her synodical month equal to 29 days, 12 hours, and 44 minutes. The motions of the hour and minute hands of a watch may serve to give some idea of the periodical and synodical revolutions of the moon; for when the minute hand has performed a complete revolution, it has yet some distance to go to obtain a coincidence with the hour hand, similar to that which it had the preceding hour.

We have observed that the same face is turned towards us during the whole of the moon's revolution, and that the other half of her surface is never visible to us. This arises from the two motions we have noticed, which, with regard to our view of the moon, appear to counteract each other. Her revolution round the earth is performed towards the *east;* while the revolution upon her own axis is performed towards the *west:* so that one of these motions turns as much of her face from us, as the other turns towards us. And from the moon's axis being inclined to the plane of her orbit, sometimes one of her poles is inclined towards the earth, and sometimes the other: in consequence of which, we see more or less of her polar regions in different periods of her revolution. When the moon is in *perigee*, or nearest distance from the earth, her motion is quickest; and when in *apogee*, or most remote distance, her motion is slowest.

The length of the day is equal to our lunar month, for all that time is included in one revolution round her axis. Her days and nights, therefore, will constantly be of the same length, or almost fifteen of our days each. The year will be exactly the same with our year; because, being an attendant on the earth, she must go round the sun in the same time as that does. Her difference of seasons will be much less than on our earth, having only a small inclination of her axis of six degrees and a half; so that the variation between her summer's heat and her winter's cold must be comparatively inconsiderable. Hence there will be only thirteen degrees of Torrid Zone, on some parts most opposite the sun, and thirteen degrees of Frigid Zone on those contiguous to her poles; which consequently must leave seventy-seven degrees for what we should call her Temperate Zones, both in the north and south parts from her Equator. Our earth, unquestionably, performs the office of a moon to the moon, waxing and waning regularly, but appearing thirteen times as large, and, of course, affording her thirteen times as much light as she does to us. When she changes to us, the earth appears full to her; when she is in her first quarter to us, the earth is in its third quarter to her; and *vice versâ*. To the moon the earth seems to be the largest body in the universe, and must indeed be a most magnificent sight.

On the supposition that the moon is inhabited, it may be observed, that those who are placed about the middle of the surface, or face next to us, will constantly see our earth over their heads, and increasing and decreasing in light, like as the moon itself appears to us. Those who are situated near the borders, whether on the right or left, or upon the top or bottom, will also constantly have the same appearance in the opposite part of the horizon. But those who live on the side of the moon which is not presented to us, will know nothing of our earth, or at least, they will never have an opportunity of seeing this large and wonderful moon, without travelling perhaps more than 1,500 of our miles on the surface of that luminary. To those who live on this side of the moon, or travel to it on any account, as we may pass from the northern into the southern hemisphere of our globe, the earth, indeed, when at full to them, will appear to be more than three times as broad as the moon does to us, and to communicate, as has been already mentioned, about thirteen times as much light to her, as she does to us when at the full.

The moon, possessing no native light, shines entirely by light received from the sun, and which is reflected to us from her surface.

That half of her which is towards the sun is enlightened, and the other half is dark and invisible: hence, when she is between us and the sun, she disappears, because her dark side is then towards us. Whilst making her revolution round the heavens, she undergoes a continual change of appearance. She is sometimes on our meridian at midnight, and therefore in that part of the heavens which is opposite to the sun; when she appears with a face completely circular, which is called a *full moon.* As she moves eastward, a part of her dark side comes forward on the western side, and, in a little more than seven days, reaches to the meridian, at about six in the morning, having the appearance of a semicircle, with the convex side turned towards the sun: this crescent gradually becomes more slender, till, about fourteen days after the full moon, being so near the sun, and in a line between that luminary and our earth, she is rendered invisible to us, from the superior splendor of that orb of light. About four days after this disappearance, she may be seen in the evening, a little to the eastward of the sun, in the form of a fine crescent,* as before, but having her convex side turned from the sun. Travelling still towards the east, the crescent becomes wider; and when advanced to the meridian, about six in the evening, she again bears the appearance of a bright semi-circle, with the same difference that we observed of the crescent, that is, its convex side is now turned *from* the sun. Advancing still more eastward, the semi-circular moon widens into an oval shape, till at last, in about twenty-nine days and a half from the last opposition to the sun, she is again in the same situation, and appears a full moon.

The following account of the *harvest moon*, so called, taken from the Pantalogia, will no doubt be acceptable to the reader.—It is remarkable that the moon, during the week in which she is full about the time of harvest, rises sooner after sun-setting than she does in any other full moon week in the year. By this means, she affords an immediate supply of light after sun-set, which is very beneficial for the harvest and gathering in the fruits of the earth; and hence this full moon is distinguished from all the others in the year, by calling it the harvest-moon.

To conceive the reason of this phenomenon, it may first be considered, that the moon is always opposite to the sun when she is full; that she is full in the signs Pisces and Aries in our harvest months, those being the signs opposite to Virgo and Libra, the signs occupied by the sun about the same season; and because those parts of the ecliptic rise in a shorter space of time than others, as may easily be shown and illustrated by the celestial globe: consequently, when the moon is about her full in harvest, she rises with less difference of time, or more immediately after sun-set, than when she is full at other seasons of the year.

* The new moon is often styled a *crescent;* a word formed from the Latin *crescere*, to *grow;* and though it is used [illegible] the same figure of the moon in her wane or decrease, when her horns are turned towards the west, yet these horns always point to the east in the just crescent.

In our winter, the moon is in Pisces and Aries about the time of her first quarter, when she rises about noon; but her rising is not then noticed, because the sun is above the horizon. In spring, the moon is in Pisces and Aries about the time of her change; at which time, as she gives no light, and rises with the sun, her rising cannot be perceived. In summer, the moon is in Pisces and Aries about the time of her last quarter; and then, as she is on the decrease, and rises not till midnight, her rising usually passes unobserved. But in autumn, the moon is in Pisces and Aries at the time of her full, and rises soon after sun-set for several evenings successively; which makes her regular rising very conspicuous at that time of the year.

And this would always be the case, if the moon's orbit lay in the plane of the ecliptic. But as her orbit makes an angle of 5° 18′ with the ecliptic, and crosses it only in the two opposite points called the nodes, her rising when in Pisces and Aries will sometimes not differ above 1h. 40min. through the whole of seven days; and at other times, in the same two signs, she will differ three hours and a half in the time of her rising in a week, according to the different positions of the nodes with respect to these signs; which positions are constantly changing, because the nodes go backward through the whole ecliptic in 18 years 225 days.

This revolution of the nodes will cause the harvest moons to go through a whole course of the most and least beneficial states, with respect to the harvest, every nineteen years. The following table shows in what years the harvest-moons are least beneficial as to the times of their rising, and in what years they are most beneficial, from the year 1790 to 1861: the column of years under the letter L are those in which the harvest-moons are least of all beneficial, because they fall about the descending node; and those under the letter M are the most of all beneficial, because they fall about the ascending node.

HARVEST MOONS.

| L | M | L | M | L | M | L | M |
|---|---|---|---|---|---|---|---|
| 1790 | 1798 | 1807 | 1816 | 1826 | 1835 | 1844 | 1853 |
| 1791 | 1799 | 1808 | 1817 | 1827 | 1836 | 1845 | 1854 |
| 1792 | 1800 | 1809 | 1818 | 1828 | 1837 | 1846 | 1855 |
| 1793 | 1801 | 1810 | 1819 | 1829 | 1838 | 1847 | 1856 |
| 1794 | 1802 | 1811 | 1820 | 1830 | 1839 | 1848 | 1857 |
| 1795 | 1803 | 1812 | 1821 | 1831 | 1840 | 1849 | 1858 |
| 1796 | 1804 | 1813 | 1822 | 1832 | 1841 | 1850 | 1859 |
| 1797 | 1805 | 1814 | 1823 | 1833 | 1842 | 1851 | 1860 |
| | 1806 | 1815 | 1824 | 1834 | 1843 | 1852 | 1861 |
| | | | 1825 | | | | |

When the moon is viewed through a good telescope, there appear vast cavities and asperities on various parts of her face, some of them extremely resembling deep caverns and vallies, and others mountains.

"Turn'd to the sun direct, her spotted disk
Shows mountains rise, umbrageous vales descend,
And caverns deep, as optic tube descries."

The cavities, it is conjectured, do not contain water; hence it is concluded that there can be no extensive seas and oceans, like those which cover a great part of our earth. It is, however, imagined that there may be springs and RIVERS. The moon seems, as a learned author has observed, in almost every respect to be a body similar to our earth, to have its surface diversified by hill and dale, mountains and vallies, rivers and lakes. With regard to a lunar atmosphere, the existence of which has long been a subject of much dispute, it is now generally admitted.* The irregularity of the moon's surface, arising from hills and vallies, renders her more capable of reflecting the sun's rays to us. Though philosophers have differed widely in their ideas concerning the materials of the moon's mountains, some from their brilliancy even supposing them to be rocks of diamonds, there is no diversity of opinion as to their use. If smooth and polished, like a mirror, or covered with water, she would not reflect and distribute the light received from the sun. In some positions she would show us his image no larger than a single point, and with a lustre that would injure our sight: but roughened by these hills and vallies, her surface returns the sun's light to us in an equable and pleasant manner, and enables us to examine her with ease and precision.

That the moon is a planet similar to our earth, is a sentiment very early adopted. Orpheus is the most ancient author, whose opinion on this subject has come down to us. Proclus presents us with three verses of that philosopher, wherein he positively asserts, that the moon was another earth, having in it mountains, vallies, &c. Pythagoras, who followed Orpheus in many of his opinions, taught likewise, that the moon was an earth like ours, replete with animals, whose nature he presumed not to describe, though he was persuaded they were of a more noble and elegant kind than ours, and not liable to the same infirmities. Stobæus gives us the opinion of Democritus about the nature of the moon, and the cause of those spots which we see upon its disk. That great philosopher imagined, that "those spots were no other than shades, formed by the excessive height of the lunar mountains," which intercepted the light from the lower parts of that planet, where the valleys formed themselves into what appeared to us as shades or spots. Plutarch went further, alleging, that there were embosomed in the moon, vast seas and profound caverns: he says, those deep and extensive shades which appear upon the disk of that planet, must be occasioned by *the vast seas* it contains, which are incapable of reflecting so vivid a light, as the more solid and opake parts; "or by caverns extremely wide and deep, wherein the rays of the sun are absorbed," whence those shades and that obscurity which we call the spots of the moon. And Zenophanes said, that those immense

* M. Schroëter, of the Royal Society of Gottingen, has recently published a very curious and elaborate work in German, entitled, Selenotographische Fragmente, &c, or Selenotopographical Fragments, intended to promote a more accurate knowledge of the moon's surface: a valuable extract from which may be seen in the Pantologia, article *Moon*.

cavities were inhabited by another race of men, who lived there just as we do upon earth.

> "And oft I think, fair planet of the night,
> That in thy orb the wretched may have rest."

[The height of the moon's atmosphere is supposed to be 1.622 miles; or a little more than a mile and a half.

The observations on the moon have been so accurate, and so often repeated, by means of the best glasses, that the *map of the moon* is now considered nearly perfect. On this map is laid down the position of *spots, cavities,* and *mountains,* representing their *size, height, depth,* and *peculiarities.* They are very numerous.

Some of these mountains are full *five miles high.* They descend in height, from the highest to small elevations.

Several astronomers, particularly Herschell, has distinctly observed and described *volcanos* in the moon, *actually flaming;* and others in an *expiring state. Craters* of extinct volcanos are visible, and so numerous as to indicate very clearly, that volcanic action was once very extensive and powerful in the moon.

Some of the *cavities* are more than *three miles and a half deep,* and sixteen broad at the surface. *Ferguson's Astronomy, additional chapters by Dr. Brewster.*]

That stones have fallen from the *clouds* or from much *higher regions,* is a fact which has recently been very closely investigated, and also fully demonstrated. A table, constructed by M. Izarn, a foreign chemist, exhibits a variety of facts of this kind, from which the following is an extract.

| *Substances.* | *Places where they fell.* | *Period of their fall.* |
|---|---|---|
| Shower of stones | At Rome | Under Tullus Hostilius |
| Shower of stones | At Rome | Consuls, C. Martius, and M. Torquatus. |
| A very large stone | Near the river Negos, Thrace | Second year of the 78th Olympiad. |
| Three large stones | In Thrace | Year before J. C. 452. |
| Stone of 72 lbs | Near Larissa, Macedonia | January, 1706. |
| About 1,200 stones; one 120 lbs.... Another of 60 lbs | Near Padua, in Italy | In 1510. |
| Another of 59 lbs | On Mount Vasier, Provence | November 27, 1627. |
| Two large stones, weighing 20 lbs. | Liponas, in Bresse | September, 1753. |
| A stony mass | Niort, Normandy | In 1750. |
| A stone of 7½ lbs | At Luce, in Le Maine | September 13, 1768. |
| A stone | At Aire, in Artois | In 1768. |
| A stone | In Le Cotentin | In 1768. |
| Extensive shower of stones | Environs of Agen | July 24, 1790. |
| About 12 stones | Sienna, Tuscany | July, 1794. |
| A large stone of 56 lbs | Wold Cottage, Yorkshire | December 13, 1795. |
| A stone of 10 lbs | In Portugal | February 19, 1796. |
| A stone of 120 lbs | Salé, Department of the Rhone | March 17, 1798. |
| Shower of stones | Benares, East Indies | December 19, 1798. |
| Shower of stones | At Plann, near Tabor, Bohemia | July 3, 1753. |
| Mass of iron, 70 cubic feet | America | April 5, 1800. |
| Mass of do. 14 quintals | Abakauk, Siberia | Very old. |
| Shower of stones | Barboutan, near Roquefort | July, 1789. |
| Large stone, 260 lbs | Ensisheim, Upper Rhine | November 7, 1492 |
| Two stones, 200 and 300 lbs | Near Verona | In 1762. |
| A stone of 20 lbs | Sales, near Ville Franche | March 12, 1798. |
| Several do. from 10 to 17 lbs. | Near L'Aigle, Normandy | April 26, 1803 |

The stones generally appear luminous in their descent, moving in oblique directions, with very great velocities, and commonly with a hissing noise. They are frequently heard to explode, or burst, and seem to fly in pieces, the larger parts falling first. They often strike the earth with such force, as to sink several inches below the surface. They are always different from the surrounding bodies, but in every case are similar to one another, being semi-metallic, coated with a thin black encrustation. They bear strong marks of recent fusion. Chemists have found, on examining these stones, that they very nearly agree in their nature and composition, and in the proportions of their component parts.

Their specific gravities are generally about three or four times that of water, being heavier than common stones. From the above account, it is reasonable to conclude, that they have all the same origin. I believe it is generally agreed among philosophers, that all these aërial stones, chemically analysed, evince the same properties; and that no stone, found on our earth, possesses exactly similar properties, nor in the same proportions: this is an extraordinary circumstance, and deserves particular notice. At the sitting of the Society of Natural History at Halle, July 6, 1816, M. Chladni submitted to the inspection of the members present, a collection of meteoric stones, or stones fallen from the atmosphere; and to the exhibition, he added his own observations on their nature and formation. Dr. Kæstner, taking up the subject in the same point of view which M. Chladni had given of it, admitted that these stones are not natives of this earth, but of other celestial bodies; to which he added, that the chemical analysis of them proves, that many of the same substances as are found in our mountains, and among the solids of our globe, are also component parts of the solids and mountains of other globes; certainly of those celestial bodies which are nearest to us; and probably of the others which form our planetary system.

That these stones are projected from lunar volcanos, very strong reasons have been assigned to prove. As 1. Volcanos in the moon have been observed by means of the telescope. 2. The lunar volcanos are very high, and the surface of that globe suffers frequent changes, as appears by the late observations of Schroëter. 3. If a body be projected from the moon to a distance greater than that of the point of equilibrium, between the attraction of the earth and the moon, it will, on the known principles of gravitation, fall to the earth. 4. That a body may be projected from the lunar volcanos beyond the moon's influence, is not only possible, but very probable; for on calculation it is found, that four times the force usually given to a twelve pounder, will be quite sufficient for this purpose: it is to be observed, that the point of equilibrium is much nearer; and that a projectile from the moon will not be so much retarded as one from the earth, both on account of the moon's rarer atmosphere, and its less attractive force.*

* See Mr. Howard's valuable paper on the Philosophical Transactions for 1802, Dr. Hutton's Dissertation in the New Abridgment, part xxi, and Dr. Adam Clarke on Josh. x, 11.

Of all the phenomena of the heavens, there are none which engage the attention of mankind more than *eclipses* of the sun and moon; and to those who are unacquainted with the principles, nothing can appear more extraordinary than the accuracy, even to a second of time, with which they are predicted. Eclipses of the sun are occasioned by the shadow of the intervening new moon falling on the earth, and those of the moon are caused by the shadow of the earth falling on the full moon, the earth at the full moon being always in a direction between the sun and moon.

It is ascertained that, for an eclipse of the sun to be annular, the most favorable circumstances will be when the sun is in perigee, and the moon in apogee; and, for an eclipse to be total, the most favorable case is when the sun is in apogee, and the moon in perigee. The motion of the moon being much swifter than that of the earth, and the motions of both being directed from west to east, an eclipse of the sun must always begin in the western edge of the sun; and as the moon is a great deal less than the earth, her shadow forms a cone, the section of which is much less than the earth, so that a small portion of the earth only can, at any time, be involved in the shadow at one time. Hence it is, that an eclipse of the sun is not perceived, at the same instant, in every part of the hemisphere that is turned towards the sun, and that, in some parts, it will not be seen at all. For instance, a friend of mine, writing from Ceylon in the month of May, (1817,) says, "On the 16th of this month, we had a fine sight of an eclipse of the sun about noon: I think about 3-4ths of the surface were covered." But in this country we had no solar eclipse at the same time. Again, in different situations, different parts of the sun's disk will appear eclipsed; but, on the contrary, an eclipse of the moon is perceived, at the same moment, in every part of the earth where this planet is visible, and appears every where to occupy the same portion of her disk. Hence, eclipses of the sun are much less frequent in any particular place than eclipses of the moon.

If the nodes of the moon constantly corresponded with the same points in the heavens, the eclipses of the sun or moon might be expected in the same months, and even on the same days; but as the nodes shift backwards, or contrary to the earth's annual motion, about 19½ degrees in a year, the same node will come round about nineteen days sooner every year than in the preceding. From the time, therefore, when the ascending node passes by the sun, as seen from the earth, there will be only 173 days before the descending node passes by him. If, then, at any time of the year, we have eclipses about either of the nodes, their return may be expected in about 173 days, in or near the other.

It may be further observed, that, after the sun, moon, and nodes, have been once in a line of conjunction, they will return nearly to the same state again in 228 lunations, or eighteen years and ten days; so that the same node which was in conjunction with the sun and moon at the beginning of the first of these lunations, will be within less than half a degree of the line of conjunction with the sun and moon again, when the last of these lunations is completed. In that time, therefore, there will be a regular period of eclipses for many ages.

These things being properly considered, it will not be difficult to conceive how astronomers are able to foretell the exact time when any phenomenon of this kind will happen; for, as an eclipse can only take place at the time of a new or full moon, the principal requisites are, to determine the number of mean conjunctions and oppositions that will happen every year, and the true places of the sun and moon in their orbits at each of those times. And, if from this, when proper calculations have been made, it appears that the two luminaries are within the proper limits of the node, there will be an eclipse. To facilitate these operations, we have astronomical tables ready computed, by which the places of the heavenly bodies, and every other particular required, may be easily found for any given instant of time.*

With delight we reflect on the invaluable benefits which this *lesser light* confers on our globe. She sometimes appears visible in the presence of the sun; but how faint and pale is her shining! God has appointed her to *rule the night*, and give light to men. How cheerless and uncomfortable would our nights be, were we destitute of the light which this faithful and inseparable companion of our earth dispenses! How strange are her eclipses, occasioned by the earth interposing and shading her face! but, they are highly useful in astronomical, geographical, and chronological calculations. How salutary, too, is her attractive influence, which sways the ocean, and actuates the world of waters; causing the swelling of the tides, and perpetuating the regular returns of ebb and flow; by which the liquid element itself is preserved from putrefaction, and the surrounding continents from infection and disease.

A moonlight night has led the greatest poets in every age to vie with each other in attempting to describe its beauty and use. Among all the treasures of modern poetry, I know not one superior, for pleasing imagery, and variety of numbers, to that of Milton:

> "Now came still evening on, and twilight grey
> Had in her sober livery all things clad.
> ———————Now glowed the firmament
> With living sapphires: Hesperus, that led
> The starry host, rode brightest, till the Moon,
> Rising in clouded majesty, at length,
> Apparent queen, unveiled her peerless light,
> And o'er the dark her silver mantle threw."

* The principal eclipse of the sun, for the present century, has been already calculated, and it is fully determined that it will take place in the year 1847. It will be annular in this country, and several other places. Time's Telescope for 1815.

The Athenians, according to Plutarch, entertained very terrific ideas of eclipses of the moon. Nicias and his army, when they were on the point of withdrawing secretly from Sicily, without being observed or suspected by the enemy, refused to embark, because the moon became suddenly eclipsed; this ignorant and superstitious conduct proved fatal, for they were all, shortly after, either slain or taken prisoners.

Homer, in the eighth book of the Iliad, gives us a description of a fine moonlight night, which is esteemed a master-piece of nocturnal painting. Milton's pencil leaves off where that of Homer begins:

"As when the Moon, refulgent lamp of night,
O'er heaven's clear azure sheds her sacred light;
When not a breath disturbs the deep serene,
And not a cloud o'ercasts the solemn scene;
Around her throne the vivid planets roll,
And stars unnumbered gild the glowing pole;
O'er the dark trees a yellower verdure shed,
And tip with silver every mountain's head;
Then shine the vales; the rocks in prospect rise;
A flood of glory bursts from all the skies;
The conscious swains rejoicing in the sight,
Eye the blue vault, and bless the useful light."

The wise Son of Sirach, although his writings are not admitted into the sacred canon, deserves to be heard on this subject. He says, "The Lord made the moon also to serve in her season, for a declaration of times, and a sign of the world. From the moon is the sign of feasts, a light decreaseth in her perfection. The month is called after her name, increasing wonderfully in her changing, being an instrument of the armies above, shining in the firmament of heaven; the beauty of heaven, the glory of the stars, an ornament giving light to the highest places of the Lord. At the commandment of the Holy One they will stand in their order, and never faint in their watches." This is paraphrased with great elegance and spirit by Mr. Broome:

"By thy command the moon, as day-light fades,
Lifts her broad circle in the deep'ning shades;
Arrayed in glory, and enthroned in light,
She breaks the solemn terrors of the night;
Sweetly inconstant in her varying flame,
She changes still, another, yet the same!
Now in decrease, by slow degrees she shrouds
Her fading lustre in a vale of clouds;
Now of increase, her gathering beams display
A blaze of light, and give a paler day;
Ten thousand stars adorn her glittering train,
Fall when she falls, and rise with her again;
And o'er the deserts of the sky unfold
Their burning spangles of sidereal gold:
Through the wide heavens she moves serenely bright,
Queen of the gay attendants of the night:
Orb above orb in sweet confusion lies,
And with a bright disorder paints the skies."

Many striking epithets have been given to this refulgent lamp of the night, some of which are noticed by Nichols in his Conference with a Theist. Tully asserts, that the moon was called *Diana*, because she made a day of the night, whilst all other stars did not make a twilight. Æschylus, a tragic poet, born at Athens 397 before the Christian era, calls her πρεσβυστον αστρων, the ancient, the governess, or mother of the stars. Apollinaris, bishop of Hierapolis, in Phrygia, about A. D. 171, denominates her, νυχιων βασιλεια αταρπων, the queen of the nightly paths. Tynesius, who flourished

A. C. 400, styles her, ποιμην νυχιων θεων, the princess of the nocturnal gods: which is consonant to Horace's lucidum cœli decus—syderum regina. Virgil likewise calls her, astrorum decus, the ornament of the stars. Seneca terms her, obscuri dea clara mundi, the bright goddess of the obscure world; and also clarumque cœli sydus et noctis decus, the bright star of heaven, and the grace of the night. Statius, who lived at Rome in the reign of Domitian, in his Thebais, terms her, arcanæ moderatrix Cynthia noctis, the moon the governess of silent night. "Fair as the moon," was an ancient manner of describing beauty, and, it is said, still prevails in the East.

Among the ancients, observes Mr. Butler, the moon was an object of prime respect. By the Hebrews, she was more regarded than the sun, and they were more inclined to worship her as a deity. The *new* moons, or first days of every month, were observed as festivals among them, which were celebrated with sound of trumpets, entertainments, and sacrifice. The moon was the goddess of the Phœnicians, whom they worshipped under the name Ashtoreth, or Astarte. The moon is sometimes in Scripture styled, the "queen of heaven." She is likewise styled, "the goddess of the Zidonians," and "the abomination of the Zidonians," as she was worshipped very much in Zidon, or Sidon, a famous city of the Phœnicians, situated upon the eastern coast of the Meditterranean. Solomon, who had many wives that were foreigners, was prevailed upon by them to introduce the worship of this goddess into Israel, and he built her a temple on the mount of Olives, which, on account of this and other idols, is called "the mount of corruption."* Milton says,

"There stood
Her temple on th' offensive mountain, built
By that uxorious king, whose heart, though large,
Beguil'd by fair idolatresses, fell,
To idols foul."

The *full* moon was held favorable for any undertaking by the Spartans; and no motives could induce them to enter upon an expedition, march an army, or attack an enemy, till the *full* of the moon. It is usual with the modern Arabians to begin their journeys at the *new* moon; a practice which, indeed, appears to be very ancient. When the Shunammite proposed going to Elisha, her husband dissuaded her by observing that it was neither *new* moon nor sabbath.

* A valuable correspondent writing from Matura, in Ceylon, May 7, 1817, says, "A festival was lately celebrated here, principally on the river. A large boat was rigged for the purpose, somewhat after the manner of a ship, which carried a number of dancers and other persons in disguise, accompanied with the music of pipes and drums. I particularly inquired into the meaning of the ceremonies; and, as far as I could learn, it was a celebration of the birth of the sun and moon. The world is believed to have been once inhabited by holy brahmins, whose bodies were transparent, and afforded sufficient light. When these fell into sin, they lost their splendor, and other lights became necessary."

The African negroes, in the West Indies, on seeing the *new* moon, take out of their pocket a piece of whatever money they have, and, holding it up in their hand, say, "God bless the new moon, this is all I can give you; take this, and give me good luck:" and then throw it up toward it. After this action, they believe that prosperity will attend them during the time that moon continues. On embracing the Christian religion, they lay aside this heathenish practice.

1. The *moon* is an emblem of the *church* of God, which receives its light from Christ as the moon does from the sun. Especially, of the Jewish dispensation, which consisted much in the observation of new moons, its solemn feasts being governed by them. The Jewish dispensation was a veiled and shadowy one: Christ and the blessings of the covenant of grace were revealed in dark promises, obscure prophecies, types and ceremonies, which were all significant figures of that grace which should be displayed, with fulness and evidence, under the Christian dispensation. The Jewish economy exhibits such marks of imperfection, as show the necessity of some new revelation to supply its defects. Its rites and precepts seem to be particularly suited to the condition, capacity, temper and genius of that particular people, for whom they were first formed, but not to be calculated for general use. It consisted chiefly of external performances, such as washings, sacrifices, and oblations, which could not purify the conscience, nor, indeed, satisfy the reason of man. The provision for sin, by way of atonement, was partial, and not thoroughly effectual: for some sins no sacrifice was admitted; and though sacrifice, where it was appointed, might atone for ceremonial impurity, yet the inward guilt and defilement still remained, and the justice of God was not satisfied. Yet the observance of these was enjoined in a very awful manner. The omission of what was prescribed by these laws, or even a defect in observing the minute circumstances of them, was made a capital crime, or rendered the delinquents liable to be cut off from the congregation. The Apostle styles the whole code of these laws, "a yoke of bondage;" and says, that, previous to the coming of Christ, the Jews were in bondage under what he terms "the beggarly elements of the world."

There were indeed wise reasons for such a dispensation: to keep the Jews a distinct people, and preserve them from idolatry, while they were continually employed in the service of God; to remind them of their obligations to purity, inward and outward holiness; and, as a schoolmaster, to bring them to Christ; the law being a type and shadow of that "truth and grace which came by Jesus Christ," who was "the end of the law for righteousness." On which account, the law of Moses was not perpetual, but a temporary institution: thus the Apostle reasons, "There is verily a disannulling of the commandment going before for the weakness and unprofitableness thereof; for," as he says in another place, "the law could not in any wise make the comers thereunto perfect." He calls the law, "a shadow of good things to come." The Levitical ceremonies led the Jewish church into the knowledge of the promised Messiah, and what he was to do, suffer, purchase, and apply. Hence the words of St. Peter, "Of which salvation the prophets have inquired and searched diligently, who prophesied of the grace that should come unto you: searching what or what manner of time the Spirit of Christ which was in them did signify, when it testified beforehand the sufferings of Christ, and the glory that should follow. Unto whom it was revealed, that not to themselves, but unto us they did minister the things which are now reported unto you by them that have preached the gospel unto you, with the Holy Ghost sent down from heaven." The Christian dispensation is attended with greater clearness. We have a far more comprehensive knowledge of the glorious Redeemer, in his person, natures, offices, and blessings; of the spiritual nature of his kingdom, and the way of salvation through faith in him, than what the Jews had. Thus the Apostle says, "But we all with open face beholding as in a glass the glory of the Lord, are changed into the same image, from glory to glory, even as by the Spirit of the Lord."

In the Revelation, we have this representation given of the Christian church: "And there appeared a great wonder in heaven; a woman clothed with the sun, and the moon under her feet, and upon her head a crown of twelve stars." An author, quoted by Dr. A. Clarke, gives the following elucidation of this passage.— That the woman here represents the true church of Christ, most commentators are agreed. In other parts of the Apocalypse, the pure church of Christ is evidently pourtrayed by a woman. In chapter xix, verse 7, a great multitude are represented as saying, "Let us be glad and rejoice, and give honor to him; for the marriage of the Lamb is come, and his *wife* hath made herself ready." In chapter xxi, 9, an angel talks with St. John, saying, "Come hither, I will show thee the *bride*, the Lamb's wife." That the Christian Church is meant will appear also from her being "clothed with the sun," a striking emblem of Jesus Christ, the Sun of Righteousness, the light and glory of the Church; for the countenance of the Son of God is, as "the sun shineth in his strength." The woman has the "moon under her feet." Bishop Newton understands this of the Jewish typical worship; and, indeed, the Mosaic system of rites and ceremonies could not have been better represented. The moon is the less light, ruling over the night, and deriving all its illumination from the sun: in like manner, the Jewish dispensation was the bright moonlight night of the world, and possessed a portion of the glorious light of the gospel. At the rising of the sun the night is ended, and the lunar light no longer necessary as the sun which enlightens her shines full upon the earth: exactly in the same way has the whole Jewish system of types and shadows been superseded by the birth, life, crucifixion, death, resurrection, ascension, and intercession of Jesus Christ. Upon the head of the woman is "a crown of twelve stars;" a very significant representation of the *twelve apostles*, who were the first founders of the Christian church; and by whom the gospel was preached in a great part of the Roman empire with astonishing success.

2. The phenomenon of the moon is *mutability*. This beautiful luminary, whose gentle beams render the summer evenings still more agreeable, and in the winter nights cheer the abodes of solitude, and aid the midnight traveller, is perpetually changing. In this, and in nothing but this, observes Mr. Basely, she is invariable, and a perfect index to all within her orbit. This should teach us, says Mr. Browne, that there is not any thing permanent in the present scene. Mutability is engraved in legible characters upon every earthly object. Every thing is in motion, and assuming a different appearance, whilst vicissitude and change wait on the affairs of mortals. Such is the fluctuating state of the present world, whether we view kingdoms in general, or the personal concerns of men in particular.

But while these things are fortuitous as to man, we should reflect that they are under the direction and control of a Divine providence. The prosperous issue of all our designs and enterprises depends entirely on the sovereign disposer of events. "Except the Lord build the house, they labor in vain that build it; except the Lord keep the city, the watchman waketh but in vain." "A man's heart deviseth his way; but the Lord directeth his steps;" the result of his designs and projects being under the dominion and direction of God. Whether his undertaking shall succeed or fail, belongs alone to the Most High to determine. Let as arrange our worldly concerns in the most prudent and politic manner, so that there shall appear the greatest probability of success, yet God has the ordering of the event. Solomon has long since observed, that, amongst the many vanities under the sun, one is, "the race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding, nor yet favor to men of skill: but time and chance happeneth to them all." Some unforeseen circumstance may interrupt our pursuit, and disappoint our expectation. So great is the uncertainty which attends all human affairs, and all future events are concealed in such thick darkness, that we can never positively affirm that this or the other scheme, however wisely laid, cannot be frustrated, or that it is impossible the success should be otherwise than as we calculate. No man knows what shall be on the morrow; the only thing we know previously is, that every event shall be as God is pleased to settle it.

This consideration, that it is not by our own choice and foresight, but the will and wisdom of God, our affairs are directed and determined, we should apply to ourselves. We are not competent to mark out our own ways, nor can we seriously imagine that matters should be arranged exactly according to our imperfect views and secret inclinations; but we should refer ourselves to his guidance who cannot err, and willingly acquiesce in his providential decisions: saying, "I know, oh Lord, that the way of man is not in himself: it is not in man that walketh to direct his own steps." We are commanded by the Apostle James to say, "If the Lord will, we shall live, and do this, or that." And Solomon's advice is, "Trust in the Lord with all thine heart; and lean not unto thine own understanding. In all thy ways acknowledge him, and he shall direct thy paths." Concerning all our lawful designs, enterprises, and projects, we may pray, "Establish thou the work of our hands upon us; yea, the work of our hands establish thou it."

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## *Section* III.—The Seasons.

Seasons: Spring, Summer, Autumn, Winter—Displaying Divine Power, Wisdom, Goodness, Faithfulness—Religious Improvement.

The Divine Architect appointed the sun and moon the places of their rising, the circuits they were to run, and where they were to go down: he marked out the line in which they were to move through all the different climates of the earth. They instantly obeyed his all-powerful word, and have ever since acted faithfully to his command. In their operations, they measure out our days and nights, distinguish between different periods of time, and produce the several seasons of the year.

> "With what an awful world-revolving power
> Were first th' unwieldy planets launched along
> Th' illimitable void! Thus to remain
> Amid the flux of many thousand years,
> That oft has swept the toiling race of men
> And all their labored monuments away,
> Firm, unremitting, matchless in their course;
> To the kind tempered change of night and day,
> And of the seasons ever stealing round,
> Minutely faithful."

God is the supreme ruler in the kingdom of nature, and the constant changes of day and night, summer and winter, seed-time and harvest, are appointed and regulated by his providential influence. This wonderful and stupendous system, consisting of matter, is preserved by motion. Deprive it of motion, and, as a system, it must expire. Who, then, breathed into this amazing combination of things acting together, the life of motion? What power impelled the planets to move, since motion is not a property of the matter of which they are composed? Did not annual observation familiarize it to us (to speak unphilosophically), who that observes the sun going in appearance further from us during six months in succession, and all that time decreasing in light and heat, could ever think that he would again return to us? What hinders his projection into boundless space, till he should appear no larger than a star, or get beyond the reach of our powers of vision? What, but the immediate control of God! for this is a work superior to all created strength, and only to be effected by almighty energy.*

When we have seen that glorious lamp of heaven, the great ruler of the day, gone so far from us that we scarcely knew how to stand before the cold, how has his return revived and cheered us, visiting the frozen earth with his friendly beams, infusing a genial warmth into every creature, and inspiring us with the pleasing hope of once more enjoying those various fruits of the earth, which are the liberal gifts of an indulgent Providence! It is the Divine Being who commands the sun to rise, who, "coming out of his chamber" in the east, rejoices as a strong man to run a race. Again, he bids this glorious orb to withdraw, and obscure his beauty behind thick clouds, or sink below the western ocean; when, behold, the day is covered with darkness, and night succeeds. At his sovereign command, the glowing summer recedes, and winter approaches with chilling aspect. "He sends his snow like wool, and scattereth his hoar frost like ashes. He casteth forth his ice like morsels: who can stand before his cold?" He then recalls the solar influence, scatters the inauspicious clouds, thaws the frozen ridges of the field; the corn springs up and flourishes, and the heart of man rejoices with the pleasing hope of a plenteous harvest. Thus does the almighty Creator, and beneficent Governor of the world, order and regulate the constant succession of the seasons; his Providence over-rules and directs the whole movement, and nothing can come to pass without his superintendence.

Reason, as well as supernatural revelation, asserts the reality of a Divine providence. The happiest inquirers into the phenomena of nature have discovered that every thing is made with the justest proportion, and that the whole machine is directed according to the most exact rules: but they have also perceived a power above and beyond the energy of natural principles, and which could not possibly be accounted for any other way than by admitting an immediate act or influence of the supreme Being. In the revolving of the celestial orbs, we observe an exact agreement with the established laws of mechanism: but, yet, there is a force demonstrable in them which is altogether immechanical; and, consequently, immediately issuing from God himself.

The remarks made by Dr. A. Clarke on this point, will, it is presumed, gratify the intelligent reader. "The *double motion* of a primary planet, namely, its *annual* revolution and *diurnal* rotation, is one of the greatest wonders the science of astronomy presents to our view.—The laws which regulate the latter of these motions are so completely hid from man, notwithstanding his present great extension of philosophic research, that the times which the planets employ in their rotations can only be determined by

* On the dial of the cathedral at Bruges, the sun is represented directing the hours, with this motto, *Non rego, nisi regar*: signifying, that the sun could not rule the day, if it was not first ruled itself. Had the Pagan world known this truth, the greatest part of it had not fallen into idolatry.

observation. How is it that two motions, so essentially different from each other, should be in the same body, at the same time, without one interfering at all with the other?—No astronomer, since the foundation of the world, has been able to demonstrate that the earth's motion in the heavens is at all accelerated or retarded by the diurnal rotation; or, on the other hand, that the earth's motion on its axis experiences the least irregularity from the annual revolution."

The rotation of the earth round its own axis, from west to east, once in 23 hours, 56 minutes, 4 seconds, is the cause of the distinction between day and night, by bringing the different parts of the earth's surface successively into, and from under the solar rays. And the revolution of the earth round the sun, from any equinox or solstice to the same point again, in 365 days, 48 minutes, 48 seconds, produces the agreeable vicissitudes of the seasons, and measures the length of our year. For though the revolution is that of the earth, yet both the hours of the day and night, the different lengths of the days and nights, and the seasons of the year, cannot be determined but by the heavenly bodies. Thus the earth has a two-fold motion, like a chariot-wheel; for while it goes forward on its annual journey, it is still in its diurnal motion turning upon its own centre. But it differs from the motion of a chariot-wheel in this: that its hourly motion in its orbit is 75,222 miles; and that by the motion upon its axis, the inhabitants on the equator are carried after the rate of 1,042 miles an hour, and those upon the parallel of London 580 miles.

The Dr. proceeds, "How wonderful is this contrivance! and what incalculable benefits result from it! The uninterrupted and equable diurnal rotation of the earth gives us day and night in their succession, and the annual revolution causes all the varied scenery of the year. If one motion interfered with the other, the return of the day and night would be irregular; and the change of seasons attended with uncertainty to the husbandman. These two motions are, therefore, harmoniously impressed upon the earth, that the gracious promise of the great Creator might be fulfilled, 'While the earth remaineth, seed-time and harvest, and cold and heat, and summer and winter, and day and night, shall not cease.'

"The double motion of a secondary planet is still more singular than that of its primary; for (taking the moon for an example) besides its particular revolution round the earth, which is performed in 27 days, 7 hours, 43 minutes, 4½ seconds; it is carried round the sun with the earth once a year. Of all the planetary motions, with which we have a tolerable acquaintance, that of the moon is the most intricate: upwards of twenty equations are necessary, in the great majority of cases, to reduce her mean to her true place; yet not one of them is derivable from the circumstance that she accompanies the earth in its revolution round the sun. They depend on the different distances of the earth from the sun in its annual revolution, the position of the lunar nodes, and various other causes, and not on the annual revolution itself, a motion which, of all others, might be expected to cause greater irregularities in her revolution round the earth than could be produced on that of the latter by the planetary attractions. Who can form an adequate conception of that influence of the earth which thus draws the moon with it round the sun, precisely in the same manner as if it were a part of the earth's surface, notwithstanding the intervening distance of about 240,000 miles; and, at the same time, leaves undisturbed the moon's proper motion round the earth? And what beneficent purposes are subserved by this harmony? In consequence of it, we have the periodical returns of new and full moon; and the ebbing and flowing of the sea, which depend on the various lunar phases, with respect to the sun and earth, (as if demonstrable from each of these phases being continually contemporaneous with the particular phenomenon of the tides,) always succeed each other with a regularity necessarily equal to that of the causes which produce them. Thus we see that God is continually present, supporting all things by his energy, and that, while his working is manifest, his ways are past finding out."

Thomson, in his descriptive, philosophical, moral, and religious poem, admirably well delineates the revolving seasons.

"These, as they change, ALMIGHTY FATHER, these
Are but the *varied* God. The rolling year
Is full of thee. Forth in the pleasing spring
THY beauty walks. THY tenderness and love
Wide flush the fields; the softening air is balm;
Echo the mountains round; the forest smiles;
And every sense, and every heart is joy.
Then comes THY glory in the summer-months,
With light and heat refulgent. Then THY sun
Shoots full perfection through the swelling year:
And oft THY voice in dreadful thunder speaks;
And oft at dawn, deep noon, or falling eve,
By brooks and groves, in hollow-whispering gales.
THY bounty shines in Autumn unconfin'd,
And spreads a common feast for all that lives.
In Winter awful THOU! with clouds and storms
Around THEE thrown, tempest o'er tempest roll'd,
Majestic darkness! on the whirlwind's wing,
Riding sublime, THOU bidst the world adore,
And humblest nature with THY northern blast.
Mysterious round! what skill, what force divine,
Deep felt, in these appear! a simple train,
Yet so delightful mix'd, with such kind art,
Such beauty and beneficence combin'd;
Shade, unperceiv'd, so softening into shade;
And all so forming an harmonious whole;
That, as they still succeed, they ravish still."

He who governs the whole frame of nature, and directs and regulates these successive changes, must possess almighty *power*, without which, he would be infinitely inadequate to the task. He who made the celestial orbs of such a prodigious bulk, and whirls them round with an almost incredible swiftness, causing the regular return of day and night, summer and winter, what can he not do? None among the mighty host of heaven, or among the inhabitants of the earth, can resist his power, or stay his arm when lifted up. He who created all things out of nothing, could, if he pleased, extinguish the lights of heaven, and shake the solid earth to atoms. How easily, then, can he stop our breath, break the slender thread of life, dissolve our feeble frame, or hurl guilty and impenitent sinners into the pit of destruction! He who brought darkness for the space of three days upon the Egyptians, and a dreadful tempest of forty days and forty nights upon the inhabitants of the old world, can make the days of the ungodly darkness, and their nights full of horror. He can strike them with "the arrow that flieth by day," his swift pointed lightning; or with the pestilential vapors of the night, which "walk in darkness," and give the deadly stroke unseen.

> "Lord, when my thoughtful soul surveys
> Fire, air, and earth, and stars and seas,
> I call them all thy slaves;
> Commissioned by my father's will,
> Poison shall cure, or balm shall kill;
> Vernal suns or zephyr's breath,
> May burn or blast the plants to death,
> That sharp *December saves.*
>
> What can winds or planets boast
> But a precarious power?
> The sun is all in darkness lost,
> Frost shall be fire, and fire be frost,
> When he appoints the hour."

Shall not, then, such a frail creature as man, think and speak of this omnipotent Being with the greatest reverence and profound humility? Oh God, fill the minds of all men with just and enlarged views of thy majesty and greatness! for thou killest, and thou makest alive; thou woundest, and thou healest: neither is there any that can deliver out of thy hand.

Divine *wisdom* also shines forth in the regular and uninterrupted succession of the seasons. "The Lord by wisdom hath founded the earth, and by understanding established the heavens." Not only the different magnitudes of the heavenly orbs, but their particular distances, and the harmonious laws by which they move, do loudly proclaim, that he who formed, ranges, and actuates them all, must be infinitely wise. Without looking into boundless space, where shine many thousand globes of light, or fixed stars, supposed to be suns like our own, and to have planets revolving round them, we may discover luminous displays of Divine wisdom in our own system, in the constant succession of the seasons, that may justly excite our wonder and adoration. How wise must he be who has so exactly proportioned the different magnitudes of the earth and the sun, and placed them at a proper distance from each other! Is not equal wisdom discovered in that equable, steady, swift, and complicate motion of the earth, by which the delightful and necessary succession of the seasons return? It is the wisdom of God that at first arranged the motion of the celestial bodies, and that preserves them in their rapid and yet regular progressions and rotations, with so much order and harmony. "How manifold, oh Lord, are thy works! in wisdom hast thou made them all. Thy understanding is infinite, for thou tellest the number of the stars, and callest them all by their names."

The *goodness* of God to the inhabitants of the earth, is also displayed in the revolving seasons. When the almighty Creator took a survey of all the works his hands had made, he saw that they were good; not only conformable to eternal reason, but proper to answer the end for which he designed them. And this goodness manifested in the formation of the world, is not more clearly discovered in any thing than in the return of day and night, heat and cold, summer and winter. We are pleased with the light in the morning, but it is after we have rested well in the night: when a few hours are spent, we grow weary of the light, and wish for the return of the silence and darkness of the nocturnal season. After a long cold winter, we joyfully welcome the approach of summer; but when scorched a few months with its heat, and ready to faint, the return of winter is not so unpleasant to us as it appeared more early in the spring. But whatever effect these successions may have upon us, it is certain they are very beneficial. The light of the day is advantageous for managing the toils and business of life; and the coolness and stillness of the night are as suitable for rest and sleep. The summer's heat is necessary for ripening the fruits of the earth, and hastening the harvest: but the winter's cold and hoary frost are subservient to prepare the earth for the seed, and render it fertile. Nay, this dreary season is serviceable both to man and beast; it tends to remove distempers contracted in the summer's unwholesome air, and gives a new spring and vigor to nature. How great, then, is the Divine goodness in preserving the constant and regular revolution of these seasons, so pleasant and beneficial to mankind! "Oh that men would praise the Lord for his goodness, and for his wonderful works to the children of men."

We cannot but perceive the *faithfulness* of God in continuing these seasons, according to his promise, to this period. We still see day succeeding day, and year succeeding year: this covenant made with mankind is inviolably kept. The husbandman cultivates his land, ploughs up the furrows, casts in the seeds, in hope of the ensuing harvest, when he expects that his expense, labor, and patience, will be recompensed with a rich and large increase. But should God, in anger, open the bottles of heaven, pour down the rain in torrents, cause swelling floods to arise, and, rolling with alarming impetuosity forward, to sweep away at once the fruit of all his toil, how great must be his grief and astonishment! Such were the consternation and confusion that seized mankind at the time of the flood. The husbandman had tilled his land, thrown his seed into the ground; he saw it with pleasure springing up, and promised himself a plentiful harvest: when quickly, all the flood-gates of heaven were opened, all the fountains of the great deep were broken up, and a rapid current overflowed the springing corn, swept away numerous flocks of cattle, overthrew the habitations of the people, and drowned man and beast to the very tops of the mountains! But in this general ruin, Noah found favor with God, and he and his family were preserved in the Ark. When the waters had abated, and the earth became dry, this pious patriarch, being much affected with the awful judgment inflicted upon mankind, especially with the distinguishing mercies conferred upon himself and family, offered sacrifice, in testimony of his gratitude, to his great Deliverer, who was well-pleased with it. And on this, he made a covenant with him, and with all his posterity, in which he promises that he will not again curse the ground for man's sake, nor any more smite every living thing, but that, "while the earth remaineth," the successive seasons of the year shall be continued. The awful disobedience of the inhabitants of the old world rendered it necessary to inflict so dreadful a judgment; but as soon as it had subsided, God promised never to punish mankind again so universally. And, in token of his faithfulness, he set the rainbow in the cloud, to be a sign of his covenant, which has not been broken, but faithfully kept even to this day. However the Almighty may contend in anger with particular nations or provinces, he will no more do so with mankind in general.

How happy is the situation of our native isle! There are few countries, if any, that exceed it. The climate is temperate; neither days nor nights are ever of immoderate length; the summer and winter are neither extremely hot, nor excessively cold; the seed-time and harvest are generally favorable, and the produce of the land is plenteous. The inhabitants of some countries endure a long and severe winter, seeing not the sun for many weeks: nay, there are some places where it rises not for several months; but these parts are not inhabited in the winter season. In other countries, the inhabitants are scorched with the rays of a vertical sun, and wish in vain for the cooling winter's snow. Some know not what is meant by the heat of summer, and others are as ignorant of the cold of winter. Some see the sun, but comparatively feel not his warming influence; while others are penetrated with his burning rays all the year. But the people of this country have moderate summer, heat sufficient for ripening the most useful fruits, and winter that may be well endured. The days are not so hot in the summer, but the nights are sufficiently cool for allaying the heat; and they are long enough in winter for managing the business that is requisite to be done. Some warmer climates produce more delicious fruits: but no country under the canopy of the heavens does more abound with all the substantial supports of life; not only equal to our own consumption, but frequently to enable us to assist our neighbors. Happy are the people that are in such a case: yea, thrice happy are they whose God is Jehovah. All his works praise him: may we join the grand chorus, and bless his holy name. Surely, if the works of creation were attentively viewed, and seriously considered, they would not only be truly admired, but their glorious Author would be sincerely regarded, diligently worshipped, and practically obeyed.

The following table has been ascribed to the illustrious astronomer, Dr. Herschell. It is constructed upon a philosophical consideration of the attraction of the sun and moon in their several positions respecting the earth, and confirmed by the experience of many years: actual observation will, without trouble, suggest to the observer what kind of weather will most probably follow the moon's entrance into any of her quarters; and that so near the truth, that in very few instances will it be found to fail.

| *New or Full Moon.* | *Summer.* | *Winter.* |
|---|---|---|
| If it be new or full moon, or the moon enters into the first or last quarters at the hour of 12. | Very rainy | Snow and rain. |
| Or between the hours of 2 and 4 | Changeable | Fair and mild. |
| 4 - 6 | Fair | Fair. |
| 6 - 8 | Fair, if wind N. W.<br>Rainy, if S. or S. W | Fair and frosty, if N. or N. E.<br>Rainy, if S. or S. W. |
| 8 - 10 | Ditto | Ditto. |
| 10 and Midnight | Fair | Fair and frosty. |
| Midnight and 2 | Ditto | Hard frost, unless wind S. or S. W. |
| 2 - 4 | Cold, with frequent showers | Snow and Stormy. |
| 4 - 6 | Rain | Ditto. |
| 6 - 8 | Wind and rain | Stormy. |
| 8 - 10 | Changeable | Cold, rain if W. snow if E. |
| 10 and Noon | Frequent showers | Cold, with high wind. |

Hence, the nearer the time of the moon's entrance, at full and change, or quarters, is to midnight (that is, within two hours before or after midnight), the more fair weather is in summer, but the nearer to noon the less fair. Also, the moon's entrance, at full, change, and quarters, during six of the afternoon hours, viz. from four to ten, may be followed by fair weather; but this is mostly dependant on the wind. The same entrance, during all the hours after midnight except the two first, is unfavorable to fair weather; the like, nearly, may be observed in winter.*

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It is an easy and excellent method of conveying instruction, and impressing it upon the heart, to take occasion from natural objects to raise the mind to things spiritual and divine. The day and

* Literary Panorama, for January, 1814, pp. 954, 955.

night, and their alternate changes, may suggest such thoughts as the following, to a serious mind engaged in meditation.

What a glorious creature is light! How beneficial to this world! How useful, nay, how necessary for managing those employments which could not be done in the night! How unwise, then, is he who postpones the necessary business of the day till night overtake him?—So beneficial, so requisite, is the light of life in the important work of human salvation. Does God allow men a day, a gracious season, and the light of his word, for the good of their souls? Of what extreme folly shall they be guilty, if they neglect the necessary business till the night of death come, and they drop into the grave, where there is neither work, nor wisdom, nor device! Now is the day of grace, and God is favoring them with the light of reason and revelation. May he give them wisdom to improve these advantages, to his glory, and their own happiness! They know not how soon their sun may set, and the night of death come upon them. If it should be before their everlasting interest is secured, they will be lost for ever. Oh Lord, teach us so to number our days, that we may apply our hearts to wisdom!

Night comes on apace; I must soon undress, and lie down to sleep. And it cannot be long before I must put off this body, lie down in the grave and sleep in the dust. What shall I do that my soul may not be found naked, but be clothed and adorned with the glorious robes of righteousness? Jesus, to whom shall I go but to thee, for thou hast the words of eternal life!—How awful, and full of horror, is this approaching darkness! If the imperfection of man did not require the rest of sleep, surely it would be a pleasant thing always to dwell in the light. Will it not then, be unspeakably delightful to abide in the light of God's countenance, to see the Divine Majesty with a strong and open eye? and to behold his unutterable glories without any fear of being deprived of the beatific vision, or of returning night? But oh! how dismal must that place of darkness be where the light never shines! where the miserable inhabitants never see one beam of Divine light, one ray from God's reconciled face! where the grossest darkness reigns for ever, without the least hope of returning day! and where nothing remains for them, but a black, a horrible, an eternal night!

> "Is light so grateful to the human sense?
> Created light? a faint, refracted ray?
> One, distant sun? the shadow, but, of God!
> Dark adumbration of the DEITY?
> Oh! what is heav'n! that day of endless light?
> Where saints shall from th' essential fountain drink
> Of radiance! in God's full, paternal shine?
> Ah! what is Hell? of ever-absent day,
> A night all hopeless!—and all endless too!"

The successive changes of day and night may suggest what is frequently the condition of good people in this world. Their day of prosperity is sometimes followed with a night of adversity; and then, when sorrow and weeping have endured for a night, light and joy spring up in the morning.—Is the light of the day pleasing? rejoice in it with trembling, for the night is advancing. Is the darkness of the night solemn and awful? rejoice in hope that the day is approaching. Hence be instructed, oh my soul, in the concerns of thy eternal welfare. Are prosperity, health, and relatives, agreeable? rejoice in them as one that rejoices not: these must have an end; and adversity, sickness, and death, will come. Are losses, affliction, and pain, not joyous, but grievous? mourn as one that weeps not: ease, health, and gladness, are in prospect, and will continue for ever. And how happy and glorious will that world be, where light and joy shall never cease! But how dreadful is that abode where darkness, despair, and anguish shall never end!

The succession of cold and heat, winter and summer, will always suggest pious and useful reflections in retirement. How pleasing it is to see the sun return, and to feel his cheering rays, after a long, cold, and tempestuous winter! So it is delightful to the humble penitent sinner, after a long season of darkness and sorrow, when the Sun of Righteousness arises with his reviving influences, and God lifts upon him the smiles of his reconciled countenance. All misery, and clouds of doubt and fear, are then dispersed, and heavenly light breaks into the soul, and fills it with gladness. And does the want of the light of God cause the serious Christian to mourn and weep, and taste no sweetness in any of the comforts of life? How extremely miserable, then, must a person be, who is driven to an everlasting distance from the presence of God, and from the glorious Sun of Righteousness; only to see his glory very remote, but never to feel the reviving beams of his love; and to be punished in hell, far "from the presence of the Lord, and the glory of his power."

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## *Section* IV.—The Planets and Fixed Stars.

Mercury—Venus—The Earth—Mars—Ceres—Pallas—Juno—Vesta—Jupiter—Saturn—Georgium Sidus—Comets—Fixed Stars—Religious Improvement.

Moses, after stating that God created the sun and the moon, says, "he made the stars also." A learned author explains it, "he made the lesser light, with the stars, to rule the night." It is very probable that the whole *solar system* was created in six days: but as the design of the sacred historian was to relate what especially belongs to our globe and its inhabitants, he therefore passes by the planetary system, leaving it simply included in the plural word, שמים *shamayim, heavens.* In a work of this nature, it is proper to take a concise view of all the planets, their number, distances, magnitudes, revolutions, &c.

*Wandering Stars*, says Baseley, is one of the many appellations by which our solar system has been sometimes designated. And the figure it makes in the heavens is not unaptly expressed by the phraseology. For we distinguish the planets from the fixed stars by the lustre of the former, which is only from that side which faces the sun, and by their motion, which is seldom, and then but apparently, interrupted. Their brightness seems more uniform, has the cast of reflected rather than direct illumination, and is altogether free from scintillation or twinkling. Their connection with the globe we inhabit is more perceptible, and their relative situation to one another less stationary. Their distance from us is not so remote, and more susceptible of calculation. The latter occupy a certain region situated in our neighborhood between us and the former.

The planets are opake bodies, and nearly spherical. Being opake in themselves, they become visible only by reflecting the light, which they receive from the sun. The laws by which they are governed were discovered by Kepler, who demonstrated that they must necessarily revolve in elliptical, and not in circular orbits. Astronomers have divided them into classes: the *primary* planets are Mercury, Venus, the Earth, Mars, Ceres, Pallas, Juno, Vesta, Jupiter, Saturn, and the Georgium Sidus; and the second class includes the satellites which belong to some of the primary planets, such as the Moon, the attendant on the Earth, the four moons or satellites that revolve about Jupiter, the seven that attend Saturn, and the six that wait on the Georgium Sidus.

*Mercury* is the smallest of the seven primary planets, and nearest to the sun; he appears as a small star, and emits a very vivid white light. He was called by the Greeks Στιλβων, plainly alluding to his brightness. Costard observes, "ברק אור *Bark-oor*, ברק אורי *Bark-oori*, or, changing the letter ב into מ as letters of the same organ frequently are, מרק אורי *Mark-oori*, we have in another dialect, with a Latin termination *us*, another name of this planet, *Mercurius;* and from whence comes *Mercury*, as he is called by us." This planet never goes to a greater distance from the sun than about 27° 50′; so that he appears only a little after sunset, and again a little before sunrise; he is never longer in setting after the sun than an hour and fifty minutes nor does he ever rise more than an hour and fifty minutes before that luminary: he is then about as far as the moon appears to be from the sun on the second day after the change. His mean distance from the sun says Dr. O. Gregory, is to that of the earth from the sun as 387 to 1,000: hence his distance is about thirty-seven millions of miles. To an inhabitant of Mercury, the sun appears almost three times broader than we see him from the earth, because the planet is almost three times nearer to the sun than the earth. Whence also the solar disk, seen from Mercury, is seven times greater than the disk as it appears to us, and Mercury has seven times more light than the earth.

> "——— Mercury the first,
> Near bordering on the day, with speedy wheel
> Flies swifter on, inflaming where he comes
> With seven-fold splendor."

The diameter of this planet is more than one-third of the diameter of the earth, or 3,180 miles. Hence his surface is about 1-7th, and his magnitude 1-16th of that of the earth. His period of revolution round the sun is 87 days, 23 hours, 14 minutes, 33 seconds, which is his year, and falls short of three of our months: hence he moves in his orbit round the sun at the rate of more than 95,000 miles in an hour. According to some astronomers, it has not been ascertained by observation, whether Mercury turns upon his own axis, and therefore it cannot be certainly affirmed that he has the vicissitude of day and night, neither the return of summer and winter: because they depend upon the inclination of the axis of his rotation, which is unknown, to the plane of the orbit which he describes about the sun; though there is very little doubt entertained on the subject. But Schroëter affirms that he "has distinguished spots and mountains, which he has assiduously followed, till he has arrived at the subsequent conclusions: that the apparent diameter of the planet is about 6″; that it does not present any sensible ellipticity; that the mountains it contains are proportionably larger than those of Venus and the Earth; that the highest are, as in these two bodies, in the southern hemisphere; that the angle which the equator makes with its orbit is very considerable; that the difference of days and seasons ought to be much greater in Mercury than it is on the earth; that its atmosphere, like that of Venus, is very dense; and lastly, that its rotation about its axis is 24 hours, 5 minutes, 30 seconds. When examined by means of a telescope magnifying about 200 or 300 times, he appears equally luminous throughout his whole surface, without the least dark spot. He exhibits the same difference of phases with the moon, being alternately horned, gibbous, and shining almost with a round face, though not entirely full because his enlightened side is never turned directly toward us; but at all times perfectly well defined without any ragged edge, and completely bright; and, like the moon, the crescent is always turned toward the sun. Mercury has no inferior planet known to us, and if that be actually the case, a spectator on his body will want the argument taken from the horned phases of the planets, to establish the true system of the world. But though we do not see any planets inferior to Mercury, it does by no means follow that there are none: for we seldom see Mercury himself, he being buried in the rays of the sun; and a planet much nearer the sun could never be seen from the earth. The first observation that was ever made of a transit, was by Gassendi, who saw Mercury on the sun, A. M. November 7, 1631. Since his time there have occurred seventeen other transits of this planet, the last of which was at his ascending node on the 9th of November, 1802. The asending and descending nodes are in the 16° of Taurus, and 16° of Scorpio. Other transits are expected in the years 1822, 1832, 1835, 1845, and 1848.

*Venus*, the second planet from the sun in the order of the system, is the most beautiful star in the heavens, being easily distinguished by her brightness and whiteness, which exceeds that of all the other planets, and is so considerable, that in a dusky night she projects a sensible shadow. Concerning her name, Costard remarks, "From the Chaldee הן *Han*, or *Hen*, which signifies *gratia*, *decor*, *elegantia*, with the Æolic digamma F, comes *Fen*, or *Ven*, and with the additional termination *us*, *Venus*; the name by which this planet was known among the Romans, and by which, from them, it has been transmitted to us." The mean distance of Venus from the sun is about 69,000,000 miles; her diameter is 7,630 miles; she performs her revolution round the sun in 224 days, 16 hours, 41 minutes, 27 seconds; her diurnal motion on her axis, according to some observations accurately made by Schroëter, is performed in 23 hours, 21 minutes; and she moves at the rate of 81,398 miles an hour.

This planet constantly attends the sun, and never departs from him more than forty-seven degrees, and consequently is never seen at midnight, nor in opposition to that luminary; being visible only for three or four hours in a morning or evening, according as she is before or after the sun. Venus is a *morning star* when she appears westward of the sun, for she then rises before him, and is among poets callèd Phosphorus or Lucifer—

> "——Fair morning star,
> That leads on dawning day to yonder world,
> The *seat of man*."

but when eastward of the sun, she is an *evening star*, shining after he is set, and then the poets give her the name Hesperus or Vesper.

> "——Her lovely beams adorn
> As well the dewy eve, as opening morn."

She is in each situation, alternately, between nine and ten months, or about 290 days. Pythagoras is said to have first discovered that Hesperus and Phosphorus were one and the same star. "From the name Phosphorus," says Costard, "it seems as if this is the same star that in Isaiah is called הילל בן שחר *Helal-ben-shahar*, or *Helal, son of the morning*; a name given it on account of its remarkable brightness. If so, that is the oldest record of a planet that occurs in any author whatever now extant: this was about the year before Christ 710."

Venus is frequently seen in the day-time, when in the inferior part of her orbit, at about forty degrees distant from the sun.

> "No stars besides their radiance can display
> In Phœbus' presence the dread Lord of day;
> Ev'n Cynthia's self, though regent of the night,
> Is quite obscur'd by his emergent light;
> But VENUS only, as if more divine,
> With Phœbus dares in partnership to shine."

To quiet the minds of some superstitious people, greatly alarmed at the appearance of Venus in the day-time, Dr. Halley wrote a small piece, published in the Philosophical Transactions (No. 349) to show that this was nothing extraordinary, and might be expected every eight years. Venus, when viewed through a good telescope, is rarely seen to shine with a full face, but has phases just like those of the moon, being now gibbous, now horned, &c, and her illuminated part constantly turned towards the sun, looking toward the east when a morning star, and toward the west when an evening star. M. de la Hire, in 1700, through a telescope of sixteen feet, discovered mountains in Venus, which he found to be larger than those in the moon. These observations have recently been confirmed by M. Schroëter, who, in the year 1780, commenced a course of observations on this planet, the results of which were published in the Philosophical Transactions for 1792.

Venus, as well as Mercury, is sometimes seen to transit the sun's disk, in form of a dark round spot; but these transits seldom happen. The first that was ever observed, was seen by our countryman Jeremiah Horrox, at Hool, an obscure village fifteen miles north of Liverpool: his account of which was published by Hevelius at Dantzic in 1661, under the title, "Venus in sole visa, anno 1631, November 24." Mr. Horrox's friend, William Crabtree, according to his direction, saw this transit at the same time, at Manchester. Two have occurred in the last century, namely, one June 6th, 1761, seen by many astronomers, which excited particular attention by a dissertation published by Dr. Halley in the Philosophical Transactions (No. 348) in which he proposed finding, from that transit, the sun's parallax, and thence the distance of the earth from the sun: and the other, June 3d, 1769, at $10^h$. 10′, according to M. de la Lande, and consequently invisible at Paris and London; but by comparing together two observations made, one at Mexico, and the other to the north of Petersburgh, we perceive the sun's parallax, was determined with great precision. The transits of Venus, occurring between the years 1631 and 2110, according to the calculations of persons most eminent in astronomical science, are as follow:

| | | | |
|---|---|---|---|
| 1631 - - - | December 6 | 1874 - - - | December 8 |
| 1639 - - - | December 4 | 1882 - - - | December 6 |
| 1761 - - - | June - 5 | 2004 - - - | June - 7 |
| 1769 - - - | June - 3 | 2109 - - - | December 10 |

The *Earth* is the next planet in order; called by the Greeks Γῆ, and by the poets Γαια, from γαω to *generate, produce*, which, says Parkhurst, is from the Hebrew, נאה *to grow* as a plant, because it produces, or is the mother of all terrestrial things; or in the poetic language of the Orphic hymn to the earth,

> "——Brings forth her various fruits,
> With throes maternal."

The word used by Moses is הארץ *haarets*, translated *earth*, whence in the Anglo-Saxon, *eard* and *eord*; Danish *jord*, *jorden*; Dutch *erd* and *aerd*; and Teutonic *erd*, *erde*.

The distance of the earth from the sun is about 95,000,000 miles: her orbit round the sun is 597,000,000 miles, and she performs her revolution round the sun, from any equinox or solstice to the same point again, in 365 days, 5 hours, 49 minutes, 57 seconds; of course, her hourly motion in her orbit is 68,000 miles. Her diameter is 7,964 miles, her circumference is 25,000 miles, and the time of rotation upon her axis, from west to east, is 23 hours, 56 minutes, 4 seconds: by which the inhabitants upon the equator are carried after the rate of 1,042 miles an hour, and those upon the parallel of London, 580 miles, as we have already noticed. The annual and diurnal motion of the earth is thus described by Milton:

> "She from the West her silent course advances
> With inoffensive pace, that spinning sleeps
> On her soft axle, while she paces even,
> And bears us soft with the smooth air along."

From this circumstance arises the *apparent* diurnal revolution of all the heavenly bodies from east to west.

"The motion of the earth," says an intelligent writer, "has so long ceased to be a disputed question, that the arguments on each side are nearly forgotten; and those who do not scruple to adopt the hypothesis of the earth's motions, are often less acquainted with the arguments on which it is supported, than they would have been in former times, when their opinions must have been the subjects of fierce contention." La Place observes, "that if the earth be at rest, and the stars move, the velocity of these latter must be immense; and yet all the purposes thereof might have been answered by a moderate motion of the earth alone. The moon's distance from the earth is 240,000 miles; of course, the length of the tract which it traverses, if it moves round the earth in 24 hours, is about 1,500,000; that is, at the rate of 62,500 miles an hour, instead of 2,290 miles, which is really the case: consequently, in each second of time, the moon, known to be the slowest of all the heavenly bodies, must move more than seventeen miles. Again, the sun's mean distance from the earth is about 95,000,000 miles; consequently, the diurnal path of that luminary, if it revolve about our globe in twenty-four hours, must be 580,000,000: and therefore, in a single second, the beat of a clock, he must move nearly 7,000 miles. Upon the same principle; that is, supposing the earth to be the centre of the system, and not the sun, the planet Mars, in a second of time, must travel at the rate of more than 10,000 miles, Jupiter 36,000, and Saturn 62,000. And, lastly, the fixed stars being yet indefinitely more remote from the earth than the sun or Saturn, their motion in or near the equator must be vastly swifter than this. If the earth does not move round the sun, the sun must move with the moon round the earth; now, the distance of the sun to that of the moon is nearly 400 to 1, and the period of the moon being about twenty-eight days, the sun's period should be, by the law above mentioned, full 600 years, whereas, it is, in fact, but a single year. This consideration was, of itself, thought of weight enough to determine the controversy between the two opinions, and to establish the motion of the earth in its orbit for ever."

That the shape of the earth was an extended plane, and the visible horizon its utmost bounds, was the opinion of the ancients. But that it is globular, a little raised at the equator, and flattened at the poles, being about thirty-seven miles shorter than at the equator, so as nearly to resemble an orange, is demonstrable on the most evident and unqestionable principles. 1. All the appearances of the heavens, both at land and at sea, are the same as they would be if the earth were a globe. Mariners first begin to lose sight of the lower parts of objects, and then gradually of the higher parts; also, persons on shore first discover the masts before the hull of approaching vessels, and on leaving a port the masts are seen when the hull is out of sight, which must be owing to the convexity of the water between the eye and the object, otherwise the largest and most conspicuous parts would have been visible the longest.

"Behold, when the glad ship shoots from the port
Upon full sail, the hulk first disappears,
And then the lower, then the higher sails;
At length the summit of the towering mast
Alone is seen; nor less, when from the ship
The longing sailor's eye in hope of shore:
For then, from the top-mast, though more remote
Than either deck, the shore is first beheld."*

2. Navigators sailing round the globe, as Magellan, Drake, Lord Anson, Cook, and others, have steered their course directly south and west till they came to the Magellanic sea, and from thence to the north and west, till they returned to their port from the east; and all the phenomena which should naturally arise from the earth's rotundity, happened to them. Beside, their method of sailing was also founded upon this hypothesis, which could not have

* "At what time the earth began to be considered, or rather suspected, to be spherical," says Costard, "is uncertain, but probably not before the undertaking long voyages; the first of which, it may be, were down the Arabian Gulf, and out of the Straits of *Bab-Al-mandub*, by Europeans corruptly called *Babelmandel*. What opinion was commonly entertained of those who undertook those long voyages, may be learned, in some measure, from this word. For *Mandub* is one that is lamented at his funeral; therefore *Bab-al-mandub* is the *gate*, or *strait*, of one lamented at his funeral; as if a person sailing beyond that point, was considered as going to certain death, or never to return."

succeeded so happily, if the earth had been of any other figure. 3. In all lunar eclipses, the shadow of the earth falling upon the moon is always circular; and a body can be no other than a globe, which in all situations casts a circular shadow. It is true, the surface of the earth is not an exact geometrical globe: but what the earth loses of its sphericity by its inequalities, as writers on this subject have remarked, is very inconsiderable: the highest mountains bearing so little proportion to its bulk, as scarcely to be equivalent to the minutest protuberance on the surface of an orange, or a grain of dust to a common globe.

> "These inequalities to us seem great;
> But to an eye that comprehends the whole,
> The tumor, which to us so monstrous seems,
> Is as a grain of sparkling sand that clings
> To the smooth surface of a sphere of glass;
> Or as a fly upon the convex dome
> Of a sublime, stupendous edifice."

It is not so easy as some imagine, says a German philosopher and divine, to determine exactly the size of the earth. It is true, there is but one longitude; but there are two latitudes, the north and the south. Both of these begin at the equator; the one extends northward, the other southward, as far as the arctic and antarctic poles. But, no one has yet been able to reach either pole. The mountains of ice in Greenland and the Northern Sea, have always obstructed the passage to the north pole: and immense fields, mountains, and islands of ice, have rendered the passage to the south pole impossible. Thanks, however, to the geometricians, we can at present know very nearly the size of our globe. According to the most exact calculations, the surface of the earth is 199,512,595 square miles. The seas and unknown parts of the earth, by a measurement of the best maps, contain 160,522,026 square miles. The inhabited parts contain about 38,990,559 square miles, in the following proportion: Europe—4,456,065; Asia—10,768,823; Africa—9,654,807; America—14,110,874: Hence it appears that scarcely one-third of the globe is habitable. It has been calculated, that there might be at least *three thousand millions* of men upon the earth at once: but in reality there are no more than about a *thousand and eighty millions:* of which there are, in Asia—650 millions; in Africa—150; in America—150; in Europe—130.

The path traversed by the earth, which, in astronomical language, is called its orbit, is the apparent path of the sun: it is called the *ecliptic*, because eclipses, both solar and lunar, always happen in this circle—also *via solis*, or the sun's path, because the sun never departs from it; and, therefore, at any time to denote the sun's place in the heavens, astronomers have divided the whole circle of the earth's motion in 360 equal parts, which they term *degrees*, and every thirty of these a *sign*, of which there are twelve. In this circle the sun advances nearly one degree every twenty-four hours, and thirty degrees every month; thus passing through the whole 360 degrees in a year. The signs are called by different names, and, with regard to their situations and corresponding seasons and months, they stand in the following order:

*Northern Signs; so denominated as being north of the Equator.*

| | |
|---|---|
| Spring. | Aries ♈, the Ram, part of March and April.<br>Taurus ♉, the Bull, April and May.<br>Gemini ♊, the Twins, May and June. |
| Summer. | Cancer ♋, the Crab, June and July.<br>Leo ♌, the Lion, July and August.<br>Virgo ♍, the Virgin, August and September. |

*Southern Signs; so called as being south of the Equator.*

| | |
|---|---|
| Autumn. | Libra ♎, the Balance, September and October.<br>Scorpio ♏, the Scorpion, October and November.<br>Sagittarius ♐, the Archer, November and December. |
| Winter. | Capricornus ♑, the Goat, December and January.<br>Aquarius ♒, the Water-bearer, January and February.<br>Pisces ♓, the Fishes, February and March. |

The order of the signs is thus poetically described by Dr. Watts.

"The Ram, the Bull, the heavenly Twins,
And next the Crab the Lion shines,
The Virgin and the Scales:
The Scorpion, Archer, and Sea-goat,
The Man that holds the Water-pot,
And Fish with glittering tails."

Dr. Long observes, that ♈ represents the horns of the ram; ♉ the head and horns of the bull; ♊ the figure of gemini, the twins joining hands and feet; the character cancer ♋ represents the changes of the sun's declination from north to south, by two lines or figures drawn so as to point two contrary ways; ♌ is the tail of the lion; ♍ was originally the three ears of corn which Virgo held; ♎ is the beam of the balance; ♏ was at first the picture of the scorpion; ♐ the arrow of the Archer; ♑ represents capricorn, the goat-fish; ♒ is a natural representation of the water's undulating surface; ♓ is the picture of two fishes tied together back to back.

The figures of the twelve signs are supposed by Dr. Jennings, and other astronomers, to be Egyptian hieroglyphics, by which they designed to exhibit some remarkable natural occurrence in each month, as the sun passed through these signs. Thus the first three months, beginning from the vernal equinox, were remarkable for the production of those animals which they most valued, namely, sheep, kine, and goats. The lambs came first, which are represented by their parent, the Ram; next the calves, represented by the Bull; and the kids, which commonly come in pairs, and which, therefore, gave the name to Gemini, the third constellation;

which was not at first represented by Two Boys, but by Two Beasts; as referring to the fruitfulness of goats, in producing *twin kids* about the time when the sun was in that constellation. When, in the fourth month, the sun is arrived at the summer solstice, he discontinues his progress towards the north pole, and begins to go back again to the southward; this retrograde motion the Egyptians expressed by the Crab, which is said to go backwards. The excessive heat that usually follows in the next month, is signified by the Lion; an animal remarkable for his strength and fierceness; or, as others observe, when that animal, driven by thirst from the desert, made his appearance on the banks of the Nile. Nothing could be more proper than the symbol for the harvest: namely, the Virgin reaper or gleaner with an ear of corn in her hand. The seventh constellation, when the sun arrives at the autumnal equinox, is expressed by the Balance or Scales, in equilibrio, because the days and nights, being then of the same length, seemed to indicate an equilibrium like that instrument. October is often a sickly season, when the surfeits acquired in the hot months of the summer produce their fatal effects; the symbol is therefore the Scorpion, who wounds with a sting in his tail, as he recedes; or, according to others, when certain regular winds brought forth a burning vapor like the poison of the scorpion. The diversion of hunting, which is chiefly followed after the fall of the leaf, is designated by Sagittarius, or the archer. The Goat, which is an animal that delights to browse up hill and to climb the highest rocks, is the emblem of the winter solstice, when the sun begins to ascend from the southern tropic, and is continually mounting higher and higher for the ensuing half year. Aquarius, or the Water-bearer, fitly represents the rains, or snows, of the winter. And the Two Fishes in a band, had, it is imagined, reference to the prime fishing season, which began in February.

The names given to our months originated as follows:

The name given to the month of *January* by the Romans was taken from *Janus*, one of their divinities, to whom they gave two faces; because on the one side, the first day of this month looked towards the new year, and on the other towards the old one. It was called *wolf-monat* by our Saxon ancestors, on account of the danger they then experienced from wolves. Some etymologists derive *February* from *Februa*, an epithet given to Juno, as the goddess of purification; while others attribute the origin of the name to *Februa*, a feast held by the Romans in this month, in behalf of the manes of the deceased. The Saxons named February *sprout kele*, on account of the sprouts of the cole-wort which began to appear in this month. Among the Romans, *March*, from Mars, was the first month, and marriages made in this month were accounted unhappy. The Saxons called March *lent-monat*, or *length-moneth*, "because the days did first begin, in length, to exceed the nights."—*April* is derived from *Aprilis*, of *aperio*, I open; because the earth, in this month, begins to open her bosom for the production of vegetables. The Saxons called this month *oster-monat*, from the goddess Eoster, or because the winds were found to blow generally from the east in this month.—*May* is so called from *Maia*, the mother of Mercury, to whom sacrifices were offered by the Romans on the first of this month; or, according to some, from respect to the senators and nobles of Rome, who were named *Majores*, as the following month was termed Junius, in honor of the youth of Rome. The Saxons called May, *tri-milki*, because, in that month, they began to milk their kine three times in the day.—The Saxons called June *weyd-monat*, because their beasts did then *weyd* or feed in the meadows.—The word *July* is derived from the Latin *Julius*, the surname of C. Cæsar, the dictator, who was born in it. Mark Antony first gave to this month the name of July, which was before called *Quintilis*, as being the fifth month in the year, in the old Roman calender established by Romulus. July was called by the Saxons, *hew-monat*, or *hey-monat*, because therein they usually mowed, and made their hay-harvest.—*Sextilis* was the ancient Roman name for *September*, it being the sixth month from March. The Emperor Augustus changed this name, and gave it his own, because in this month Cæsar Augustus took possession of his first consulship, celebrated three triumphs, reduced Egypt under the power of the Roman people, and put an end to all civil wars. "The Saxons called August *arn-monat* (more rightly *barn-monat*,) intending thereby the then filling of their barnes with corne." *September* is composed of *septem*, seven, and the termination *ber*, like *lis* in *Aprilis*, *Quintilis*, *Sextilis*. This rule will also apply to the three following months, Octo-ber, Novem-ber, Decem-ber. Our Saxon ancestors called it *Gerst-monat*, "for that barley which that moneth commonly yielded was anciently called gerst."—*October* was called *Domitianus* in the time of Domitian: but, after his death, by the decree of the senate, it took the name of October, every one hating the name and memory of so detestable a tyrant. It was called *wyn-monat*, or wine month, by the Saxons—The Saxons called *November* *wint-monat*, or wind-month, on account of the prevalence of high winds in this month.—*December* was called *winter-monat* by the Saxons; but, after they were converted to Christianity, it received the name of *heligh-monat*, or holy month.*

The names of our days are of Heathen origin. The seven planets were anciently looked on as presiding over the affairs of the world, and to take it by turns each one hour at a time, according to the following order: Saturn first, then Jupiter, Mars, the Sun, Venus, Mercury, and last of all, the Moon. Hence they denominated

* See Verstigan's "Restitution of Decayed Intelligence," Edit. 1673, pp. 64—68; and Time's Telescope.

each day of the week from the planet whose turn it was to preside the first hour of the nychthemeron, a term compounded of νυξ, *night*, and ημερα, *day*, which implies both night and day, and is divided into twenty-four parts, called *hours*. Thus, assigning the first hour of Saturday to Saturn, the second will fall to Jupiter, the third to Mars, and so the twenty-second of the same nychthemeron will fall to Saturn again, and therefore the twenty-third to Jupiter, and the last to Mars: so that on the first hour of the next day, it will fall to the Sun to preside; and by the like manner of reckoning, the first hour of the next will fall to the Moon, of the next to Mars, of the next to Mercury, of the next to Jupiter, and the next to Venus: hence the days of the week came to be distinguished by the Latin names of *Dies Saturni*, *Solis*, *Lunæ*, *Martis*, *Mercurii*, *Jovis*, and *Veneris*. The ancient Saxons had a great many idols, seven of which were appropriated to the seven days of the week, because of some worship that was offered to each idol on its respective day. The northern nations substituted, for the Roman Divinities, such of their own as most nearly resembled them in their peculiar attributes, and hence the derivation of the names now in use. These were Seater, the Sun, the Moon, Tuisco, Woden, Thor, Friga: hence among us the names of Saturday, Sunday, Monday, Tuesday, Wednesday, Thursday, and Friday. For, as Saturday, Sunday, and Monday, plainly denote the day of Saturn, the Sun, and the Moon; so Tuesday, Wednesday, Thursday, and Friday, denote the day of Tuisco, Woden, Thor, and Friga, which are the Saxon names respectively answering to Mars, Mercury, Jupiter, and Venus. Verstegan, in his "Restitution of Decayed Intelligence," describes the Saxon deities who presided over each day of the week, and gives plates of the idols, pp. 74—85.

How amazing it is that this ponderous globe should be suspended in the fluid air, without any visible support, and upheld only by the sovereign will of its almighty Creator! His power, who "hangeth the earth upon nothing," is inconceivably great; and the revolutions of this globe produce the most beneficial effects. The daily rotation of the earth causes the uniform succession of light and darkness; and its annual motion occasions the difference of the length of the days and nights, and the beautiful diversity of the seasons. Many pious Christians, who read the Scriptures to great personal advantage, but who are unacquainted with the science of astronomy, are apt to doubt the truth of the astronomical principles concerning the shape and motion of the earth, because, as Dr. O. Gregory judiciously observes, they think them contrary to divine revelation. Such persons would do well to consider for what purpose the Holy Scriptures were written, whether as a measure of faith, or as a rule to regulate our philosophical notions? Gassendus, though he does not give a direct answer to the question, has made the following very pertinent observations on the subject. "There are," says he, "two sacred volumes, the one written, called the Bible; the other Nature, or the World; God having manifested himself by two lights, the one of revelation, and the other of demonstration; accordingly the interpreters of the former are divines; of the latter mathematicians. As to matters of natural knowledge, the mathematicians are to be consulted; and as to objects of faith, the prophets; the former being no less interpreters, or apostles, from God to men than the latter. And as the mathematician would be judged to wander out of his province, if he should pretend to controvert, or set aside any article of faith from principles of geometry; so it must be granted, the divines are no less out of their limits, when they venture to pronounce on a point of natural knowledge, beyond the reach of any not versed in geometry and optics, merely from Holy Scripture, which does not pretend to teach any thing of the matter."

*Mars* is the first of the four superior planets in order from the sun, his orbit being immediately beyond that of the earth. He was called by the Greeks Αρης, the supposed god of war, which, says Parkhurst, comes from the Hebrew עריץ *violent*, *destructive*. Costard remarks, "This planet, I suppose, was called ערץ *Ara*, ערץ *Aretz*, Αρης, and, in another dialect, מערץ *Ma-aretz*, or *Mars*, in a softer pronunciation, from his *strong glowing brightness*." He is distinguished from the other planets by the red and fiery appearance of his disk: whether his ruddy troubled color arises from a natural disposition to reflect the red rays of light best, or from a thick atmosphere attending it, is rather uncertain; but it is generally attributed to the density of his atmosphere.

> "In larger circuit rolls the orb of Mars,
> Guiltless of stern debate, and wasteful wars,
> As some have erring taught: he journies on,
> Impell'd and nourish'd by the attractive sun;
> Like us, his seasons and his days he owes
> To the vast bounty which from Phœbus flows."

His figure, like that of the earth, is an oblate spheroid. His mean distance from the sun is 145,000,000 miles, and he travels round that common centre of gravity in about 687 of our days, or 1 year, 321 days, 22 hours, 18 minutes, 27 seconds, which is nearly equal to two of our years; and therefore his velocity in his orbit is at the rate of 55,000 miles an hour. He has likewise a rotation upon his axis, which is performed in 1 day, 39 minutes, 22 seconds. This was discovered by means of spots seen on his surface. Dr. Hook, in 1665, observed several spots, which, having a motion, he concluded that the planet revolved upon its axis. In 1666, M. Cassini saw several spots in the two hemispheres of Mars, which, by continuing his observations very diligently, he found to move from east to west, and to return in the space of 24 hours, 40 minutes, to their former situation. Whence both the motion and period, or natural day of this planet, were determined. In 1781, Dr. Herschell observed the spots of Mars very minutely, from the motion of which he has found his rotation upon his axis to be performed in 24 hours, 39 minutes, $21\frac{2}{3}$ seconds; and he says that there cannot be more than two seconds of uncertainty in this result. The different seasons will take place on this planet very much like what they are known to do upon our earth, with this difference, that the seasons there will be almost as long again as with us, on account of the time he takes in moving round the sun being nearly twice as long as our year. The diameter of Mars being 4,135 miles, he is about 2–11, or less than a fifth, and more than a sixth part as large as the earth; and if any moon attend him, she must be very small, for it has not yet been discovered by the best telescopes of our most eminent astronomers; if without a moon, walking his round in perpetual solitude, he must consequently want that division of time, which, from the moon's revolution round the earth, is called a month.

From the greater distance of Mars in his orbit than our earth is, the inhabitants there will scarcely see Mercury, unless it be when he appears on the sun's face, and passes over him like a dark spot, in the same manner as he sometimes does to us. Venus will to them appear somewhat similar to the appearances of Mercury to our earth, the apparent distance from the sun being nearly the same to them as Mercury is to us. Our earth to them, also, will be an inferior planet, or within his orbit, being nearer to the sun, in a way similar to what Venus appears to us, and will alternately be a morning or evening star; and our moon, which will always be seen to accompany her, when in a position to have the benefit of the sun's light, will not be seen at a greater distance, than about a semi-diameter of the sun or moon from it.

This planet being half as far again from the sun as our earth is, his light and heat are not half so much as our own. When in opposition to the sun, he is found to be five times nearer to us than when in conjunction; and, therefore, he appears so much bigger and brighter at one time than another. In 1719, his apparent magnitude and brightness were so much increased, that, by the uninformed, he was taken for a new star.

The telescopic appearance of Mars is very variable. This planet exhibits larger and more remarkable spots than any of the others. The belts and cloudy appearances are found to change their shape and arrangement frequently. The predominant brightness of the polar regions leads to the supposition that those parts of his surface, like the poles of the earth, are intensely frozen, or always covered with snow; and Dr. Herschell imagines that the changes in brightness are connected with the summer and winter seasons on that planet. The phases of Mars were first discovered by Galileo. Having his light from the sun, and revolving round it, he has an increase and decrease like the moon. At his quadratures, he appears gibbous, but never horned, like Venus, Mercury, and the Moon; which shows, that his orbit includes that of the earth, and that it is from the sun that he receives his light.

Between the orbit of Mars and that of Jupiter, the smaller planetary bodies, lately discovered, revolve. *Ceres* was discovered on the 1st of January, 1801, by M. Piazzi, astronomer at Palermo, in the island of Sicily. When viewed through a good telescope, it is of a ruddy color, appears to be of the size of a star of the eighth magnitude, and surrounded with a dense atmosphere. Her mean distance from the sun is 260,000,000 miles; and her revolution is performed in 4 years, 7 months, 10 days. Dr. Herschell and Schroëter differ very much as to the magnitude of this planet; the former says the diameter is only 160 miles, but the latter makes it more than ten times greater, or 1,624 miles. *Pallas* was discovered on the 28th of March, 1802, by Dr. Olbers, of Bremen. Its mean distance from the sun 270,000,000 miles; its diameter 80 miles; and it performs its revolution in about 4 years, 280 days. *Juno* was discovered on the 1st of September, 1804, by M. Harding, of Lilienthal. Its mean distance from the sun is 290,000,000 miles; and its diameter is 119 miles, and the time of revolution round the sun 5 years, 181 days. *Vesta* was discovered by Dr. Olbers, on the 29th of March, 1807. It is nearer to Mars than either of the other newly discovered planets; and the revolution through its orbit is performed in less time. The size of this planet is not known. Its light is more intense, pure, and white, than any of the other three.

A century and half ago it was conjectured, says a very intelligent author, that there must be a planet between the orbits of Jupiter and Mars, on account of the distance subsisting between those two planets. The discovery of Ceres confirmed this happy conjecture; but the opinion which it seemed to establish respecting the harmony of the solar system, appeared to be completely overturned by the discovery of Pallas and Juno. Dr. Olbers, willing to find a theory that should account for the facts newly ascertained, imagined that these small celestial bodies were merely the fragments of a larger planet, which had burst asunder by some internal convulsion, and that several more might yet be discovered between the orbits of Mars and Jupiter. He therefore concluded, that though the orbits of all these fragments might be differently inclined to the ecliptic, yet, as they must have all diverged from the same point, they ought to have two common points of re-union, or two nodes in opposite regions of the heavens, through which all the planetary fragments must sooner or later pass. One of these nodes Dr. Olbers found to be in Virgo, and the other in the Whale; and it was actually in the latter of these regions that M. Harding discovered the planet Juno. With the intention, therefore, of detecting other fragments of the supposed planet, Dr. Olbers examined, thrice every year, all the little stars in the opposite constellation of the Virgin and the Whale, till his labors were crowned with success, by the discovery of a new planet in the constellation of Virgo, to which he gave the name of Vesta.

The existence of four planets between the orbits of Mars and Jupiter, (continues the same author,) revolving round the sun at nearly the same distances, and differing from all the other planets in their diminutive size, and in the form and position of their orbits, is acknowledged to be one of the most singular phenomena in the history of astronomy. The discordance of these phenomena with the regularity of the planetary distances, and with the general harmony of the system, naturally suggests the opinion, that the inequalites in this part of the system were produced by some great convulsion, and that the four planets, as we have already hinted, are the fragments of a large celestial body, which once existed between Mars and Jupiter. To suppose them independent planets, as they must necessarily be if they did not originally form one, their diminutive size, the great eccentricity and inclination of their orbits, and their numerous intersections, when projected on the plane of the ecliptic, are phenomena absolutely inexplicable on every principle of science, and subversive of that harmony and order which before the discovery of these bodies, seemed to pervade the planetary system. Admitting, however, the hypothesis that these planetary bodies, are the remains of a larger body, which circulated round the sun, nearly in the orbit of the greatest fragment, the system resumes its order, and we discover a regular procession in the distances of the planets, and a general harmony in the form and position of their orbits. But, independently of analogical reasoning, the elements of the new planets furnish several direct arguments, drawn from the eccentricity and inclination of their orbits, and from the position of their perihelia and nodes; and all concurring to show, that the four new planets have diverged from one point, and have, therefore, been originally combined in a larger body.

*Jupiter* is the largest of all the planetary bodies, and, next to Venus the brightest. He was called by the Greeks Ζευς, which is from ζεω, *to be hot*, or, says Parkhurst, immediately from the Hebrew זי *to shine*, compounded, perhaps, with יש *substance*, q. d. *the shining substance;* a name very justly given to this planet, on account of his strong and clear light.

> ——"In distant skies
> Revolves the mighty magnitude of Jove,
> With kingly state, the rival of the sun."

His mean distance from the sun is 490,000,000 miles, and his diameter is 89,170 miles, or more than 11 times that of the earth, and therefore his magnitude is 1,400 times greater than our earth;

of course, as the surface of a globe increases according to the square of its diameter, our earth will, to the inhabitants of Jupiter, appear 121 times less than this noble planet appears to us. His revolution round the sun, from east to west, is performed in 11 years, 315 days, 14 hours, 39 minutes, 2 seconds, which is nearly twelve of our years; and his motion in his orbit is 29,000 miles an hour. He performs his diurnal rotation upon his axis in 9 hours, 55 minutes, 33 seconds, by which motion his equatorial parts are carried round at the amazing rate of 26,000 miles an hour, which is about twenty-five times the velocity of the like parts of our earth. He has, of course, a rapid succession of days, as the poet observes,

> "In ample compass Jove conducts his sphere,
> And later finishes his tedious year;
> Yet swiftly on his axle turn'd, regains
> The frequent aid of day to warm his plains."

The axis of Jupiter is nearly perpendicular to his orbit, so that he has no sensible change of seasons. This is not the work of chance, as Dr. O. Gregory observes, but wisely ordered by the Divine Architect; for if the axis of this planet were inclined any considerable number of degrees, so many degrees round each pole would be almost six years together in darkness. And as each degree of a great circle on this planet contains more than 700 miles, it is natural to conceive, that vast tracts of land would be rendered uninhabitable by any considerable inclination of his axis.

The appearance of this planet, through a telescope, opens a vast field for interesting inquiry. His surface is not equally bright, but variegated with certain bands, or belts, of a dusky appearance: they run parallel to each other, and are continued round the body of the planet. They are not regular or constant in their appearance: sometimes only one is seen; at other times six or eight. The breadth of them is likewise variable; one belt is sometimes becoming narrow, while another, in its neighborhood, grows broader as if one had flowed into the other: in these cases, an oblique belt has been observed to lie between them, as if for the purpose of establishing a communication. Sometimes, one or more spots are formed between the belts, which increase till the whole is united in a large dusky belt. There are also bright spots to be discovered on Jupiter's surface; these are rather more permanent than the belts, and re-appear after unequal intervals of time. The remarkable spot, by whose motion the rotation of Jupiter upon his own axis was first ascertained, disappeared in the year 1694, and was not seen again till 1708, when it re-appeared exactly in the same place, and has been occasionally seen ever since.

Jupiter is enlightened by four moons, or satellites, each of them larger than that with which we are supplied, and which revolve at different distances from that planet. In the solar system the moons, or satellites, revolve round their respective primary planets as centres, in the same manner as the primary planets revolve round the sun. By means of Jupiter's satellites, a method has been obtained for demonstrating that the motion of light is progressive, and not instantaneous, as was formerly supposed; which discovery is important to the interests of science. M. Huygens, in his Treatise on Light, concludes from these eclipses, that light transmits itself about 600,000 times faster than sound.

Distances and Revolutions of Jupiter's Satellites.

| | Distance. | Revolution. d. | h. | m. |
|---|---|---|---|---|
| 1st Satellite | 250,000 | 1 | 18 | 36 |
| 2d | 401,000 | 3 | 13 | 15 |
| 3d | 648,000 | 7 | 3 | 59 |
| 4th | 1,128,000 | 16 | 18 | 30 |

They are thus referred to by Mallet:

"About him round *four* planetary moons,
On earth with wonder all night long beheld,
Moon above moon, his fair attendants dance."

To a spectator placed on the surface of Jupiter, each of the satellites would put on the phases of the moon; but as the distance of any of them from Jupiter is but small, when compared with the distance of that planet from the sun, the satellites are therefore illuminated by the sun very nearly in the same manner with the primary itself; hence they appear to us always round, having constantly the greatest part of their enlightened half turned towards the earth: and indeed they are so small, that were they to put on the phases of the moon, these phases could scarcely be discerned through the best telescopes. When the satellites pass through their inferior semicircles, they may cast a shadow upon their primary, and thus cause an eclipse of the sun to his inhabitants; and in some situations this shadow may be observed going before or following the satellite. On the other hand, in passing through their superior semicircles, the satellites may be eclipsed in the same manner as our moon by passing through the shadow of Jupiter: and this is actually the case with the first, second, and third; but the fourth, by reason of the extent of its orbit, passes sometimes above or below the shadow, as is the case with our moon.

These satellites were first discovered on the 7th of January, 1610, by the celebrated Galileo, who called them *Medician Stars*, in honor of the family of the Medici, dukes of Tuscany, his patrons. These satellites, revolving about Jupiter at different distances, from west to east, when viewed through a telescope, make a beautiful appearance. As our moon revolves round the earth, enlightening the nights, by reflecting the light she receives from the sun; so these satellites, revolving round Jupiter, may also be supposed to enlighten the nights of that planet.

*Saturn* is a very conspicuous planet, though he shines with a pale and feeble light, very unlike that of Jupiter and the other planets. He was called by the Greeks φαινων. "From the account given by Diodorus Siculus," says Costard, "it seems as if the Chaldeans called this planet by some name not widely different from this of the Greeks. In the language of Chaldea, the verb פנא *phana*, or פנה *phanah*, signifies *convertere se*, *divertere se*, *declinare*. And whatever *vanishes*, or *disappears*, very properly *declines*, or *turns aside*, from our view. This planet, therefore, was most probably called פן *phen*, or פין *phain*, and, with a Greek termination, φαινων, on account of his *withdrawing* himself, by reason of his distance. And this conjecture is yet further confirmed from his name in another dialect, or among another people. For from סתר *sater*, *latuit*, *abscondit se*, with the paragogic ן *nun* which is not unusual in the formation of Eastern words, comes the word סתרן *Saturn*, and with the Latin termination *us*, *Saturnus*."

His mean distance from the sun is 900,000,000 miles, consequently his motion in his orbit is proportionably slow; and his annual revolution round the sun, from west to east, being so much longer likewise than that of the other planets, he takes 29 years, 164 days, 7 hours, 21 minutes, 50 seconds, which is almost *thirty* of our years, to accomplish it, in his orbit travelling with a velocity of 22,000 miles an hour. His diameter is 79,000 miles; and his magnitude is about 1,000 times that of the earth. The time of rotation upon his axis is 10 hours, 17 minutes.

"Still further off, scarce warm'd by Phœbus' ray,
Through his wide orbit, Saturn wheels away;
How great the change, could we be wafted there!
How slow the seasons! and how long the year!"

There is a singular and curious appendage to Saturn, namely, a thin, broad, opake ring, encompassing the body of the planet, without touching it; like the horizon of an artificial globe; it appears to be suspended round the planet, and to keep its place without any immediate connection with it. The distance of this prodigious circle from the body of the planet is usually stated to be about 21,000 miles.

The dimensions of the ring, or of the two rings with the space between them, Dr. Herschell has given as follows:

| | Miles. |
|---|---|
| Inner diameter of the smaller ring | 146,345 |
| Outside diameter of ditto | 184,393 |
| Inner diameter of the larger ring | 190,248 |
| Outside diameter of ditto | 204,883 |
| Breadth of the inner ring | 20,000 |
| Breadth of the outer ring | 7,200 |
| Breadth of the vacant space, or dark zone | 2,839 |

It puts on different appearances to us, sometimes being seen quite open, or as a wide oval, and at others, only as a single line. When our eye is in the plane of the ring, or looking at it directly on the edge, it is invisible to us; and it is in this situation twice in each revolution of the planet; that is, once in about fifteen years: at these times, he appears quite round, for nine or ten months together. The ring was invisible to us on the 15th of June, 1803, and, since that time, gradually increased in light and breadth for about seven years: and, after which, has again decreased, till, as before, after an interval of fifteen years, in the present year 1818, the ring is again edgewise to us, and invisible. With telescopes of great magnifying power, two belts or stripes have been discovered on Saturn; they appear parallel to the ring, and are supposed to be permanent. Of what component materials this ring is composed, or by what means it is suspended, we as yet remain ignorant: but of its use, it is supposed to supply light and heat to the planet, agreeably to the observation of a poet who has evinced an extensive acquaintance with philosophy.

> "Muse! raise thy voice, mysterious truth to sing,
> How o'er the copious orb a lucid ring,
> Opake and broad, is seen its arch to spread,
> Round the big globe at stated periods led;
> Perhaps (its use unknown) with gather'd heat
> To aid the regions of that gelid seat,
> The want of nearer Phœbus to supply,
> And warm with reflex beams his summer sky;
> Else might the high-plac'd world, expos'd to frost,
> Lie waste, in one eternal winter lost."

Besides the ring, Saturn is also furnished with seven attendant moons, or satellites, which move around him at different distances, in a way similar to those of Jupiter.

Distances and Revolutions of Saturn's Satellites.

| | Distance. | Revolution. *d.* | *h.* | *m.* | *s.* |
|---|---|---|---|---|---|
| 1st Satellite - - | 172,000 - - | 1 | 21 | 18 | 26 |
| 2d - - - - - - | 217,000 - - | 2 | 17 | 44 | 51 |
| 3d - - - - - - | 315,000 - - | 4 | 12 | 25 | 11 |
| 4th - - - - - - | 705,000 - - | 15 | 22 | 41 | 14 |
| 5th - - - - - - | 2,126,000 - - | 79 | 7 | 53 | 42 |
| 6th - - - - - - | 137,000 - - | 1 | 8 | 53 | 9 |
| 7th - - - - - - | 107,000 - - | 0 | 22 | 37 | 30 |

The sixth and seventh satellites were discovered by Dr. Herschell in 1787 and 1788: they are nearer to Saturn than any of the other five; but, to prevent confusion, they have been called the 6th and 7th. The 5th satellite has been observed by Dr. Herschell to turn once round its axis, exactly in the time in which it revolves round Saturn: in this respect it resembles our moon. Their distance from us is so far, as not to be easily visible, even with a good telescope, unless the air be exceedingly clear.

It was for ages that astronomical science limited the solar system to six planets, and Saturn was considered as its utmost extent. Vitruvius, speaking of the planet Saturn, says, that star "is near the extremity of the world, and touches the frozen regions of heaven." He did not understand the extent of our planetary system.

It is to the indefatigable application of Dr. Herschell that we are indebted for the discovery of a new planet, which is the fourth of the superior ones then known, and, being at twice the distance of Saturn from the sun, has quadrupled the bounds formerly assigned to the solar system. This planet was discovered on the 13th of March, 1781, and is called by different names: the discoverer bestowed upon it that of *Georgium Sidus*, in honor of our present venerable and beloved sovereign; by the French it is called *Herschell*, and by the Italians, *Uranus*. This important discovery is very deservedly noticed by the Poet Laureat, in his Ode entitled "Carmen Seculare for the year 1800."

"Mathesis with uplifted eye,
Tracing the wonders of the sky,
Beholds new constellations rise,
New systems crown the argent skies;
Views with new lustre round the glowing pole,
Wide his stupendous orb the *Georgian Planet* roll."

On the 11th January, 1787, Dr. Herschell discovered the second and fourth satellites which attend his own planet the Georgium Sidus; and in the following years, previously to 1791, he observed four others revolving round the same body. Though this celebrated astronomer was the first who discovered the Georgium Sidus to be one of the planets of the solar system, yet no doubt can be entertained of its having been before observed and considered as a fixed star. Flamsteed in 1690, Mayer in 1756, and Monnier in 1769, determined the places of three stars which cannot now be found. And M. La Place, according to his theory of Jupiter and Saturn, has found that the Georgium Sidus was *exactly* in those three points at those very times. These truly singular occurrences leave no doubt of the identity of these three stars with the new planet. The lines which Mallet applied to Saturn are now, with a little alteration, more applicable to the Georgium Sidus, or Herschell planet.

"Last, outmost Herschell walks his frontier round,
The boundary of worlds; with his pale moons,
Faint-glimmering through the darkness night has thrown,
Deep-dy'd and dead, o'er this chill globe forlorn:
An endless desert, where extreme of cold
Eternal sits, as in his native seat,
On wintry hills of never-thawing ice;
Such Herschell's earth."

His mean distance from the sun is about 1,800,000,000 miles, and he performs his revolution from west to east round the sun in 83 years, 294 days, 8 hours, 39 minutes; and in his orbit he moves with a velocity of 15,846 miles an hour. His diameter is 4½ times larger than that of the earth, being more than 35,000 miles; and his magnitude is 80½ times larger than that of the earth. The orbit in which he revolves is nineteen times further from the sun than the earth's orbit; consequently he has 361 times less light and heat from the sun than we have. Notwithstanding this, his proportion of light is considerable; for having been calculated, it is found to be equal to the effect of 284 of our full moons. When the sky is very serene and clear, and the moon absent, this planet may be perceived with the naked eye, unassisted by a telescope: and it appears as a star of the fifth magnitude, with a blueish white light, and a brilliancy between that of Venus and the Moon.

The want of light arising from the great distance of this planet from the sun, is supplied by six satellites, which revolve at different distances round their primary.

Distances and Revolutions of the Satellites of the Georgium Sidus.

| | Distance. | Revolution. d. | h. | m. | s. |
|---|---|---|---|---|---|
| 1st Satellite | 226,450 | 5 | 21 | 25 | 0 |
| 2d | 293,053 | 8 | 17 | 0 | 0 |
| 3d | 342,784 | 10 | 23 | 0 | 0 |
| 4th | 392,514 | 13 | 11 | 0 | 0 |
| 5th | 785,028 | 38 | 1 | 49 | 0 |
| 6th | 1,570,057 | 107 | 7 | 35 | 10 |

All these satellites, it has been said, perform their revolutions in their orbits contrary to the order of the signs; that is, their real motion is retrograde, but probably, as suggested by Dr. Hutton, this is an optical illusion.* As the indefatigable Dr. Herschell has already discovered six satellites belonging to this planet, does not its immense distance from the sun leave some ground for conjecture, that there may remain some undiscovered, and that his attendants are as numerous, if not more so, than those of Saturn?

Characters used for the Sun, Moon, and Planets.

| | |
|---|---|
| ☉ The Sun | ♂ Mars |
| ☽ The Moon | ♃ Jupiter |
| ☿ Mercury | ♄ Saturn |
| ♀ Venus | ♅ Herschell, or Georgium Sidus. |
| ⊕ The Earth | |

The mark which characterises the planet Herschell is the initial of the discoverer's name, intersected by a cross bar to represent a cross, by which to denote that the discovery of the planet took place after the birth of Christ.

Astronomy produces calculations concerning the magnitudes, distances, and revolutions of the planets, and their respective satel-

* On June 14, 1815, was published the following astronomical notice. The Georgium Sidus is now visible to the naked eye any clear night. It souths now a little before midnight, is paler and less vivid than the fixed stars near it in Scorpio; it will remain in company with Arcturus for two or three years, passing north of it about the middle of the year 1816, and veering to the east, or left hand, at the rate of 4° 18' annually, being near seven years in passing one sign, and near 84 in making an entire revolution.

Dr. Herschell assumes, that the eclipses of the satellites of the Georgium Sidus will, in the year 1818, be visible to those who possess telescopes of high magnifying powers, when they will appear to ascend through the shadow of the planet in the direction almost perpendicular to the ecliptic.

lites, which, to the uninformed, appear absurd, chimerical, and presumptuous; while, probably, they laugh at such notions as were received among men, when even the wisest of them were weak enough to believe, that the earth was an immense plain, situated in the centre of the universe; that the vault of heaven was of crystal; and that the sun was no other than a plate of red hot iron, about as large as the Peloponnessus. The following thoughts, communicated by my much esteemed friend Thomas Exley, A. M. may assist such persons to entertain more favorable sentiments of the science of astronomy, and also serve to enlarge their views of the Supreme Being.

"Many persons who have not had the advantages of proper instruction in mathematical science, cannot be persuaded that it is in the power of man to ascertain the distances of the sun, moon, and planets, and, of course, pay little regard to the assertions of astronomers on this subject. Sometimes, they are bold enough to say the thing is impossible, because no one has ever been to any of those bodies. Let such persons consider, that it is not necessary to go to a remote object in order to measure its distance; for that purpose, it will be sufficient to know the length of a line at the place of the spectator, and the inclination of this line to two others directed from its extremities to the object; for, on the length of this line, and the position of the two others, depends the distance of the object from the ends of that line.

"Thus, if I wish to know the distance of a neighboring tower, or other object beyond a river, or in some other way inaccessible; I measure any convenient line terminating in my station, and by some instrument proper for measuring angles, I ascertain the position of my measured line to the lines connecting its extreme points and the object. On these data depends the distance, and from this line and these angles accurately measured, the exact distance may be with great ease truly found. It is on similar principles that astronomers investigate the distances of the heavenly bodies. They take as the given or measured line, which may be called the base, some line on the earth, the semi-diameter for instance, as being the most convenient. The angle formed, or rather contained by two lines drawn from the sun or planet to the ends of the semi-diameter of the earth, is called the parallax, because it shows the difference of the apparent situation of the object as seen from the extremities of the semi-diameter, that is, it measures the arc of a great circle in the heavens contained between its two apparent places. Hence to ascertain its parallax, or difference of the apparent place when the object is viewed from the other end of the semi-diameter, becomes a problem of great importance in astronomy; for this being truly discovered, the distance of the planet will be obtained with the utmost exactitude. If any other line besides the semi-diameter of the earth, whose length and position are known, be used as a base, and the parallax in respect of this line be found, the same conclusions will follow. The chief difficulty in this affair arises from the smallness of the angle to be measured, which is a consequence of the greatness of the distance in respect of the earth's semi-diameter. Several ingenious methods have been proposed and employed by astronomers to discover the distances of the sun and planets, but nothing serves this purpose so well as the transits of Venus over the sun's disk. At certain periods, which can be foretold by astronomers, this planet passes exactly between us and the sun, and is seen as a dark round spot for some hours, moving in a line across the sun's face or disk. The observer should be furnished with a good chronometer, or pendulum clock with seconds, to note the time of the transit; and good instruments, to take the apparent diameters of the sun and Venus, and her greatest distance from the sun's limb while passing over his disk: from these observations, and the known phenomena of the motions of the earth and Venus, the parallax may be found. But if two observers, at very distant places of the earth properly chosen, make these observations, the parallax may be obtained with much greater ease and nicety; because the distance of the apparent tracks of Venus across the sun as seen from the two places, and also the difference of the time of the passage, arises from the parallax of Venus and that of the sun. The two last transits, which happened in the years 1761 and 1769, were carefully observed for this purpose; and it is to the results of these observations that the present astronomers are indebted for their more accurate knowledge of the distances of the planets, and the dimensions of the solar system.

"It should be observed, that if the parallax, and consequently the distance of any one of the planets by any means becomes known, the same is easily obtained for each of the other planets, from the relation which has been clearly discovered to subsist between the periodical times of revolution of the planets round the sun, and their distances from that central luminary. Astronomers have most decidedly proved that the square of the time in which any planet revolves is to the square of the time in which any other revolves, as the cube of the distance of the first, is to the cube of the distance of the other; and since all the times are known from observation, if the distance of any one be determined, there is no difficulty at all to find the distances of all the other planets from the sun.

"It has also been matter of great surprise to the unlearned, that astronomers should pretend to tell the magnitudes of the sun and planets. But this is no difficult problem when the distance is known. The *apparent* diameter is readily found from observation, and on this and the distance depends the *true* diameter. If the apparent diameters of two objects be equal, the true diameter of the one will be greater as it is more remote; and the apparent diameter of any object will increase as the distance of it from the observer diminishes. From this every one sees, that a knowledge of the distance of the object is an indispensible element for finding its bulk; and, according to the accuracy of the measure of the distance, will be that of the measure of the magnitude, provided the apparent distance be truly taken; and this, in the present improved state of our instruments, presents no obstacle. There can be no doubt but that astronomers are very near the truth in the numbers which they now give us for expressing the distances and magnitudes of the sun and planets.

"The telescope has been of singular use to the astronomer; it has shown him many phenomena of the heavenly bodies, concerning which he would otherwise have been totally ignorant. It is by the assistance of this noble instrument that we have attained to the knowledge of the rotations of the sun and planets, the phases of Venus and Mercury, Saturn's ring, and many other particulars exceedingly interesting. The telescope has discovered several planets which otherwise would have revolved in their courses unknown and unnoticed by the inhabitants of this globe; it has informed us that several of the planets have moons moving round them, as our moon revolves round the earth; besides, it has presented to our view an innumerable multitude of fixed stars which without this assistance we should never have seen.

"It is no wonder that great efforts have been made to improve this excellent instrument; these efforts have been attended with great success, and what may be further done in this respect we cannot tell; however, there is a limit to the improvements of the telescope, for after it has attained a certain degree of magnifying power, the motes and vapors in the atmosphere would be so magnified as to occupy its whole field of view, and thus render it a useless incumbrance."

Who can contemplate the power which produced the solar system, at once so magnificent, beautiful, and delightful, without astonishment and admiration? The planets are kept in a regular motion, and retained in an invariable course round the sun, by the power of this luminary's attraction or gravity. These bodies have a projectile force, being propelled forwards in a right line, which is the nature of all simple motion; but the sun's attraction combining with their own projectile force, withdraws them from their rectilineal courses, and preserves the most perfect harmony in the system. This wonderful mechanism was originally impressed on the system by its infinitely wise and omnipotent Creator; to which primary impulse it has with undeviating uniformity adhered, having never suffered in its operations from the greatest distance of space, or intervals of time.

Surely no power less than that which at first gave existence and modification to matter, is equal to the government of the world.

The solar orb and the planetary bodies could no more subsist in their present form and order, without a Divine, supporting, and directing hand, than they could at the beginning make themselves. What is that general law or force called *gravitation*, without which the whole frame of nature would soon be dissolved? Is it not a power constantly issuing from the Deity, and which if he should suspend but for one moment, the whole creation would sink into ruins? How inconceivably great and operative must that power be, that is present throughout the universe, with all the heavenly orbs to preserve them in their courses; and on this earth, with every creature, and every particle of matter, to preserve its present form!

In addition to the planets and their satellites, there are *Comets*, which revolve round the sun, aud, consequently, are a part of the solar system. They have often a long tail, in appearance resembling hair, issuing from that side which is turned away from the sun. Comets are popularly divided into three kinds, namely, bearded, tailed, and hairy: but this arrangement seems to apply rather to the different circumstances of the same comet, than to the phenomena of several. Thus, when a comet is eastward of the sun, and moves with him, it is said to be bearded, because the light precedes it in the manner of a beard: but when it is westward of him, it is said to be tailed, because the train of light follows it in the manner of a tail: and, lastly, when the sun and comet are diametrically opposite, the earth being between them, the train is hid behind the body of the comet, excepting the extremities, which being broader than the body of the comet, appear round it like a border of hair (*coma*), from which circumstance it is said to be hairy, and is denominated a comet.

Without attending to the variety of opinions which philosophers and astronomers have entertained concerning the nature and use of comets, we may affirm, that they have been considered as alarming phenomena, displayed by the Divine Being to warn mankind of the near approach of some dreadful calamity, such as wars, pestilence, and famine. This opinion prevailed during the dark ages between the decline of the Roman empire, and the dawn of the Reformation. To this apprehension some of our modern poets have alluded in strong and descriptive language. Young says,

"Hast thou ne'er seen the comet's flaming light?
Th' illustrious stranger passing, terror sheds
On gazing nations, from his fiery train
Of length enormous; takes his ample round
Through depths of ether; coasts unnumber'd worlds
Of more than solar glory; doubles wide
Heaven's mighty cape; and then revisits earth,
From the long travel of a thousand years."

Milton uses still greater strength of language when he compares his hero to a comet:

"Incensed with indignation, Satan stood
Unterrified, and like a comet burn'd
That fines the length of Ophiucus huge
In the arctic sky, and from his horrid hair
Shakes pestilence and war."

Similar ideas are finely expressed by Savage:

"In fancy's eye encount'ring armies glare,
And sanguine ensigns wave unfurled in air!
Hence the deep vulgar deem impending fate,
A monarch ruined, or unpeopled state.
Thus comets, dreadful visitants! arise,
To *them* wild omens science to the *wise*,
These mark the comet to the sun incline,
While deep red flames around its centre shine!
While its fierce rear a winding trail displays,
And lights all ether with a sweeping blaze!
Or when, compell'd, it flies the torrid zone,
And shoots by works unnumbered and unknown;
By worlds, whose people, all aghast with fear,
May view that minister of vengeance near."

Notwithstanding the present improved state of astronomical science, it is evident that the philosophy of comets is very imperfect. Kepler, though in other respects a very great genius, and to whose useful labors astronomy is deeply indebted, indulged in the most extravagant conjectures; he imagined that the planets were large animals, swimming round the sun: and that the comets were animals still more huge and monstrous, which had been generated in the celestial spaces. Jean Bodin, a learned Frenchman of the 16th century, entertained an opinion, if possible, still more absurd and ridiculous. He maintained that the comets are spirits, which having lived on the earth innumerable ages, and being at last arrived on the confines of death, celebrated their last triumph, or are recalled to the firmament like shining stars! Mr. Whiston was of opinion, that comets are so many hells, appointed in their orbits alternately to carry the damned into the confines of the sun, there to be scorched by its violent heat, and then to return with them beyond the orb of Saturn, there to starve them in those cold and dismal regions. Thus

"Born in an age more curious than devout;
More fond to fix the place of heaven or hell,
Than studious this to shun, or that secure."*

* In the year 1712, Mr. Whiston having calculated the return of a comet, which was to make its appearance on Wednesday, the 14th of October, at five minutes after five in the morning; he gave notice to the public accordingly, with this terrifying addition, that *a total dissolution of the world by fire was to take place on the Friday following*. The reputation Mr. Whiston had long maintained, both as a divine and a philosopher, left little or no doubt with the populace of the truth of his prediction. Several ludicrous events took place in consequence. A number of persons in and about London seized all the barges and boats they could lay hands on in the Thames, very rationally concluding, that when the conflagration took place, there would be the most safety on the water. A gentleman who had neglected *family prayer* for longer than five years, informed his wife that it was his determination to resume that laudable practice the same evening; but his wife having engaged *a ball at her house*, persuaded her husband to put it off till they saw whether the comet appeared or not. The South-sea stock immediately fell to *five per cent.*, and India stock to *eleven*. The captain of a Dutch ship threw all his powder into the river, that the ship might not be endangered.

The next morning the comet appeared according to the prediction, and before noon the belief was universal, that *the day of judgment was at hand*. About this time of the day 123 clergymen were ferried over to Lambeth, it was said, to petition that a short prayer might be penned and ordered, there being none in the church service on that occasion. Three maids of honor burnt their collec-

James Bernoulli, in his Systema Cometarum, says, that comets are no other than the satellites of some very distant planet, which is itself invisible to us on account of its vast distance, as are also the satellites, unless when they are in that part of their orbits which is nearest the earth. Comets, according to Des Cartes, were formerly fixed stars: but which becoming gradually covered with maculæ, and at length wholly deprived of their light, cannot keep their places, but are carried off by the vortices of the circumjacent stars; and in proportion to their magnitude and solidity, moved in such a manner as to be brought nearer the orb of Saturn; and thus, coming within reach of the sun's light, are rendered visible.

Aristotle, Seneca, Plutarch, and others, testify, that the Pythagoreans, and the whole Italian sect, maintained, that a comet was a kind of planet or wandering star, which appeared again after a long interval of time. Hippocrates Chius was of the same opinion as Aristotle informs us. Democritus held also the same opinion, as Seneca tells us in his "Natural Questions;" book vii, chap. 3, "For," says he, "Democritus, the most curious and subtle of all the ancients, suspected that there were many more stars which moved, meaning by this expression the comets; but he neither established their number, or their names, the courses of the five planets not having as yet been discovered." Again, Seneca assures us, that Apollonius Myndius, one of the most skilful philosophers in the search of natural causes, asserted, that the Chaldeans reckoned comets among the other wandering stars, and that they knew their courses. Apollonius himself maintained, that a comet was a star of its own kind, as the sun and moon are, but that its course was not yet known; that by its motions it mounts very high in the heavens, and only appears when it descends into the lower part of its orbit. And Seneca himself embraces this opinion in the following truly philosophical words: "I cannot believe," says he, "that a comet is a fire suddenly kindled, but that it ought to be ranked among the eternal works of nature. A comet has its proper place, and is not easily moved from thence; it goes its course, and is not extinguished, but runs off from us. But you will say, if it were a wandering star it would keep in the zodiac. But who can set one boundary to all the stars? Who can restrain the works of the Divinity to a narrow compass? For each of

tions of novels and plays, and sent to a bookseller's to buy each of them a Bible, and Bishop Taylor's Holy Living and Dying. The run upon the Bank was so prodigious, that all hands were employed from morning till night in discounting notes, and handing out specie. On Thursday, considerably more than *seven thousand kept mistresses were legally married!* in the face of several congregations. And to crown the whole, Sir Gilbert Heathcote, at that time head director of the Bank, issued orders to all the fire-offices in London, requiring them "to keep a good look out, and have a particular eye upon the Bank of England."

The comet which might have put the earth in most hazard, was that of 1680. By Halley's calculation it passed, November 11, within 60 semi-diameters of the earth's orbit: and if, at that time, the earth had been in that part of her orbit, there is no conjecturing at the consequences.—Literary Panorama, for December, 1811.—Probably the above was only a hoax upon Mr. Whiston on account of the singularity of his opinion concerning comets.

those bodies, which you imagine to be the only ones that have motion, have very different circles; why, therefore, may there not be some that have peculiar ways of their own, wherein they recede far from the rest? But that their courses may be known, it is necessary to have a collection of all the ancient observations about comets; for their appearances are so rare, that their orbits are not yet determined; nor can we as yet find whether they have their periods, or whether they return again in a certain order."—"The time will come," continues he, "wherein these things which are now hid from us will be discovered; which observation, and the diligence of after ages, will find out. For it is not one age that is sufficient for so great matters: the time will be when posterity will wonder that we were ignorant of things so plain; one will arise who will demonstrate in what regions of space the comets wander, why they recede so far from the other planets; how great and what sort of bodies they are."* The period, predicted by Seneca, in the first century of the Christian era, is not yet arrived. "After all that has been done and written on the subject of comets," says a late writer, "we must confess, that our knowledge of these wandering bodies is still very imperfect." "It appears to me," says La Lande, "that almost every thing depends on comets. The only thing that I recommend to my correspondents, is to look after and attend to comets: the knowledge of comets is alone wanting to complete the science of astronomy."

Several ages elapsed before this prediction of Seneca seemed likely to be fulfilled. Tycho Brahé was the first who attempted to restore the comets to their proper rank in creation. Having diligently observed the comet of 1577, and finding that it had no sensible diurnal parallax, he very properly determined its true place to be among the other revolving bodies in the planetary regions, as appears by his book De Cometa, 1577. And Sir Isaac Newton, from his amazing discoveries, gives the following theory of comets: "They are," says he, "compact, solid, fixed, and durable bodies; in fact, a kind of planets, which move in very oblique and eccentric orbits, every way with the greatest freedom; persevering in their motions even against the course and direction of the planets: and their tail is a very thin and slender vapor, emitted by the head or nucleus of the comet, ignited or heated by the sun."

Various conjectures have been formed concerning the nature of the tails of comets. Dr. Hamilton, of Dublin, in the second of his Philosophical Essays, urges several objections against the Newtonian hypothesis: he remarks, that, since the tail of a comet, though exceedingly rare, meets with no resistance in its rapid motion round the sun (except so slight a one as can only cause a very small condensation on that side of it which moves foremost, and thereby may make it a little brighter than the other side), it cannot

* Dr. Keill's Astronomy, 5th Edit. pp. 189, 190.

possibly move in a medium denser and heavier than itself, and therefore cannot be raised up from the sun by the superior gravity of such a medium. And since the stars seen through all parts of a comet's tail appear in their proper places, and with their usual colors, he infers that the rays of light suffer no refraction in passing through the tail; therefore, since bodies reflect and refract light by one and the same power, he concludes that the matter of a comet's tail has not the power of refracting or reflecting light, and is, of consequence, a lucid or self shining substance. Also from what astronomers say of the splendor of comets' tails, it is manifest they do not shine with such a dull light as would be reflected to us by the clouds or vapors at so great a distance, but with a brisker though a glimmering light, such as would arise from a very thin, volatile, burning matter. Dr. Halley, speaking of the great streams of light in the remarkable aurora borealis seen in 1716, says, "they so much resembled the long tails of comets, that at first sight they might be taken for such:" and afterwards, "this light seems to have a great affinity to that which the effluvia of electric bodies emit in the dark." Dr. Hamilton improves upon these hints: and since, as he shows, the tails of comets, the aurora borealis, and the electric fluid, agree remarkably, not only in their appearance, but also in such properties as we can observe of each of them, he concludes that they are substances of the same nature. And, because the electric matter, from its vast subtility and velocity, seems capable of making great excursions from the planetary system, he imagines that the several comets, in their long excursions from the sun in all directions, may overtake this matter; and by attracting it to themselves may come back replete with it, and being again heated by the sun, may disperse it among the planets, and so keep up a circulation of this matter, which there is reason to think is necessary in our system.*

Comets, descending from the remote parts of the system with great rapidity become visible to us in the lower parts of their orbits; and after a short stay, go off again to vast distances, and disappear. They move about the sun in very eccentric ellipses; and the velocity with which they seem to move is variable in every part of their path round the sun; when near to which they appear to move with great swiftness, and, when very remote, their motion is slow. They are opake bodies, but of a much greater density than the earth; for some of them are heated in every period to such a degree, as would vitrify or dissipate any substance known to us. Sir Isaac Newton computed the heat of the comet, which appeared in the year 1680, when nearest the sun, to be 2,000 times hotter than red hot iron, and that, being thus heated, it must retain its heat till it comes round again, although its period should be more than 20,000 years; and it is computed to be only 575.

* Dr. O. Gregory's Treatise on Astronomy, p. 413.

The number of the comets is much greater than that of the planets belonging to our system. From the beginning of the Christian era, till now, there have appeared about five hundred. Before that time, we have accounts of about one hundred others. But, when it is considered that there may have been many that have not been seen, from being too near the sun, from appearing in moon-light, from being in the other hemisphere, or from being too small, or from not being recorded, the number is probably much greater. Miss Herschell, by means of the telescope, has, within the last twenty years, discovered several comets. The orbits of about one hundred comets have been calculated with sufficient accuracy for ascertaining their identity on any future appearance. Many of these orbits are inclined to the plane of the ecliptic in large angles, and many of them approach much nearer the sun than the earth does. Their motions are also different from those of the planets, some of them being direct and others retrograde, nearly half the number moving each way. The different motions of the comets, and the various inclinations of their orbits to the plane of the ecliptic, must not be regarded as the work of chance, but as calculated to answer beneficial purposes, or avoid baneful consequences; for if these orbits had been nearly coincident with that of the earth, both bodies might have arrived at the common point of intersection of their orbits at the same time; in which case a derangement of both motions must, at least, have been the necessary result.* But, according to all the observations that have been made respecting their present distribution and direction, there is not the least reason to apprehend any such consequence.

The following table contains a list of the last twenty-three of the principal comets that have been observed, with the time of passing their perihelia, and their nearest approach to the sun.

| Years. | Passage of the Perihelion. | Nearest distance from the Sun in English Miles. | Direction of their Motion. |
|---|---|---|---|
| 1790 | January 15 | 71 millions | Retrograde. |
| 1790 | January 28 | 101 | Direct. |
| 1790 | May 21 | 75 | Retrograde. |
| 1792 | January 13 | 122 | Retrograde. |
| 1792 | December 27 | 91 | Retrograde. |
| 1793 | November 4 | 38 | Retrograde. |
| 1793 | November 18 | 142 | Direct. |
| 1795 | December 15 | 23 | Direct. |
| 1796 | April 2 | 149 | Retrograde. |

* The celebrated Buffon supposed, that our earth was originally formed by a comet's sweeping off and receiving in his train a portion of the exterior part of the sun; which, after having been sufficiently cooled, in the lapse of time, perhaps hundreds of thousands of years, has gradually assumed its present form! When we reflect that this eminent French naturalist was an infidel and a libertine, his many strange theories confirm the remark of the Poet,

"An undevout astronomer is mad."

When a person through the pride of intellect, will not submit his fallible understanding to the sure light of Divine revelation, he is liable to embrace the greatest absurdities, which a sober and well-regulated mind would prevent.

| Years. | Passage of the Perihelion. | Nearest distance from the Sun in English Miles. | Direction of their Motion. |
|---|---|---|---|
| 1797 | July 9 | 50 millions | Retrograde. |
| 1798 | April 4 | 46 | Direct. |
| 1798 | December 31 | 73 | Retrograde. |
| 1799 | September 7 | 79 | Retrograde. |
| 1799 | December 25 | 25 | Retrograde. |
| 1801 | August 8 | 22 | Retrograde. |
| 1802 | September 9 | 103 | Direct. |
| 1804 | February 13 | 101 | Direct. |
| 1805 | November 18 | 35 | Direct. |
| 1805 | December 31 | 84 | Direct. |
| 1806 | December 28 | 102 | Retrograde. |
| 1807 | September 18 | 61 | Direct. |
| 1811 | August 20 | 25 | Direct. |
| 1815 | April 26 | 121 | Direct. |

But of all the comets, the periods of three only are known with any degree of certainty, being found to return at intervals of 75, 129, and 575 years; and of these, that which appeared in 1680 is the most remarkable. This comet, at its greatest distance, is about 11,200 millions of miles from the sun, while its least distance from the centre of the sun is about 490,000 miles; being less than one third part of the sun's semi-diameter from his surface. In that part of its orbit which is nearest the sun, it flies with the amazing velocity of 880,000 miles in an hour; and the sun, as seen from it, appears 100 degrees in breadth, consequently 40,000 times as large as he appears to us. The astonishing distance that this comet runs out into empty space, naturally suggests to our imagination the vast distance between our sun and the nearest of the fixed stars, of whose attractions all the comets must keep clear, to return periodically and go round the sun. How wonderful that, though this body travelled almost two thousand times faster than a cannon ball, yet it drew after it a tail of fire, or of phosphoric gas, eight millions of miles in length! How amazing to consider, that this stupendous body, traversing the immensity of the creation with such rapidity, and at the same time wheeling about in that line which its great Creator prescribed to it, should move with such inconceivable velocity, and at the same time with such exact regularity! How spacious must the universe be, that gives such bodies as these full play, without suffering the least disorder or confusion by it! With what a glorious exhibition must those beings be entertained, who can look into this great theatre of nature, and see myriads of these tremendous objects wandering through those immeasurable depths of æther, and running their appointed courses! Our eyes may hereafter be strong enough to command this magnificent prospect, and our understandings able to find out the several uses of these immense parts of the universe. In the mean time, they are most suitable objects for our imagination to contemplate, that we may form more extensive notions of infinite wisdom and power, and learn to think humbly of ourselves, and of all the little works of human invention.*

The *Fixed Stars* are objects of peculiar interest, and are so denominated, because they are observed always to preserve the same distance from each other; and are distinguished from the planets by their twinkling, which seems to depend on the atmosphere; for we are assured, that where the air is exceedingly pure and dry, the stars appear with a light altogether free from scintillation. All the heavenly bodies, the sun, moon, and stars, appear to move round the earth, in circles parallel to the equinoctial, once in the compass of twenty-four hours; though these *apparent* motions are almost entirely to be accounted for by the *real* motions of the earth: but by far the greater number of them never change their relative situations, each (so long as an observer continues in the same place) rising and setting at the same interval of time, and at the same points of the horizon;—these are called the *fixed stars*.

The fixed stars, as appears from several considerations, are placed at immense distances from us. Mr. Exley, in a friendly communication, says, "It should be noticed, that the distances of the fixed stars have never yet been discovered; not indeed so much for want of a method, as for want of a base line sufficiently large for this admeasurement. The diameter of the earth's orbit is about one hundred and ninety millions of miles; and the fixed stars, viewed from the opposite ends of this extensive base line or diameter, have no sensible parallax, but all appear in the very same situations, and of the same magnitudes; and as this is the greatest line to the extremities of which we can have access, it is very probable we shall ever remain in ignorance of the true distances of the fixed stars. One thing, however, is fully ascertained by the observations which have been made to find the parallax of the stars, which is, that they are so immensely distant from our planetary regions, that the whole solar system, consisting of the sun and planets, with their satellites, and the comets, would, if viewed from the nearest fixed star, appear as crowded into one single point of space, which is also known from other observations. How astonishingly extensive is the view of the universe which such observations furnish!"

Our earth is at so great a distance from the sun, that if seen from thence, it would appear no bigger than a point, although its diameter is 7,954 miles. Yet that distance is so small, compared with the earth's remote situation from the fixed stars, that if the orbit in which the earth moves round the sun were the circumference of a globe, that globe, seen from the nearest star, would likewise appear no bigger than a point, although it is at least 190,000,000 miles in diameter. For the earth in going round the

* Guardian, No. 103.

sun is 190,000,000 miles nearer to some of the stars at one time of the year than at another, and yet their apparent magnitudes, situations, and distances from one another still remain the same; and being viewed through a telescope which magnifies above 200 times, they still appear as mere points: which proves them to be at least 400,000 times further from us than we are from the sun.

It is not to be imagined, that all the stars are placed in one concave surface, so as to be equally distant from us; but that they are scattered at immense distances from one another through unlimited space. So that there may be as great a distance between any two neighboring stars, as between our sun and those which are nearest to him. Therefore an observer, who is nearest any fixed star, will look on it alone as a real sun; and consider the rest as so many shining points, placed apparently at equal distances from him in the firmament. The star nearest to us, or the largest in appearance, is Sirius, or the Dog Star; and astronomers have calculated from indubitable principles, that its distance from us is considerably more than two millions of millions of miles! The apparent magnitude of Sirius has been computed at 27,000 times less than the sun, and, therefore, supposing their magnitudes equal, is 27,000 times more distant. If so, as our earth is ninety-five millions of miles from the sun, that multiplied by twenty-seven thousand, will give two millions of millions, and an addition of 565 thousand millions, for the distance of this star from the sun.* Our earth, in moving round the sun, is 195,000,000 miles nearer to this star in one part of its orbit, than in the opposite one; and yet the magnitude of the star appears not to be in the least altered or affected by it. A cannon-ball flying from thence at the rate of 400 miles in an hour, would not reach us in 732,000 years! The distance of the star $\gamma$ Draconis appears, by Dr. Bradley's observations, to be at least 400,000 times that of the sun, and the distance of the nearest fixed star not less than 80,000 diameters of the earth's annual orbit; that is, the distance of the earth from the former is $=$ to $400{,}000 \times 95{,}000{,}000 = 38{,}000{,}000{,}000{,}000$, and the latter not less than 7,600,000,000,000. As these distances are much too great to be comprehended by the human imagination, we shall, perhaps, obtain a better idea of them by comparing them with the velocity of some moving body, by which they may, in some way, be estimated. The swiftest motion we know of is that of light, which passes from the sun to the earth in about eight minutes, or, at the rate of 200,000 miles nearly in a second of time: and yet even light would be more than six years in traversing the first space, and a year and a quarter nearly, in passing from the nearest fixed star to the earth. Again, a cannon ball, moving with its

* The distances of the fixed stars have never been absolutely determined, and what is here stated is not given as the true distance of Sirius; but from what has been ascertained, the distance cannot be less than as above. Dr. Bradley, after another method of calculation, makes it to be more than ten times greater, or twenty-five millions of millions, and 650 thousand of millions.

initial or greatest velocity of about ten miles in a minute, would be more than seven millions of years in passing from the star $\gamma$ Draconis to the earth. The celebrated M. Huygens carried his thoughts so far upon this subject, as to believe that there might be stars at such inconceivable distances from our earth, that their light, though it is known to travel at the rate of 12,000,000 miles in a minute, has not yet reached us, since the creation of the world!

> "How distant some of the nocturnal suns!
> So distant, says the sage, 'twere not absurd
> To doubt, if beams, set out at nature's birth,
> Are yet arrived at this so foreign world;
> Though nothing half so rapid as their flight."

And Mr. Addison observes, that this thought of Mr. Huygens is far from being extravagant, when we consider that the universe is the work of infinite power, prompted by infinite goodness, having an infinite space wherein to exert itself, so that our imaginations can set no bounds to it.

The magnitudes of the stars appear to be very different from one another; which difference may probably arise, partly from a diversity in their real magnitude, but chiefly, no doubt, from their different distances. Hence it is, that the fixed stars have been divided, for the sake of distinction, into six orders or classes. Those which appear largest, are considered as stars of the first magnitude; the next to them in lustre, stars of the second magnitude; and so on, through the different gradations, to the smallest that are visible to the naked eye, which are said to be of the sixth magnitude. This distribution having been made long before the invention of telescopes, the stars which cannot be seen without the assistance of these instruments, are distinguished by the name of telescopic stars. Bayer, besides accurately distinguishing the relative size and situation of each star, marked the stars in each constellation with the letters of the Greek and Roman alphabets, setting the first Greek letter to the first or principal star in each constellation, to the second in order; then, when the Greek alphabet was gone over, he passed to *a*, *b*, *c*, of the Roman, and so on. This useful method of noting and describing the stars has been adopted by all astronomers since the time of Bayer; and they have further enlarged it, by adding the ordinal numbers 1, 2, 3, &c, when any constellation contains more stars than can be marked by the two alphabets.

As it would be impossible to furnish names for all the fixed stars, and retain those names in the memory; it became necessary not only to ascertain their exact relative situations, but to invent some method by which the principal part of the stars which can be seen may be known, without having recourse to a separate name for each. Ancient astronomers formed a commodious plan of arranging the fixed stars in constellations under names and figures of various personages, celebrated in antiquity, and even of birds, beasts, fishes, &c. This division of the heavens into constellations is obviously very ancient; for some of them are mentioned by Hesiod and Homer, both of whom probably flourished nearly 1000 years before the Christian era. Arcturus, Orion, and the Pleiades, are twice mentioned in the book of Job: and in the prophecy of Amos, composed about 400 years before Christ, the *seven stars* and *Orion* are mentioned. As the knowledge of the stars became more extensive, the number of the constellations was increased; and at the same time more stars were introduced into each constellation. Such of the stars as were not comprehended under any constellations, were by the ancient astronomers, called unformed stars. The modern astronomers have reduced not these unformed stars only, but many other stars, into new figures; and it is probable that other constellations will still continue to be invented.*

With respect to the number of fixed stars, there have been several accounts, given by different persons, at various times. The celebrated Hipparchus, of Rhodes, 120 years before Christ, formed a catalogue of 1,022 stars; to which Ptolemy added four more. Ulug Beigh, the grandson of Tamerlane, formed a catalogue of 1,017 stars. Tycho Brahé's catalogue only extended to 777; but he took care to ascertain all their places. Kepler's catalogue amounted to 1,163, which Ricciolus enlarged to 1,468. Bayerus extended his catalogue further than any of his predecessors, having described the places of 1,725. Hevelius increased the catalogue to 1,888. Flamsteed enlarged these catalogues to the number of about 3,000. But by means of the telescope, which affords us a glimpse of infinite space, and presents to our view myriads of worlds, and systems of worlds, by which it is filled, the number of the stars is astonishingly increased. Galileo found eighty stars in the space of the belt of Orion's sword, and F. de Rheita observed more than 2,000 in the whole constellation of Orion, of which not more than seventy or eighty can ever be seen without glasses. Dr. Hook reckoned seventy-eight stars in the single constellation of the Pleiades; and F. de Rheita, with a better telescope, discovered 188: whereas we cannot reckon above seven or eight seen by the naked eye. At the present period, the positions of 60,000 fixed stars have been exactly recorded, and they are generally arranged according to the size they appear; 20 of the largest are called stars of the first

* In 1627, Schiller published a work, entitled Cœlum Stellatum Christianum, containing the ancient catalogue, with new constellations. In this work he rejected the old designations, and substituted new figures for the constellations, and names taken from the sacred Scriptures; thus Aries he changed into St. Peter; Taurus, into St. Andrew; Andromeda, into the holy sepulchre; Lyra, into the manger of Christ; Hercules, into the wise men of the east; Canis Major, into David; and so on. This he is said to have done in imitation of the venerable Bede, who, instead of the profane names and figures adopted by pagans, substituted the names of the twelve apostles for those of the twelve constellations in the zodiac; but these innovations were disregarded by astronomers. Weigelius, professor of mathematics at Jena, attempted to make an innovation of another kind; he wished to change the starry heavens into a kind of Cœlum Heraldicum, by introducing the arms of all the princes and states of Europe, by way of constellations; but his project experienced the same fate as those of Bede and Schiller.

magnitude; 65 are of the second magnitude; 205 of the third; 485 of the fourth; 648 of the fifth; and about 1,500 of the sixth magnitude; the remainder, being invisible to the naked eye, are called telescopic stars.

Where the stars are in great abundance, Dr. Herschell supposes they form primaries and secondaries, that is, suns revolving about suns, as planets revolve about the sun in our system. He considers that this must be the case in what is called the *milky way*, the stars being there in prodigious quantity. Of this he gives the following proof: on August 22, 1792, he found that in forty-one minutes of time, not less than 258,000 stars had passed through the field of view in his telescope! Dr. Chalmers observes, If we ask the number of suns and of systems—the unassisted eye of man can take in a thousand, and the best telescope which the genius of man has constructed can take in eighty millions. Thus, by the help of telescopes, we discover a vast multitude of stars which are invisible to the naked eye; and the better the glasses are, still the more become visible; so that we can set no limits either to their number, or to their distances.

> "Myriads beyond with blended rays inflame
> The *milky way*, whose stream of vivid light,
> Poured from innumerable fountains round,
> Flows trembling, wave on wave, from sun to sun,
> And whitens the long path to heaven's extreme:
> Distinguished tract!"

From an attentive examination of the stars with good telescopes, many that appear only single to the naked eye, are found to consist of two, three, or more stars. The late Dr. Maskelyne observed the $\alpha$ Herculis to be a double star, and other astronomers have discovered many more to be double. Dr. Herschell has found 700; of these about forty had been observed before. The following will serve as a specimen, and afford the observer a few objects for his attention. $\alpha$ Herculis is a beautiful double star: the two bodies are apparently unequal: the largest is red, and the smallest of a blueish color inclining to green. $\gamma$ Andromedæ, double, very unequal: the larger of a reddish white color; the smaller a fine bright sky blue, inclining to green. $\beta$ Lyræ, quadruple, unequal white, but three out of the four inclined to red. $\epsilon$ Bootis, double, very unequal, larger, of a reddish color; the smaller is blue, or of a faint lilac color. $\alpha$ Lyræ, double, very unequal; the larger is a fine brilliant white, the smaller dusky.

New stars sometimes appear, while others disappear. Several stars mentioned by ancient astronomers are not now to be found: several are now visible to the naked eye, which are not mentioned in ancient catalogues; and some stars have suddenly appeared, and again after a considerable interval vanished. Fortunio Liceti, a celebrated physician, who died in 1656, in Padua, published a treatise, entitled, "De novis Astris et Cometis." In it he gives us an ample account of the several new stars spoken of by the ancients, among which he mentions that remarkable one which appeared A. D. 389, near the Eagle. It was as bright as the planet Venus, for the space of three weeks, but afterwards entirely disappeared. In the ninth century, the Arabian astronomers, Massahala, Haly, and Albumazar, observed a new star in the 15th degree of Scorpio, whose light equalled that of the moon in her first octant: it was visible for four months. Cyprianus Leovitius relates, that in the reign of the emperor Otho, A. D. 946, a new star was seen between the constellations of Cepheus and Cassiopeia; and also that another was seen A. D. 1264, very near the same part of the heavens, which had no proper motion. One of the most celebrated of the new stars is that discovered by Cornelius Jansen, November 8, 1572, in the chair of Cassiopeia: it exceeded Sirius in brilliancy, and Jupiter in apparent magnitude; it gradually decayed, and, after sixteen months, disappeared. On the 13th of August, 1596, David Fabricius observed a new star in the neck of the Whale, and it disappeared after October in the same year, but was supposed to be again discovered in the year 1637. In the year 1600, William Jansen discovered a changeable star in the neck of the Swan. It was seen by Kepler, who wrote a treatise upon it, and determined its place to be $16^\circ\ 18'$ ♒, and $55^\circ\ 30'$ or $32'$ north latitude. Ricciolus saw it in 1616, 1621, and 1624. Cassini saw it again in 1655; it increased till 1660; then decreased, and at the end of 1661 it disappeared. In November, 1665, it appeared again, and disappeared in 1681. In 1715 it appeared, as it does at present, and is of the sixth magnitude. In 1686, Kircher observed χ in the Swan, to be a changeable star in the neck of that constellation; and, from twenty years' observations, the period of the return of the same phases was found to be 405 days. In 1604, Kepler discovered a new star near the heel of Serpentarius, so very brilliant that it exceeded every fixed star, and even Jupiter, in apparent magnitude. For more recent discoveries, see Dr. Herschell's paper, "On the proper Motion of the Sun and the Solar System, with an account of the several changes that have happened among the fixed stars since the time of Mr. Flamsteed," vol. lxxiii, of the Philosophical Transactions, or the fifteenth of the Abridgment.

All the stars seem to have a common and general motion about the pole of the ecliptic, at the rate of a degree in seventy-two years; this is occasioned by the precession of the equinoctial points. In consequence of this apparent motion, the constellations change their positions in regard to the equinoctial points. Hence it is, that the constellation Aries now is in the sign Taurus, and Taurus occupies the sign Gemini. It has been the common opinion that the fixed stars have no real motion, but the accurate observations of modern astronomers show, that some of them have a motion peculiar to themselves, by which they slowly change their places. Thus Arcturus is found to approach the ecliptic about four minutes in 100 years; and its distance from a small star near it has been sensibly changed during the last century. Sirius seems to recede from the ecliptic about two minutes per century. Similar motions have been observed in Aldebaran, Rigel, the eastern shoulder of Orion, the Goat, the Eagle, &c. Other stars have been observed to have a motion in different directions. Perhaps all the stars have similar motions, which are performed by certain fixed laws in spaces, which, though very large in reality, yet, because of their immense distance, subtend at the earth angles so very small, as in some cases to be quite imperceptible, while in other cases they may be observed, as in the stars above-mentioned; and on this rational supposition the appearance and disappearance, and variations in magnitude, of some stars may be accounted for.

The fixed stars do not appear to be all regularly disseminated through the heavens, but the greater part of them are collected into clusters; and it requires a large magnifying power, with a great quantity of light, to distinguish separately the stars which compose these clusters. With a small magnifying power, and small quantity of light, they only appear as minute whitish spots, much like small light clouds, and thence they are called nebulæ. The number of nebulæ was formerly imagined to be about 103; but Dr. Herschell, early in the year 1784, had discovered 469 more, and since then has given a catalogue of 2,000 nebulæ which he has discovered. The most careful and accurate observations give great reason to conclude, that they all consist of large masses or clusters of stars at prodigious distances from our system. Dr. Herschell is of opinion the starry heaven is replete with these nebulæ, and that each of them is a distinct and separate system independent of the rest. The milky way he supposes to be that particular nebulæ in which our sun is placed; and, in order to account for the appearance it exhibits, he supposes its figure to be much more extended towards the apparent zone of illumination, than in any other direction; which is a supposition that he thinks allowable, from the observations he has made on the figures of other nebulæ.

That there are other worlds, beside our earth, inhabited by rational beings, endued with bodily constitutions adapted to the nature and economy of the respective planets for which they are destined, is a conjecture that approaches the nearest to certainty. There is scarcely any doubt now remaining amongst philosophers, that our moon is a habitable globe. The most accurate observations that have been made with the most powerful telescopes, have confirmed the opinion. The surface of the moon seems to be diversified by high mountains, large valleys, and small and larger collections of water; consequently she resembles our earth; and there can be no doubt that our earth serves as a moon to the moon, whose inhabitants, comparing it with the sun, may well say,

——"gives us his blaze again
Void of its flame, and sheds a softer day;"

which similarity existing between them, is a presumptive proof that the moon, like our earth, is a commodious habitation for creatures endowed with capacity for knowing and adoring their beneficent Creator. By a very correct analogy we are led to infer, says a learned author, that all the *planets* and their *satellites* or attendant moons, are *inhabited;* for matter seems only to exist for the sake of intelligent beings. And Dr. Herschell's discoveries have, by the general consent of philosophers, added, besides the Georgian planet, a *new habitable world* to our system, which is the SUN.

To an attentive mind it will appear highly probable, that the planets of our system, and their moons, are much of the same nature with our earth, and destined for the like purposes; for they are solid opaque globes, capable of supporting animals and vegetables. Some of them are bigger, some less, and others about the size of our earth. They move round the sun, as the earth does, in a shorter or longer time, according to their respective distances from him: and have, where it would not be inconvenient, regular returns of summer and winter, spring and autumn. They have warmer and colder climates, as the various productions of our earth require: and, in such as afford a possibility of discovering it, we observe a regular motion round their axis like that of our earth, causing an alternate return of day and night; which is necessary for labor, rest, and vegetation, and that all their surfaces may be exposed to the rays of the sun.

Can a person who attends to the vast magnitude of the three planets, Jupiter, Saturn, and Herschell or the Georgium Sidus, and compares the systems of moons together which belong to them, bring himself to think, that an infinitely wise Creator should dispose of all his animals and vegetables here, leaving the other planets destitute of living and rational creatures? To suppose that he had any view to our benefit in creating these moons, and giving them their motions round their respective primaries; to imagine, that he intended these vast bodies for any advantage to us, when he well knew, that they could not be seen but by a few astronomers looking through telescopes; and that he gave to the planets regular returns of day and night, and different seasons to all where they would be convenient, but of no manner of service to us, except only what immediately concerns our own planet, the earth; to imagine, I say, that he did all this on our account, would, I presume, be charging him with having done much in vain: and be as absurd, as to fancy that he has created a little sun, and a planetary system within the shell of our earth, and intended them for our use.

"As well might the minutest emmet say,
That Caucasus was raised to pave his way
The snail, that Lebanon's extended wood
Was destin'd only for his walk and food.
The vilest cockle, gaping on the coast,
That rounds the ample seas, as well may boast,
The craggy rock projects above the sky,
That he in safety at its foot may lie;
And the whole ocean's confluent waters swell,
Only to quench his thirst, and move and blanch his shell."

These considerations amount to little less than a positive proof, that all the planets are inhabited: for if they are not, why all this care in furnishing them with so many moons, to supply those with light which are at the greater distances from the sun? Do we not see, that the further a planet is from the sun, the greater apparatus it has for that purpose? Such of the planets as are most remote from the sun, and therefore enjoy least of his light, have that deficiency made up by several moons, which constantly accompany, and revolve about them, as our moon revolves round our earth. So that if the more distant planets have the sun's light in less proportion by day than we, they have an addition made to it morning and evening by one or more of their moons, and a greater proportion of light during the night. We know that the earth goes round the sun, and turns round upon its own axis, to produce the vicissitudes of summer and winter by the former, and of day and night by the latter motion, for the benefit of its inhabitants: may we not then fairly conclude, by parity of reason, that the end or design of all the other planets is the same? And is not this agreeable to the beautiful harmony which exists throughout the works of nature? Surely it is! and it raises in us the most magnificent ideas of the supreme Being, who is every where, and at all times present; displaying his power, wisdom, and goodness, among all his creatures; and distributing happiness to innumerable beings of various ranks!

When we consider the infinite power and goodness of God; the latter inclining, the former enabling him to make creatures suited to all states and circumstances; that matter exists only for the sake of intelligent beings; and that wherever we see it, we always find it pregnant with life, or necessarily subservient thereto; the numberless species, the astonishing diversity of animals in earth, air, water, and even on other animals; every blade of grass, every tender leaf, every natural fluid, swarming with life; and every one of these enjoying such gratifications as the nature and state of each requires: when we reflect also, that some centuries ago, till experience undeceived us, a great part of the earth was judged uninhabitable; the Torrid Zone, by reason of excessive heat, and the two Frigid Zones because of their intolerable cold; it seems highly probable, that these numerous and large masses of the planets are not destitute of beings capable of contemplating with wonder, and acknowledging with gratitude, the wisdom, symmetry, and beauty of the creation. It is an undoubted truth, that wherever God exerts his power, there also he manifests his wisdom and goodness.

From what we know of our own system, it may be reasonably concluded, that all the rest are with equal wisdom contrived, situated, and provided with accomodations for rational inhabitants. Taking a survey of the system to which we belong; the only one accessible to us; from thence we are the better enabled to judge of the nature and end of the other systems of the universe. For although there is almost an infinite variety in the parts of the creation which we have opportunities of examining, yet there is a general analogy running through and connecting all the parts into one scheme, one design, one whole!

The stars, being at such immense distances from the sun, cannot possibly receive from him so strong a light as they seem to have; nor any brightness sufficient to make them visible to us. For the sun's rays must be scattered and dissipated before they reach such remote objects, that they can never be transmitted back to our eyes, so as to render these objects visible by reflection.

> "I launch into the trackless deeps of space,
> Where, burning round, ten thousand suns appear
> Of elder beam, which ask no leave to shine
> Of our terrestrial star, nor borrow light
> From the proud regent of our scanty day."

The stars, therefore, shine with their own native and unborrowed lustre, as the sun does; and since each particular star, as well as the sun, is confined to a particular portion of space, it is plain, that the stars are of the same nature with the sun.

It is not probable that the Almighty, who always acts with infinite wisdom, and does nothing in vain, should create so many suns, fit for so many important purposes, and place them at such distances from one another, without proper objects near enough to be benefited by their influences. Whoever imagines they were created only to give a faint glimmering light to the inhabitants of this globe, must have a very superficial knowledge of astronomy, and a mean opinion of the Divine wisdom: since, by a much less exertion of creating power, God could have given to our earth considerably more light by one single additional moon. Since the fixed stars are prodigious globes of light and heat, like our sun, and at inconceivable distances from one another, as well as from us, it is reasonable to conclude they are made for the same purposes that the sun is; each to bestow light, heat, and produce vegetation, on a certain number of inhabited planets, kept by gravitation within the sphere of its activity.

Instead then of one sun, and one world only, in the universe, as the unskilful in astronomy imagine, that science discovers to us such an inconceivable number of suns, systems, and worlds, dispersed through boundless space, that if our sun, with all the planets, moons, and comets belonging to it, were annihilated, they would with difficulty be missed, by an eye that could take in the whole creation; the space they possess being comparatively so small that it would scarce be a sensible blank in the universe, although Herschell, or the Georgium Sidus, the most remote of our planets, revolves about the sun in an crbit whose mean distance from the sun is 1,822,575,228 miles, and some of our comets make excursions to an amazing distance beyond the bounds of that planet: and yet, they are incomparably nearer to the sun than to any of the stars; as is evident from their keeping clear of the attractive power of all the stars, and returning periodically by the virtue of the sun's attraction.

"In the immensity of God's creation," says a learned author, "we may readily conceive one system of heavenly bodies, and others beyond them, and others still in endless progression, through the whole vortex of space! Every *star* in the vast abyss of nature being a *sun*, with its peculiar and numerous attendant worlds. Thus there may be systems of systems, in endless gradation, up to the throne of God!"

> "Oh, for a telescope HIS THRONE to reach!
> Tell me ye learn'd on earth, or blest above!
> Where your great Master's orb? His planets where?
> * * * * * * * * * On nature's Alps I stand
> And see a thousand firmaments beneath!
> A thousand systems as a thousand grains!
> *Each* of these STARS is a *religious house;*
> I saw their altars smoke, their incense rise,
> And heard Hosannas ring through *ev'ry sphere;*
> A seminary fraught with future gods!
> Oh, what a root! Oh, what a branch is here!
> Oh, what a Father! What a family!
> Worlds, systems, and creations!——And creations
> In one agglomerated cluster hung,
> Great *Vine!* on THEE; on THEE the cluster hangs;
> The filial cluster! infinitely spread
> In glowing globes, with various being fraught;
> And drinks (nectareous draught!) immortal life!"

What an august! what an amazing conception, if human imagination can conceive it, does this give of the works of the Creator! Thousands of thousands of suns, multiplied without end, and ranged all around us, at immense distances from each other, attended by ten thousand times ten thousand worlds, all in rapid motion, yet calm, regular, and harmonious, invariably keeping the paths prescribed them; and these worlds peopled with myriads of intelligent creatures, formed for endless progression in perfection and felicity. If so much power, wisdom, goodness, and magnificence, is displayed in the material creation, which is the least considerable part of the universe, how great, how wise, how good must He be, who made and governs the whole!*

The persuasion that rational beings inhabit other worlds, has a powerful tendency to excite our curiosity.

* See Ferguson's Astronomy.

"Ye sparkling isles of light that stud the sea
Of empyrean ether! Ye abodes
Of unknown myriads, spirits, or in bands
Held of corporeal frame! Fain would my soul
A thirst for knowledge unreveal'd to man,
Question your habitants, and fain would hear
A voice responsive from your distant bourn.
Tell, tell me who possess your radiant climes;
What are their forms, their faculties, their hopes,
Their fears, if subject or to hope or fear?
What fond pursuits, what animating toils
Diversify existence with delight?
Rove they in course aërial unconfined
From sphere to sphere, with interchange of joy
Heightening their mutual bliss; or dwell they fix'd,
Each in his native solitary orb,
Unconscious of the lot of neighboring worlds?
What homage, what returns of grateful love
Yield they to Him who made them? Stand they fast
In undecaying blessedness, secure
From risk of loss: or tread they yet the stage
Of perilous probation? Hath sin won
Conquests through disobedience o'er those hosts
In your bright regions yawn the gates of Death?
Falls he, who falls, for ever?—Power supreme
Pardon the aspiring thoughts that would presume
To pierce the veil which shrowds from mortal eye
The wonders of thy realms! Enough, to know
That Thou art Lord! Thy universal love
Pervades Creation; on each living form
Showers down its proper happiness; and, when guilt
Wakes thy reluctant vengeance, stays the bolt
Of wrath, and pales its mitigated fire!"*

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Stars are the hieroglyphics used to express both rulers and teachers; therefore they may with great propriety be applied to the pastors of the church. The Jews, says Dr. Doddridge, are said to have called their teachers *stars*. They are represented under that emblem in the Revelation, where St. John, speaking of our Lord, says, "He had in his right hand seven stars;" and the allegorical explanation is, "The seven stars which thou sawest in my right hand are the angels (or ministers) of the seven churches," namely, in Ephesus, Smyrna, Pergamos, Thyatira, Sardis, Philadelphia, Laodicea. By αγγελοι, *angels*, we are to understand the *messengers* or persons whom God sent to preside over these churches. "Angel of the church," in this place, says a learned author, answers exactly to that officer of the synagogue among the Jews, called שליח ציבור *sheliach tsibbor*, the messenger of the church, whose business it was to *read*, *pray*, and *teach*, in the synagogue. The ministers of the gospel bear this allegorical designation.

1. Because, like stars in the firmament, they are placed in a *high situation* in the church. Eliphaz says, "Behold the height of the stars, how high they are!" The sacred office is the highest that men can occupy, both in point of rank and importance; and therefore the views, dispositions, and deportment of ministers, should accord with it. They should not be sordid in their

* Gisborne's *Walks in a Forest*, sixth edit. pp. 44, 45, 46.

attachments, nor grovelling in their pursuits. A predilection for lucrative places, and worldly honors, is inconsistent with the sanctity of their character, and the design of their profession. As they are in a station above others, so their minds should have a high elevation, contemplating spiritual and divine things, with intense application, and holy delight. The glories of the new Jerusalem, and the felicities of the celestial Paradise, are subjects which should engross their thoughts, and be exhibited in their official ministrations. They should look on all debasing pleasures, fleeting honors, and perishing riches, as things vastly below the dignity of their character, and contrary to the objects of their professional engagements. They have higher considerations to excite their solicitude, and more important affairs to employ their powers, than to spend their time in things, which neither can afford them any rational satisfaction, nor are of long duration. St. James calls their attention to what is of most interest to them, where he says, that "he who converteth a sinner from the error of his way shall save a soul from death, and shall hide a multitude of sins." Success is the most valuable remuneration, and should actuate ministers both in their private studies, and their public labors.

2. Because of the *beneficial effects* of their ministerial labors, being useful to men, in affording them light, direction, and comfort; and, consequently, the need the church has of them. Gospel ministers are as necessary to the moral world, during the present state of things, as the sun, moon, and stars are in the universe. A church without such helps, would be like a firmament deprived of globular lights. Ministers, with the bright rays of heavenly doctrine, dispel the darkness of ignorance, chase away the clouds of error, scatter the mists of prejudice, disperse the fogs of vice, from the human mind. As stars engage the attention, and draw the eyes of persons toward heaven, presenting in themselves astonishing displays of the infinite perfections of wisdom, power, and goodness: so it is the work of ministers to endeavor to excite people to the contemplation of Divine things—to behold through the medium of the sacred Writings, the mediatorial character of Christ, the results of his passion, the prevalence of his intercession, the happiness of his subjects, and the glories of his kingdom. As the stars serve for guides to seafaring men, while traversing the untrodden paths of the swelling ocean; so these symbolical stars are guides to those who embark in the vessel of the church, directing her course, through the inconstant sea of this tumultuous and fluctuating world, to the harbor of everlasting rest. And as an extraordinary star in the east directed the wise men to Bethlehem, where Christ was born; so it devolves upon ministers, as stars of the church, to conduct inquiring sinners to Jesus, who is able and willing to save them from their sins, and bless them with holiness

and eternal life. They may with propriety adopt the language of an old poet:—

"Oh that his light and influence
Would work effectually in me
Another new Epiphany,
Exhale and elevate me hence:

That as my calling doth require,
Star-like I may to others shine;
And guide them to that Sun divine,
Whose day-light never shall expire."

3. All the light that ministers communicate to mankind, or to the members of the church, is derived from Christ, the Sun of Righteousness, as the light of the planets is from the natural sun. The pastors of the church have neither light nor grace of themselves: they receive all from the "Father of lights," in whose light only they can see light; and it pleased him that in Christ should "all fulness dwell." Both ministers and people must be enlightened with emanations from him, or remain in darkness. St. Paul frankly acknowledges, "By the grace of God I am what I am." Without him, the most eminent minister would be like a dark lamp. Hence they have no reason to be proud of their qualifications; for they have received all their gifts and graces from Christ. Their fitness for the ministerial work is not to be ascribed either to their natural powers, the force of a superior genius, a liberal education, intense study, or even to goodnes and piety, but to the gratuitous bounty of God only. So likewise, whatever success in the exercise of those gifts and graces they may have had, it flowed not from such sources, but from Christ. "I have planted," says St. Paul, "and Apollos watered; but God gave the increase." The largest planets are inconsiderable in comparison of the sun, which is the great natural fountain of light and heat. The holy prophets are nothing when brought into contrast with Jesus Christ. And John the Baptist, though superior to all his predecessors, conscious of his own vast inferiority, confessed, "He it is who coming after me is preferred before me, whose shoe's latchet I am not worthy to unloose."—As the planets shine with no other light than that derived from the sun; so ministers are to be resplendent only with the radiance of Divine truth, received from the eternal Fountain of illumination. They are not to shine with the glimmering light of fallable reason, the sparks of human wisdom, the glowworm rays of vain philosophy; not with the subtlety of Aristotle, the penetration of Cartes, the eloquence of Cicero, the speculations of Plato, the propositions of Euclid; but with the correct and comprehensive knowledge of the Scripture, which is "given by inspiration of God, and is profitable for doctrine, for reproof, for correction, and for instruction in righteousness; that the man of God may be perfect, thoroughly furnished unto all good works."

In a lower sense, it must be acknowledged, that human learning is of considerable use, affording ministers certain qualifications for their work. The knowledge of the languages, moral and natural philosophy, sacred and profane history, mathematical science, the art of speaking, particularly those branches of logic which teach us to range our thoughts in a right method, to form propositions distinctly, and to draw just conclusions from acknowledged premises : I say, the knowledge of these different branches of literature and science, may very much assist ministers to discover and defend the truth, and refute its adversaries with their own weapons. But they must derive all their peculiar lustre and excellence from the volume of Divine inspiration, whence, as chosen instruments, they can make people wise to salvation.

4. Ministers are like the stars of heaven, because of the difference that is among them, in respect of gifts and ability. The stars differ from one another in situation, magnitude, influence, and glory. "There is one glory of the sun, another glory of the moon, and another glory of the stars : for one star differeth from another star in glory." The gradation extends from stars of the first to those of the sixth magnitude. Some are so dazzling, that they appear with a peculiar splendor among the shining beauties of the night : others are obscure and nebulous ; and there are many which can only be seen with the help of telescopes. The stars of the moral hemisphere are not all enlightened, "by the Day-spring from on high," with the same degree of intellectual and Divine radiance. They have not all the same gifts, nor gifts in the same measure. Profound knowledge, excellency of speech, solidity and firmness of judgment, prudence and dexterity of conduct, are not usually the portion of one, but distributed among several ministers. One excels in a talent for preaching, another is eminent for utterance and power in prayer, and another is distinguished by wisdom and stability for government. Paul was sublime and cogent in reasoning ; Apollos was copious, eloquent, and mighty in the Scriptures ; John soars high in mysteries, and yet excels in sweetness ; Isaiah is pompous and magnificent in his style ; David charms and surprises us at the same time, with his ecstatic raptures and poetic strains. In the largest assembly of ministers there are not two alike, far less equal in all things. Some, like stars of the first magnitude, shine with great brilliancy : others have rays which are weak and obscure. Some are prudent, but not eloquent. Some have the gift of preaching, but are not remarkable for prudence and moderating their passions. Some have the art of affecting the passions : others have the skill of enlightening the mind, and informing the judgment. Some, appearing as if formed in a finer mould, have a talent of politeness and address, in their intercourse with people of character. Some, like skillful physicians, know how to deal with afflicted souls, and relieve wounded consciences. Some are sons of thunder,

while others are sons of consolation. Though every minister should have a competency of each of these gifts, yet some excel in one, and some in another. Thus "there are diversities of gifts, but the same Spirit;" and God, in diversifying his gifts, makes his manifold wisdom appear. The Christians at Corinth not understanding this, or too emulous for the first-rate talent, without sufficiently regarding Divine agency, which can render the meanest useful, became clamorous, and their indecorous conduct is held up to all succeeding ages, with the censure they deservedly merited. However, to calm their perturbation, he says, "Therefore let no man glory in men. For all things are yours; whether Paul, or Apollos, or Cephas; and ye are Christ's; and Christ is God's."

5. While some stars disappear, others arise that were not previously observed. "Your fathers, where are they? and the prophets, do they live forever?" Many, "of whom the world was not worthy," who were bold to suffer for the name of Christ, not only the spoiling of their goods, the loss of liberty, and banishment from their native country, but even death itself, have rested from their labors and afflictions, and are now enjoying a glorious reward. The Lord also sometimes raises up extraordinary lights, for asserting and propagating the truth, when his church is overwhelmed with the dark clouds of heresy and superstition. Of this Moses, Joshua, Elijah, and Elisha, as well as many other prophets, whom the Lord called in an extraordinary manner, were remarkable instances, in the Old Testament: and, in the New Testament, John the Baptist, and the apostles of Christ, whose voices were heard, and whose rays extended to the ends of the earth. When the Christian church was covered with the dark superstition and idolary of antichrist, God raised up some eminent lights, from time to time, to diffuse the pure doctrines of the Gospel, and lead the people out of mystic Babylon. Such were John Wickliffe in England, John Huss and Jerome of Prague in Bohemia; and, a hundred years afterwards, Luther in Germany, Zuinglius in Switzerland, Calvin in France and Geneva, and John Knox in Scotland, whom Beza calls the apostle of the Scots. Then did the Gospel run, and was glorified, like a mighty torrent carrying before it not only cities and provinces, but whole nations and kingdoms.* Actuated by zeal for religion, says a clergyman of the Establishment, "Wickliffe, Jerome, and Huss, roused the slumbering clergy to opposition. The zeal of Luther and his associates alarmed all Germany, and shook the Papal throne itself. Gilpin alone, in a dark period, evangelized a large part of the northern counties of England. Cranmer, Latimer, and Ridley, by their steady perseverance unto death, illuminated the British Isles. The zeal of Whitefield and the two Wesleys has, even in our day, made Eng-

* The author thankfully acknowledges his obligations for many of the above thoughts to an old sermon preached "at the opening of the Synod of Lothian and Tweeddale;" but cannot say of what date, or by whom delivered, as his copy of it is without title-page.

land, Scotland, Ireland, and America, experience very important consequences." Missionaries actuated by primitive zeal, and sent out by different societies to preach the Gospel among Heathen nations, like burning luminaries are chasing away the darkness of ignorance, gross superstition, and degrading idolatry, and, on their ruins, establishing the kingdom of Christ, and the reign of truth, peace, righteousness, and benevolence, in the earth.

6. Ministers, considered as stars placed in the moral firmament, should shine with purity of doctrine, fervency of zeal, and holiness of life, both in the summer of prosperity, and in the winter of adversity. 1st. In the *solemn assemblies* of God's people. Jerome says, Our pulpit should be as Mount Tabor, where we should converse with Moses and the Prophets, Christ and his Apostles, minding that we have to do with a holy God, and with the immortal souls of people, which must be shortly either in heaven or hell. 2d. Amongst *their flocks*, by an innocent, instructive, and pious conversation, giving them no encouragement, by their example, to sin; but alluring them to better worlds, and pointing out the way thither. Their whole life should be a transcript of the holy life of the blessed Jesus, a living epistle in which the people may read the way wherein they ought to walk. 3d. In *their families.* A minister should be "one that ruleth well his own house," properly presiding over and governing his own family: "for if a man know not how to rule his own house, how shall he take care of the church of God?" Eli's conduct brought heavy judgments on himself and family, and a great scandal on the church.

*Theory of the earth.*

[Such intimations and analogies as can be drawn from nature may, with propriety, be applied to the explanation of natural phenomena, in the absence of direct and satisfactory proof. Allowing this assumption, we conclude that the intimations and analogies in nature are sufficiently strong and clear to authorize a belief, *that all heavenly bodies are similar in their great constitutional principles, and designs, and that our earth may be taken as a fair and satisfactory sample of them all.*

The only probable departure from this strong analogy in the heavenly bodies, seems to be this: the *suns*, or *centres of systems,* have a peculiar collection of phosphorescent clouds, which are designed to be the great exciting causes, or dispensers, of light to the planets which move round them. The planets have not these phosphorescent clouds.

This does not interfere with the *general* analogies between the heavenly bodies; and establishes the *strict analogies* between the planets of all systems; and the suns, or centres of all systems.

From all this we conclude, that a theory of *our earth* which is satisfactory, will also be deemed satisfactory in regard to the other heavenly bodies. We therefore lay down, as authorized by the intimations and analogies of nature, the following positions.

1. *There is a general analogy between the constitutional principles and designs of the heavenly bodies; i. e. the suns and their planets.*

2. *That the sun, or center of each system, with all the planets and satellites revolving about it, were created simultaneously, as it regards their substances.*

3. *That they were created at their relative distances from the centre which they now preserve.*

4. *That they were stationary when first created, having no motion either on their axis, or in their orbits.*

5. *That the materials of each body, when first created, were solid, frozen, and lifeless.*

6. *That the materials of each body were created in their simple, uncombined, or elementary states.*

7. *That it is most probable these elementary materials were promiscuous in the mass, without regard to specific gravity, or any other principle or law.*

8. *That the arrangement of the materials of which our earth is composed was effected by the operation of the laws of nature, as they are called, which were simultaneously impressed upon the matter of the Solar System, and is continued impressed, by the direct agency of the Divine Being.*

9. *That this reference of the commencement, and continuance of the energies of the laws of nature, directly to the Almighty, is both philosophical and scriptural; and is noted by Moses in these words: "And the spirit of God moved upon the face of the waters (or deep.")*

Reasoning from these data, let us now see whether the phenomena of the structure and arrangement of our planet are explicable to a satisfactory degree.

1. Immediately upon the impress of the laws of nature, by the direct effort of the Divine Being, the whole mass would commence revolving on its own axis, and moving around its centre in its orbit. At the same time a quickening impulse would be felt, from the operation of the laws of nature, which would impart life and animation to the mass. The first effect of this impulse would be to call the *caloric*, light, and electricity into action throughout the body. This would raise its temperature instantly, and call into action all the other powerful agents, as soon as formed: such as the acids, alkalis, &c.

2. There will be no difficulty, to those who know the power of these agents, in believing *that the consequence of their united action would be an immediate fusion of the whole mass.* This would establish a state of *chemical mobility;* i. e. the various materials, owing to their fusion, would be at liberty to *combine*, according to the laws of chemical affinity; and to take their relative positions, according to the laws of gravitation.

3. The result of this process would be binary, and ternary, and other combinations. Oxygen would enter into combination with the bases of the various acids, and thus form the acids; and with the various metals and thus form oxides; and the acids and oxides would unite and thus form other compounds, commonly called *salts.*

4. As such combinations as these would commence forming first,

water and air would be gradually and subsequently formed, by the three gasses, oxygen, hydrogen, and nitrogen, escaping from the mass and rising to the surface, where the oxygen combining with the hydrogen would form water; and with the nitrogen would form air.

5. It is evident that the very small specific gravity of the gases would cause them to escape from the interior parts of the earth, rapidly, and to accumulate at the surface in immense quantities. The consequence of this would be, *an immense amount of water would be generated at the earth's surface; but the oxidizable bodies in the interior of the mass would not, all of them, be completely saturated with oxygen.*

6. The condition of the earth, at this stage of the action, would be an inconceivably high state of ignition, specially in the interior, and a rapid chemical action still going on; the combinations still forming, and the bodies thus formed arranging themselves. In a very little time the various classes of bodies would have obtained, generally, their natural relative positions, according to their specific gravities; and all the combinable elements, in the same neighborhood, having combined, a state of comparative rest would ensue of course.

7. In the mean time, large quantities of different substances would be held in solution by the acids, alkalis, and water, whose solvent powers would be very much increased by the presence of intense heat.

8. If we examine the whole mass at this stage of the natural process, we will find it is in a condition to *crystallize* whenever it can be *reduced* to a sufficiently low temperature to admit of crystallization. We know that the reduction of temperature would commence at the surface, where the caloric would be conducted upwards through the waters, and would fly off into the celestial spaces. Of course, the first crystallized depositions would take place *at the junction of the waters with the oxides or earths, in a state of fusion, on which the lower stratum of water was resting.*

9. This first deposition would extend all around the globe, as the waters *entirely invested* the earth, and would lay the *foundation of the primitive family of rocks,* which are well known to be crystalline in their structure, and the result of chemical action. It is, however, evident that there were occasional tremendous agitations, and concussions during the deposition of the primitive rocks, which altered the state of the fluids, and caused successive, and, sometimes, alternating strata to deposit.

10. The period of the deposition of the primitive rocks continued until the elevations on the earth's surface were uncovered, became dry, and were subject to the disintegrating, and rending powers of the elements: at which time some marine animals, and some vegetables, adapted to warm and moist climates, were created. The consequence of this state of things would be that fragments of rocks, and marine animal and vegetable remains, would be found in the composition of the strata deposited at this period, and subsequently. The family of rocks thus deposited is called *transition* rocks.

11. This is the proper place to institute an inquiry into the origin of these *primitive elevations or mountains.*

12. It will be very obvious, that a mass of materials thrown into chemical action, and raised to a very high temperature, as explained above, would naturally, and necessarily be upheaved at different points on its surface, by the gases, and other bodies escaping from the interior. And though the general softness of the mass would cause these elevations to sink back again *at first*, upon the escape of the gaseous bodies upheaving them; yet, when the surface of the earth, which would cool by coming into contact with the water, would thus begin to become solid, *the elevations would maintain themselves, and consolidate*, and thus lay the foundations of the irregularities which, subsequently, would rise into mountains, and mountain chains, and sink into vallies, by the combined action of the internal heat, and the occasional rapid rise and subsidence of the waters, which would alter the shape and appearance of the mountains, and deepen the vallies.

13. But it becomes very natural to inquire into the cause of the rapid rise, and subsidence of the waters at particular times; which will also explain the cause of the distinctions so obvious in the nature and ages of the different families of rocks.

14. It will be recollected that the interior parts of the earth are in a state of high ignition, and an immense quantity of water surrounds the globe, the crust of which is consolidating. By the natural pressure of the water, by an occasional eruption of gas from the interior, and by percolation, &c, the water would have access to the interior materials in a heated state. In this case there would be an immense production of steam, and decomposition of water, which would of course produce an earthquake, until it broke forth in a volcano under the waters. In this case an *elevation* would be produced on the surface, and, in all probability, a *cavity* in the interior from whence the elevated materials came.

15. These phenomena would happen in quick succession, and very extensively in the first period of the world; and every time they happened, they would *reduce* the quantity of water at the surface, by admitting some into the interior cavities; and by decomposing much; the oxygen and hydrogen of which would enter into other combinations.

16. This will account for the rise and subsidence of the waters, the formation of vallies, and mountains, and the alterations in the fluids, so as to deposit the different strata in succession.

17. During this process above, cavities sufficiently numerous and capacious, filled with water, would be formed in the earth to relieve the surface, in a great measure. But it seems pretty evident that the waters thus retired into those cavities were occasionally thrown back on the earth, by the same means with which earthquakes and volcanos are produced; and thus tremendous currents would ensue, which would successively bury the vegetable materials in the adjoining lakes, out of which the coal basins are formed; and also bury those immense forests of trees, with the bones of animals, and fishes also, which have been so clearly and satisfactorily described by geologists.

18. Each successive deluge, in proportion to its power and extent, would alter the quantity and quality of the materials held in solution, and thus cause a corresponding deposition subsequently. Hence, as

remarked above, the distinction in the strata, and the alternations of different substances successively.

19. It may not be amiss here to say, it is very probable, that many deluges preceded the formation of man, produced on the same principles as the deluge of Noah, though for different purposes, according to the wishes of the Divine Being.

20. To what has been said above, it is only necessary to add, that all depositions, or formations of rocks took place *at the bottom of the ocean*, or waters which held the materials in solution, or suspended; and that this ocean maintained its dominion for long periods together, in comparative tranquility, and during such times the different rock formations were deposited. The marine animals would multiply, die, and their exuviæ quietly fall to the bottom: at the same time carbonate of lime would be copiously deposited from the sea waters, and thus would consolidate into a stratum of rock, the thickness of which would bear some proportion to the length of the period of its deposition. If this stratum *remained in its place*, upon the retiring of the sea, it would appear at the surface at first; until it was covered with mould, and the ruins of other rocks disintegrated into earth, or soil. But if it were *upheaved* by the force of the internal fire, it would become a *limestone mountain*, containing the organic remains as they were first quietly deposited. The same may be said of primitive mountains, or any other kind.

21. The *transition* rocks, the formation of which was barely noticed above, (No. 10) were deposited successively in strata, indicating their relative ages by the increase of rocky fragments, and fossil remains in their composition, from the oldest of the family to the newest: and also by the gradual change in their structure, which is more crystalline in the oldest, and becomes less so in the newest, owing to the decrease of chemical action, and the increase of mechanical deposition.

22. From the fossil remains in the different strata of the transition rocks, we have good evidence of successive deluges, which swept away the animals existing at the time, and buried their remains which are now found in a fossil state; and others succeeded them. This will account for particular animals being peculiar to particular strata of rocks.

23. During the transition period the chemical action ceased almost entirely, and the succeeding family of rocks, i. e. the *secondary*, was deposited *mechanically*, their materials being merely *suspended* in the waters. This class, therefore, is not crystalline in its structure, and is nearly horizontal in position and contains greater quantities of fossil remains, both of animals and vegetables. These remains are, also, the relics of beings more delicately organized, and approach much nearer to the genera and species of animals now existing.

24. During the deposition of this class of rocks, and also of the *tertiary* class which succeeded it, the sea retired far from the up-lands, and well nigh into its permanent beds. The up-lands would, by the disintegrating power of the elements, be worn away at their surface, and thus afford the matter of soil, which would naturally be carried down towards the final retreat of the sea, by the waters, and be de-

posited in the vallies, and low countries. The same process would furnish fragments of rocks in abundance, and of all kinds, which would be rolled down the declivities of the up-lands, and become more or less rounded, and thus be found entering into the rocks of the secondary and tertiary classes; or in beds of sand and gravel, or in the channels of rivers in the form of *pebbles.* If these fragments were thrown together in sufficient quantities, and a suitable cement deposited among them they would consolidate and form *pudding-stone,* or breccia marble; such as the Potomac marble, of which the columns in the Capitol at Washington City are made.

25. It is very evident that this process would deposit the heavier fragments, and materials nearest the highlands whence they originated; and carry the finer and richer matter further away towards the sea, and deposit it nearer the mouths of the rivers. This is well known to be the case, as in the Mississippi. Here the phenomena are doubtless, from the mouth, along all its tributaries to their sources.

26. While these successive depositions were making, modified by tremendous eruptions from the force of subterranean fire, the same agent of these modifications would produce another very striking phenomena. The immense quantity of matter thrown from the interior to the surface in a melted state, would either shoot up in the form of cones, or columns, and by cooling crystallize and consolidate; or would flow in its melted state over the surface of the upper rocks, and thus cover them. This is the case with a class of rocky substances which may be called by the general name of *basalt.* Sometimes when the force below was not sufficient to protrude the melted matter through the superincumbent rocks, it drove it in *between* the strata, or shot it up *through* some of the strata; frequently upheaving the rocks on one side of the protruding body, or depressing them on the other. In this case the injected matter constitutes what is called a *fault, shaft,* or *dike,* by miners.

27. It is not improbable, nay, it is pretty certain, that many of these basaltic ejections took place under the ancient chaotic abyss of waters, and have become visible by the retiring of the sea.

28. In this theory we have a satisfactory explanation of the formation of *metallic veins,* and the *dispersion* of metallic grains in sands, and soil. The metals being in a pure state, or nearly so, in the bowels of the earth when *projected* upwards by the force of subterranean power, would be *injected* into the rocks in the direction of the operating force. Hence they are found in veins in solid rocks, running in all directions, and descending to unknown depths. Sometimes the whole of the vein appears to be *insulated* by the rock. In this case, the whole mass was *fused,* at least partly, and when the force ceased to act, it would consolidate around the injected metal, leaving no trace of its injection. Sometimes the metalic vein evidently entered the rock *from above.* In this case the metal in a *melted* state was thrown to the surface, and *meeting with a chasm, ran into it and consolidated into a vein.* When the metal was raised from below in a state of fusion in conjunction with an immense mass of rocky matter in a state of fusion, they would appear at the surface mixed throughout. When this rocky mass yielded to the disinte-

grating power of the elements, the particles of the metal and rock would be carried off together into the lower positions, and be found in the form of *dust*, in the secondary, or lower countries.

29. The shape of the earth, in regard to which it is said the polar diameter is less than the equatorial, would be the same on the above theory, as it has been shown to be, on the supposition that the earth was in a soft state by the solvent powers of water, as commonly supposed.

30. It is a matter of peculiar pleasure to the Christian philosopher, to observe the strong tendency in the Science of Geology, to confirm the account of the creation of the world, as given by Moses in the Bible. By a careful comparison of the account of Moses with well established geological positions, it will be found that *they agree expressly, in the* ORDER *and* NATURE *of the events.* This is a splendid evidence in favor of revelation. There can be no doubt, but, that if the phenomena of nature, and the teachings of the Bible were better understood, more striking and unexpected agreements would be found. Religion and Science will one day be inseparable.

*Remarks.*

1. It will be necessary for the reader to peruse the above theory very attentively, in order to form a correct judgment of it, as it is merely an *outline*, very briefly drawn up, yet it is hoped, pretty clearly. Whether it be well calculated to explain the great leading geological phenomena which we observe, the reader will determine for himself. It was not drawn up *in view* of such explanation, but was constructed by *induction* from those well ascertained phenomena. It was drawn up *out of view* of any ultimate object, or system, *previously* embraced, and is even *different* from the writer's previous opinions, before he had diligently compared all the facts within his reach. It is therefore entitled to the merit of having been drawn up with a sincere desire to attain to truth on this interesting subject, and not to support a favorite theory.

2. Upon examination it will be found to reconcile, in a great measure, the *Vulcanian* and *Neptunian* theories which have so long divided the principal writers on Geology. It will be found that both *fire* and *water* were concerned in producing the great geological phenomena. It cannot be doubted but that subterranean force *commenced* the irregularities on our earth's surface, and continued the action, probably with occasional intermissions, in upheaving the mountains, and mountain chains: but as this was commenced, and principally accomplished, *under* the ancient sea, there can be no doubt but that the water has had a powerful and extensive agency in modifying the structure and composition of mountain, and moderate elevations. And while we have every reason to believe the force of subterranean fire was the principal agent in rending, dislocating, and confusing the rock formations of the crust of our earth; we have no less reason to acknowledge the agency of water in depositing the various strata; contributing to the disintegration of the exposed uplands; and carrying down the *alluvion* which form the fertile tracts of vallies, and low countries; and the sand bars, and banks at the outlets, of rivers, bays, gulfs, &c.

3. This view will be more clearly explained by examining the *shape* of continents, islands, and countries, which will be found to correspond, pretty nearly with the shape of the mountain ranges in each. That is: the *length* of a continent, island, or country will be found to be *in the direction of the mountain range;* and the *breadth across* the mountain range.

4. This would be the shape which would naturally result from the transition, secondary, and tertiary formations arising principally from the disintegration of the materials of the mountain range. This is evident from a single reflection: if a *conical* body stood in the midst of a plain, and was equally exposed to a power which wore it away, the portions thus torn from the body would roll down the declivity towards the base of the cone, and would occupy a circle, generally speaking, of the plane at the base equidistant from the body. In the same manner the wasting away of the primitive elevations would deposit the detritus equidistant from the foot of the range.

5. It will be obvious, however, that the conformity of a country, *in shape*, to the mountain ranges which run through it, will be more or less modified by adventitious circumstances. If one side of the mountain range was originally more precipitous than the other: or if some tremendous collection or current of water lashed or swept one side, and not the other, the shape of the country would be modified; but not so much as to destroy the general conformity in shape. The above remarks will be confirmed by an inspection of accurately drawn maps.

6. Finally: Some formations are entirely owing to the agency of water; as sand banks, bars, shoals, &c, and some entirely owing to the action of fire, as the deposites of lava; the upheaving of volcanic mountains, even in the memory of man. These are *adventitious* formations, and do not even *modify* a general theory.]

# CHAPTER VI.

## FIFTH DAY.

### *Section* I.—FISHES.

Of Fishes in general—The Cetaceous kind—Cartilaginous—Spinous—Crustaceous—and Testaceous.—Animalcules.—Religious Improvement.

ON the *fifth day* were created fishes, and the fowls of heaven, whatsoever flies in the expansion above us, or swims in the watery element: these were produced from the waters. "God said, Let the waters bring forth abundantly the moving creature that hath life, and fowl that may fly above the earth in the open firmament of heaven. And God created great whales, and every living creature that moveth, which the waters brought forth abundantly, after their kind, and every winged fowl after his kind: and God saw that it was good. And God blessed them, saying, Be fruitful and multiply, and fill the waters in the seas, and let the fowl multiply in the earth."

> "See through this air, this ocean, and this earth,
> All matter quick, and bursting into birth;
> Above how high progressive life may go,
> Around how wide, how deep extend below!
> Vast chain of being, which from God began,
> Nature's ethereal, human, angel, man,
> Beast, *bird, fish, insect,* what no eye can see,
> No glass can reach; from infinite to THEE,
> From THEE to *nothing!*"

It is generally granted that life is the highest perfection of corporeal beings, the most inestimable jewel of the creation. Life, though but in an insect, is more glorious than the sun. Solomon, making a comparison between living and lifeless things, prefers the meanest of living creatures before the best and noblest of dead things, "A living dog is better than a dead lion." How much soever we may be astonished at the stupendous mass of inactive matter, yet the least animated particle is still an object of greater admiration. God, in creating the first individual of each species of living creatures, not only gave a form to matter, but also a principle of life; inclosing in each a greater or less quantity of organical particles, indestructible and common to all organized beings. These pass from body to body, perpetuating this life, and ministering to the nutrition and growth of each. Thus every production, or increase by generation, is a continuance of this life, of which every succession of creatures is always full. The total quantity of life remains the same; for whatever death seems to destroy, it does not affect that primitive life, which is diffused through all organized beings.

However much the nature of life may perplex the most able, acute, and diligent inquirers into the subject, or exceed the utmost reach of human comprehension ; yet we see that it enables creatures to act, as it were, of themselves, and to seek and obtain such enjoyments as give them a sensible pleasure. The creatures on which this amazing property has been conferred, have also an inclination and ability to communicate it to their own species, which will succeed one another till time shall be no more! If we exercise our understanding on this remarkable instance of creating energy, it will tend to excite in us the most august thoughts of that almighty Being, who is the boundless source of existence, vitality, and motion to all his creatures!

In the work of creation, observes a learned author, after the formation of light, air, water, and earth, the originals of all material objects, God proceeded from creatures less excellent to those of a superior order. Such was his progress in the work of creation. Fish and fowl were both formed out of the water. Hence there is a nearer alliance and greater resemblance between the form and motions of creatures that swim and those that fly, than between such as creep and those that walk on the earth ; and their bodies being intended to be lighter, and their motion swifter, the wise Creator saw fit to form them from a light and fluid element.

The number of the different species of fish to which names are given, and with whose figure at least we are a little acquainted, is, according to Linnæus, above four hundred. The majority of these are confined to the sea, and would expire in the fresh water, though there are a few which annually swim up the rivers, to deposit their spawn. Among the various sizes, some have monstrous shapes, and amazing qualities. Fishes are usually classed into three general divisions: the *cetaceous*, or those of the whale kind ; the *cartilaginous*, or those which have gristles instead of bones ; and the *spinous*, or bony kind, called so from their bones resembling the sharpness of thorns.

In the cetaceous species are included all the various kinds of Whales, the Norwhal, or Sea-Unicorn, the Dolphin, the Grampus, and the Porpoise. Though "God created great whales,"* the words of Moses, according to the original, התנינם הגדלים *ha-tanneenin ha-gedoleen*, says Dr. A. Clarke, must be understood rather as a general than a particular term, comprising all the great aquatic animals, such as these now mentioned. All these resemble quadrupeds in their internal structure, and in some of their

* The great Greenland Whale is a large, heavy animal, usually found from sixty to seventy feet long. The head alone is equal to a third of its bulk ; and the cleft of the mouth is above twenty feet long. The upper jaw is furnished with barbs, that lie like the pipes of an organ, the greatest in the middle, and the smallest on the sides; these compose the whale-bone, the longest spars of which are found to be not less than eighteen feet. The fins on each side are from five to eight feet, consisting of bones and muscles, and sufficiently strong to give speed and activity to the great mass of body which they move. The tail is about twenty-four feet broad ; and, when the fish is on one side, its blow is tremendous. The skin is smooth and black, and in some places dappled with white and yellow : which, running over the surface, have a very beautiful effect. The outward or scarf skin is no thicker than parchment ; but this removed, the real skin appears of about an inch thick, and covers the fat or blubber that lies beneath : this is from eight to twelve inches in thickness ; and, when the fish is in health, of a beautiful yellow. The muscles lie beneath : and these, like the flesh of quadrupeds, are very red and tough.

appetites and affections. Like quadrupeds, they have lungs, a midriff, a stomach, intestines, liver, spleen, bladder, and parts of generation; their heart also resembles that of quadrupeds, with its partitions closed up as in them, and driving red and warm blood in circulation through the body; and to keep these parts warm, the whole kind are also covered between the skin and the muscles with a thicker coat of fat or blubber. The *aorta*, or principal artery, in that stupendous animal the *whale*, measures about a foot in diameter; and it is computed that the quantity of blood thrown into it, at every pulsation of the heart, is not less than from *ten to fifteen gallons.*

> "Nature's strange work, vast Whales of differing form,
> Toss up the troubled floods and are themselves a storm;
> Uncouth the sight, when they, in dreadful play
> Discharge their nostrils, and refund a sea;
> Or angry lash the foam with hideous sound,
> And scatter all the watery dust around.
> Fearless the fierce destructive monsters roll,
> Ingulph the fish, and drive the flying shoal.
> In deepest seas these living isles appear,
> And deepest seas can scarce their pressure bear:
> Their bulk would more than fill the shelvy strait,
> And fathom'd depths would yield beneath their weight."

These animals possessing finer organs and higher sensations than others, show an eminent superiority. They have all the tenderness of birds or quadrupeds for their young, nurse them with constant care, and protect them from every injury. The female never produces more than one young, or two at the most; and this she suckles entirely in the manner of quadrupeds, her breasts being placed, as in the human kind, above the navel. The ends of these she protrudes at pleasure, to afford nutriment to her offspring. Perhaps the prophet Jeremiah has an eye to this when he says, "The sea-monsters draw out the breast, they give suck to their young ones." Those of the cartilaginous kind, though not capable of nursing their young, yet bring them alive into the world, and defend them with courage and activity; while the spinous kind, a fierce, unmindful tribe, deposit their spawn, and leave the success to accident, without affording any protection.

As this first class of sea animals breathe the air, it is obvious they cannot bear to be a long time at once under water. They necessarily, every two or three minutes, emerge to the surface to take breath, as well as to spout out through their nostril (for they have but one), that water which they sucked in while gaping for their prey.

> "Hugest of living creatures, on the deep,
> Stretched like a promontory, sleeps or swims,
> And seems a moving land, and at his gills
> Draws in, and at his trunk spouts out, a sea."

Their tails therefore are different from those of all other fish: they are placed so as to lie flat upon the surface of the water; while the other kinds have their tails, as we frequently see, upright or edge-ways. This position of the tail enables them to force themselves suddenly to the surface of the water, at pleasure. How well is it that animals of this enormous size do not approach our shores, for their presence would fright the other valuable fish from our coasts: they are therefore kept in the abysses of the ocean: just as wild beasts, impelled by the same over-ruling Power, which hide themselves in the recesses of the forest.*

The cartilaginous tribe, which have gristles instead of bones, unite the principal of both the other classes in their conformation: like the cetaceous, they have organs of hearing, and lungs: like the spinous, they have gills, and a heart without a partition. From the structure of their gills, these animals are enabled to live a longer time out of water than other fishes. The cartilaginous Shark, or Ray, lives some hours after it is taken; while the spinous Herring, or Mackarel, expires a few minutes after it is brought on shore. Some of this class bring forth their young alive; and others produce them by eggs, which are afterwards brought to maturity. Most fishes having cold blood, have not heat sufficient to produce the fœtus. The all-wise Creator therefore has ordained, that many of them shall propagate their species by eggs, and this they do near the shore; where, by means of the solar rays, the water is warmer, and fitter for that purpose; and also because water-insects abound more there, which afford the young fry nourishment. To the fish of the ocean, which cannot reach the shores by reason of the distance, the Creator has given eggs that swim, and these are hatched amidst the floating fucus, called *sargazo*. In all, however, the manner of gestation is nearly the same: for, on dissection, it is ever found, that the young, while in the body, continue in the egg till a very little time before they are brought forth; and as soon as they leave the shell, they also begin to quit the womb. It is confidently asserted, that the young of the several species of the Shark, when pursued, will take refuge in the belly of its mother, by swimming in at her mouth. Of the same class of fishes are the Ray, the Torpedo,† the Lamprey, the Sturgeon, the Diodon, the Angler,

* A variety of opinions we meet with concerning the *whale* which swallowed Jonah, and in whose belly he was *three days and three nights*. The following is offered by Dr. A. Clarke. "That a fish of the *shark* kind, and not a *whale*, is here meant, *Bochart* has abundantly proved, vol. iii, col. 742, &c, edit, Leyd. 1692. It is well known, that the throat of a *whale* is capable of admitting little more than the *arm* of an ordinary man; but many of the shark species can swallow a whole man; and men have been found whole in the stomachs of several. Every natural history abounds with facts of this kind. Besides, the shark is a native of the *Mediterranean Sea*, in which Jonah was sailing, when swallowed by what the Hebrew terms דג גדול *dog gadol, a great fish*; but every body knows that *whales* are no produce of the Mediterranean Sea, though some have been by *accident* found there, as in most parts of the maritime world; but let them be found where they may, there is none of them found capable of swallowing a man."

† The *Torpedo* is formidable, being well known by the effect it produces when touched; but the manner of its operating is to this hour a mystery to mankind. Such is the unaccountable power it possesses, that, the instant it is touched, it benumbs not only the hand and arm, but sometimes also the whole body. The shock received, by all accounts, much resembles the stroke of an electrical machine; being sudden, tingling, and painful. "The instant, says Kemfer, I touched it with my hand, I felt a terrible numbness in my arm, and as far up as the shoulder. Even if one tread on it with the shoe on, it affects not only the leg, but the whole thigh. Those who touch it with the foot, are seized with a stronger palpitation than even those who touch it with the hand. This numbness bears no resemblance to that which we feel when a nerve is a long time pressed, and the foot is said to be asleep; it rather appears like a sudden vapor, which, passing through the pores in an instant, penetrates to the very springs of life; whence it diffuses itself over the whole body, and gives real pain. The nerves are so affected, that the person struck imagines all the bones of his

the Lump-Sucker, the Pipe Fish, the Hippocampus, or Sea Horse, the Sea Porcupine, and the Galley Fish.

Of the spinous, or bony kind of fishes, these are obviously distinguished from the rest, by having a complete bony covering to their gills; by their being furnished with no other method of breathing than through the gills only; by their bones which are sharp and thorny; and by their tails, which are placed in a situation perpendicular to the body. The history of any one of this order very much resembles that of all the rest. They propagate not by bringing forth their young alive, as do the cetaceous tribes, nor by distinct eggs, as do the generality of the cartilaginous tribes, but by spawn, or pease, as they are generally called, which they produce by hundreds of thousands. The bones of this order of fishes, when examined slightly, appear to be entirely solid; yet, when viewed more closely, every bone is seen to be hollow, and filled with a substance less rancid and oily than marrow. These bones are very numerous, and pointed; and, as in quadrupeds, are the props or stays to which the muscles are fixed, which move the different parts of the body. The number of bones in all spinous fishes of the same kind is always the same. As this species partake less of the quadruped in their formation than any other, so they can bear to live out of their own element a shorter time. Some, indeed, are more vivacious in air than others: the eel will live several hours out of water; and the carp has been known to be fattened in a damp cellar. The method is, by placing the fish in a net well wrapped up in wet moss, the mouth only out, and hung up in a vault; then fed with white bread and milk, and the net sometimes plunged into the water.

The spinous class of fishes is more prolific than any other animal. Although their usual way of propagation is by spawn, yet there are some, such as the eel and the blenney, which produce their young alive. Their power of increasing is such, that if they were suffered to multiply unmolested, and remain undiminished for only a few years, the progeny of an individual would far exceed all human calculation. It is asserted, that a single herring, in the space of twenty years, would yield an offspring greater in bulk than ten such globes as this we inhabit. A female herring deposits at least 10,000 eggs, in the sea near to Great Britain!* A tench lays 1,000

body, and particularly those of the limb that received the blow, are driven out of joint. All this is accompanied with an universal tremor, a sickness of the stomach, a general convulsion, and a total suspension of the faculties of the mind."

We are in possession of some facts which relate to the manner of its acting. Reaumur, who made several trials on this animal, has at least convinced the world that it is not necessarily, but by an effort, that the Torpedo benumbs the hand of him that touches it. He tried several times, and could easily tell when the fish intended the stroke, and when it would continue harmless. Always before the fish meditated the stroke, it flattened the back, raised the head and the tail; and then by a violent contraction in the opposite side, struck with its back against the pressing finger; while the body, which before was flat, became humped and round. The most probable solution of this phenomenon is, that it depends on electricity. When the fish is dead, the whole power is destroyed, and it may be handled, or eaten with perfect security.

* A large herring-fishery is carried on at Douglas, in the Isle of Man. Herrings are so abundant in the neighborhood of Gottenburgh, that 200,000 barrels, on an average, are salted there every year,

eggs. There have been 200,000 ova or eggs found in a carp; and in one of eighteen inches, 342,144: in a perch, weighing one pound two onces, 69,216; and in a sturgeon of one hundred and sixty pounds, there was the enormous number of 1,467,500. Leewenhoeck counted in a middling-sized cod, *nine million* 384,000.

This multiplication of fishes is very astonishing; but the fact is, as they are obliged to devour one another for necessary subsistence, the whole natives of the deep without these extraordinary supplies, would soon be totally extinct. Were they to bring forth no more at a birth than land animals, the increase would be far too small for the consumption. The weaker species would soon be destroyed by the stronger, and the latter would soon after perish. Therefore to supply millions of animals with food, and yet not depopulate the watery realms, the issue produced by some of their species is almost incredible. The spawn is not by scores, but by millions: and by this amazing expedient, constant reparation is made proportionable to the immense havoc.

As the different species of fishes are designed to occupy the waters, and range to and fro in that element, so they are wonderfully formed for that purpose. The chief instruments of the motion of a fish are the fins, which in some fishes are more numerous than in others. The fish in a state of repose, spreads all its fins, and seems to rest on its pectoral and ventral fins near the bottom: on folding the right pectoral fin, its body inclines to the right side; and on folding the left fin, it inclines to that side.—When the fish desires to have a retrograde motion, striking with the pectoral fins, in a contrary direction, effectually produces it. When the fish desires to turn, a blow from the tail sends it round; but if the tail strike both ways, then the motion is progressive. If the dorsal and ventral fins be cut off, the fish reels both to the right and left, and endeavors to supply its loss by keeping the rest of the fins in constant action. If the right pectoral fin be cut off, the fish leans to that side; if the ventral fin on the same side be cut off, then it loses its equilibrium entirely. When the tail is cut off, the fish loses all motion, and is carried wherever the water impels it.

In addition to the fins, an aquatic animal is furnished with an air bladder, a philosophical apparatus in its body; this sustains and enables it, at will to raise itself to the surface of the water, or, otherwise, to descend. When any accident has burst this air bladder, or it has been punctured by way of experiment, the fish remains at the bottom of the vessel or river, totally unable to ascend. Flounders, Soles and Skates, which are without this appendage, seldom rise in the water, and when they do, require a great effort. The simple action of the fins is not sufficient to raise the fish, its specific gravity

and about 400,000 are employed in making train oil. Besides these, 50,000 barrels are consumed fresh in the country, or sent to Denmark. Allowing 1,200 fish to each barrel, in this district alone, about 780,000,000 of herrings are caught in a season. In the year 1776, 56,000 barrels were sent to Ireland, and thence exported to the West Indies.

being greater than the fluid in which it is immersed. The bag containing the air is supposed to be muscular, and when the air is compressed into a smaller compass by the action of this muscular power, the bulk of the fish is contracted with it; whereby, since the absolute weight remains the same, the specific gravity, which is the sinking force, is increased, and the fish sinks; when, on the contrary, this compression is removed, the air bladder expands, the fish is specifically lighter, and it ascends.

In fish, we find the arrangement of the teeth nicely adapted to the habits of the different species. For instance, in the Pike, the teeth are placed with their points projecting backwards towards the throat, by which an easy ingress is afforded, but which at the same time prevents all egress, and retains most effectually the prey when seized. The alarm excited among smaller fishes at the approach of the Pike, is thus poetically expressed:

> "*Beware*, ye harmless tribes, the *tyrant comes*,
> Exclaims the silver-mantled naiad of the pond;
> *Beware*, ye flirting *gudgeons*, *barbles* fair,
> And ye, quick-swimming *minnows*, gliding *eels*,
> And all who breathe the lucid crystal of the lake,
> Or lively sport between the dashing wheels
> Of river mills, *beware; the tyrant comes!*
> Grim death awaits you in his gaping jaws,
> And lurks behind his hungry fangs—*beware!*"

The Sword-Fish is distinguished by the upper jaw, which runs out in the figure of a strong and sharp sword, sometimes to the length of three feet, with which he scruples not to engage the whale himself.* The Sun-Fish is one round mass of flesh; only it has two fins, which act the part of oars.

The great Creator has beautified the innumerable myriads that swim in the vast ocean, giving the greatest proportion to their shapes, the gayest colors to their skins, and a polished surface to their scales. The eyes of some are surrounded with a scarlet circle; while the backs of others are diversified with crimson stains. View them when they glance along the stream, or when they are fresh from their native brine; the silver is not more bright, nor the rainbow more glowing than their vivid, glossy hues! But we are lost in wonder at the exquisite contrivance and delicate formation of their gills: by which they are accommodated, even in that dense medium, with the benefits of respiration! A piece of mechanism this, possessed by the meanest of the watery tribe; yet infinitely surpassing, in the fineness of the structure of its operation, what-

* The Indians of Jamaica and Cuba (says Oviedo) go a fishing with the Romora, or Sucking-Fish, which they employ as falconers employ hawks.—This fish, which is not above a span long, is kept for the purpose, and regularly fed. The owner, on a calm morning, carries it out to sea, secured to his canoe by a small but strong line, many fathoms in length; and the moment the creature sees a fish in the water, though at a great distance, it darts away with the swiftness of an arrow, and soon fastens upon it. The Indian, in the mean time, loosens and lets go the line, which is provided with a buoy that keeps on the surface of the sea, and serves to mark the course which the Remora has taken, and pursues it in his canoe until he conceives his game to be nearly exhausted and run down: he then, taking up the buoy, gradually draws the line towards the shore; the Remora still adhering with inflexible tenacity to its prey; and it is with great difficulty that he is made to quit this hold. By this method (adds Oviedo) I have known a turtle caught, of a bulk and weight which no single man could support.—Edward's West Indies, vol. I. p. 100.

ever is curious in the works of art, or commodious in the palaces of princes.

As the spinous order of fishes is extremely numerous, various modes of classing them have been followed by different naturalists. The simplest is that of Linnæus, who ranks them in four divisions, according to the positions of the fins. The 1st division is what that celebrated naturalist terms *Apodal ;* and includes the most imperfect of the order, namely, those which want the ventral or belly fins, and it consists of the following genera :—The Eel, the Wolf-Fish, the Launce, or Sand-Eel, and The Sword Fish.—The 2d division consists of the *Jugular* fishes, or those which have ventral fins before the pectoral, or nearer to the gills ; and includes the Dragonet, the Weever, the Cod, and the Blenny. The 3d division is called the *Thoracic*, or those fishes which have the belly fins immediately under the pectoral ; and includes the Goby, or Roch-Fish, the Bull-head, the Doree, the Flounder, the Wrasse, the Perch, the Stickleback, the Mackerel, the Surmulet, and the Gurnard. The 4th division consists of the *Abdominal*, or those which have the ventral fins behind the pectoral, nearer the tail, and includes the Loach, the Salmon, the Pike, the Argentine, the Atherine, the Mullet, the Flying-Fish, the Herring, the Carp, &c. To the fishes, included in these four divisions, must be added, all the several species belonging to each, some of which are numerous.

There are two classes of animals inhabiting the water, which commonly receive the name of fishes, entirely different from the preceding ones, and also very distinct from each other. They are divided by naturalists into crustaceous and testaceous: both of which, being totally unlike fishes in appearance, seem to invert the order of nature. As those of the cetaceous, cartilaginous, and spinous orders, have their bones on the inside, and their muscles externally placed for the purpose of life and motion ; so these, on the contrary, have all their bony parts on the outside, and their muscles within. For instance, persons who have seen a Lobster, or an Oyster, perceive that their shells bear a strong analogy to the bones of other aquatic animals ; and that by these coverings they are sustained and defended.

Crustaceous fishes, such as the Crab and Lobster, have shells resembling a firm crust, and in some measure capable of yielding to pressure or strength. Testaceous fishes, such as the Oyster or Cockle, are furnished with shells of considerable hardness, very brittle, and susceptible of yielding to compressure like the others. Of the crustaceous kinds, are the Lobster, the Crab, and the Turtle :*

* A species of sea turtle, weighing 840 lb. was harpooned and caught on the 27th of September, 1811, off Sandy Hook, near New-York. It measured three feet two inches round the neck, was seven feet long, eight feet in circumference, and seven feet and a half from the extremity of one fin to the other : of a coal black color, with five black ridges on the back resembling the sturgeon. It is said to be a trunk turtle, a native of the East Indies, and was the first ever seen in the American seas. The proprietor of a museum purchased it for fifty dollars.

and the testaceous, includes the numerous tribes of Oysters, Muscles, Cockles, and Sea Snails. Some of these are extremely prolific. Under the tail of a Lobster, Dr. Baster says, he counted 12,444 eggs, besides those that remained in the body unprotruded. The female Turtle lays about eighty or ninety eggs at a time, each the size of a pigeon's egg, in a hole prepared with her fore feet in the sand, a little above the high-water mark, which she covers so dexterously, that it is no easy task to find the place; and then returns to the sea, leaving them to be hatched by the solar rays. At the end of fifteen days, she deposits about the same number of eggs again: and in fifteen days more, repeats the same; three times in all, using the same precautions every time for their safety.

Among shell-fish, how various is their figures? The shells of some seem to be the rude production of chance, rather than of skill or design. Yet, even in these, we find the nicest dispositions. Though uncouth, they are exactly suited to the exigencies of their respective tenants. Some, on the other hand, are extremely neat; their structure is all symmetry and elegance; no enamel is comparable to their polish. Not a room in all the palaces of Europe is so adorned as the tenement of the little fish that dwells in Mother of Pearl. Where else is such a mixture of red, blue, and green, so delightfully staining the most clear and glittering ground? But what is more admirable than all their beauty, is the provision made for their safety. As they have no speed to escape, so they have no dexterity to elude their foe: so that, were they naked, they must be an easy prey to every free-booter. To prevent this, what is only clothing to other animals, is to them clothing, habitation, and castle. They have a fortification which grows with them, and is part of themselves. And by means of this, they live secure amidst millions of ravenous jaws. The dark inky fluid, which the Cuttle-Fish emits when alarmed, not only tinges the water, but, at the same time, is so bitter, as immediately to drive off its enemies.

> "Th' endangered *cuttle* thus evades his fears,
> And native hoards of fluid safely bears.
> A pitchy ink peculiar glands supply,
> Whose shades the sharpest beams of light defy.
> Pursued he bids the sable fountain flow,
> And, wrapt in clouds, eludes th' impending foe.
> The fish retreats unseen, while self-born night,
> With pious shade, befriends her parent's flight."

The Nautilus, when he means to sail, discharges a quantity of water from his shell, by which it is rendered lighter than the surrounding medium, and, of course, rises to the surface. The shell forms a kind of boat, and he extends two of his arms upward, which are each furnished at their extremity with an oval membrane, that he unfurls to the wind for a sail. The other six arms hang over the sides of the shell, and supply the place of either oars or rudder, with which he rows himself along. When disposed to dive, he strikes sail, and at once sinks to the bottom. When the weather is calm, he ascends again, and performs his voyage without chart or compass.

> "Two feet they upwards raise, and steady keep;
> These are the masts and rigging of the ship.
> A membrane stretched between supplies the sail,
> Bends from the masts, and swells before the gale.
> The other feet hang paddling on each side,
> And serve for oars to row, and helm to guide.
> 'Tis thus they sail, pleased with the wanton game,
> The fish, the sailor, and the ship the same.
> But, when the swimmers dread some danger near,
> The sportive pleasure yields to stronger fear:
> No more they wanton drive before the blasts,
> But strike the sails, and bring down all the masts.
> The rolling waves their sinking shells o'erflow,
> And dash them down again to sands below."

Thus, we see, according to the beneficent purpose and blessing of God, the "waters bring forth abundantly." The finny tribes are numerous beyond all calculation; they crowd to our shores in vast abundance, from which our markets are regularly and plentifully supplied. And, as one judiciously observes, what a merciful provision is this for the necessities of man! Many hundreds of thousands of mankind live, during a great part of the year, on fish only. Fishes, which are liable to few diseases, afford not only a wholesome, but a very nutritive diet; and generally come in vast quantities to our shores, when in their greatest perfection. In this also we may perceive that the kind providence of God goes hand in hand with his creating energy; for, while manifesting his wisdom and power, he is making a permanent provision for the sustenance of man through all his generations. The Mackerel, the Herring, and various other kinds, when lean, wander up and down the ocean: but when fat they throng our creeks and bays, or haunt the running streams. Who bids these creatures leave our shores when they become unfit for our service? Who rallies and recalls the undisciplined vagrants, as soon as they are improved into desirable food? Surely the furlough is signed, the summons issued, and the point of re-union settled, by a Providence ever indulgent to mankind, and loading us with benefits.

By the invention and assistance of magnifying glasses, the two extremes of the creation, as Mr. Baker intimates, which were out of the reach of former ages, have been brought under our observation: the telescope is directed to the heavenly bodies, and the microscope to unknown species of animals, &c. The first appearance of the microscope was about the year 1621; since which period it has been very much improved. It is to this valuable optical instrument that we are indebted for a great part of our present philosophy: we are brought into a kind of new world.

Numberless animals are discovered, which, from their minuteness, must otherwise for ever have escaped our observation. How many kinds of these invisibles there may be, says Mr. Adams, is still unknown; as they are discerned of all sizes, from those which are barely invisible to the naked eye, to such as resist the action of the microscope, as the fixed stars do that of the telescope, and with the greatest powers hitherto invented appear only as so many moving points.

The smallest living creatures our instruments can show, are those which inhabit the waters; for though animalcules, equally minute, may fly in the air, or creep upon the earth, it is scarcely possible to get a view of them; but as water is transparent, and confines the creatures in it, we are able, by applying a drop of it to our glasses, to discover, to a certain degree of smallness, all that it contains.

> "Where the pool
> Stands mantled o'er with green, invisible,
> Amid the floating verdure millions stray.
> Each liquid, too, whether it pierces, soothes,
> Inflames, refreshes, or exalts the taste,
> With various forms abounds. Nor is the stream
> Of purest crystal, nor the livid air,
> Though one transparent vacancy it seem,
> Void of their unseen people. These, concealed
> By the kind art of forming Heaven, escape
> The grosser eye of man: for, if the worlds
> In worlds inclosed should on his senses burst,
> From cates ambrosial and the nectared bowl,
> He would abhorrent turn; and in dead night,
> When silence sleeps o'er all, be stunned with noise."

Leewenhoeck calculates, that a thousand millions of animalcules, which may be discovered in common water, are not altogether so large as a common grain of sand! Eminent naturalists have discovered not less than 30,000 in a single drop of water! What a display is this of the manifold wisdom of God! While he makes some of the aquatic tribes so large, that they seem to require almost a whole sea to float in, he forms others so astonishingly minute, that several thousands will adhere to the point of a needle.*

* Sir W. Jones, when in India, formed an acquaintance with an intelligent and respectable Brahmin. The religion of these men permits them not to destroy life, nor to swallow any creature which has possessed it; and so strict are some, that in the season when insects abound, they cover their mouths and nostrils, and sweep the ground on which they walk with a soft broom, that they may not tread on them. Sir William had a solar microscope sent from England, and showing it to his Hindoo friend, demonstrated the impossibility of his eating even fruit and vegetables without swallowing the animalcules which adhere to them. The Brahmin was astonished and seemed gratified; but begged importunately for the microscope, *so* importunately, that, at length, Sir William reluctantly resigned it to him. A momentary gleam of joy flashed across the Brahmin's countenance; and, grasping the instrument, he immediately descended from the viranda, where they were conversing, into the garden, when, seizing a stone, he instantly smashed it to pieces. On assigning his reason for this act, which he did a few days afterwards, when his friend's anger had subsided, he said, "Oh that I had remained in that happy state of ignorance wherein you first found me! Yet will I confess, that, as my knowledge increased, so did my pleasure, until I beheld the last wonders of the microscope. From that moment I have been tormented by doubt, and perplexed by mystery: my mind, overwhelmed by chaotic confusion, knows not where to rest, nor how to extricate itself from such a maze. I am miserable, and must continue so to be, until I enter on another stage of existence. I am a solitary individual, among fifty millions of people, all educated in the same belief with myself, all happy in their ignorance! So may they ever remain! I shall keep the secret within my own bosom, where it will corrode my peace, and break my rest; but I shall have some satisfaction in knowing that I alone feel those pangs which, had I not destroyed the instrument, might have been extensively communicated, and rendered thousands miserable! Forgive me, my valuable friend, and, oh, *convey no more implements of knowledge and destruction!*" These religious prejudices, which cannot bear the light of sound philosophy, we perceive to be the results of lamentable ignorance and degrading superstitions, and it may be hoped will soon be removed by the cultivation of science, and especially the dissemination of the Scriptures. The missionaries now in the East will certainly be of very singular use to the natives.

Every animalcule being an organized body, how delicate and subtile must the parts be that are necessary to constitute it, and to preserve its vital actions! How inconceivably small must it be, and yet a perfect animal. In animalcules, we discover the same multiplication of parts, diversity of figures, and variety of motions, as in the largest animals. How amazingly curious must be the internal structure of these creatures! how minute the bones, joints, muscles, tendons! how exquisitely delicate the veins, arteries, nerves! What a number of vessels and different circulations must be contained in one of these little creatures, and yet all have sufficient room for the performance of their several functions, without interfering with each other! It is difficult to conceive how in so narrow a compass, there should be contained a heart as the fountain of life propelling the circulating fluid, veins and arteries as the conductors of the blood, a brain to supply nerves in every part of the minute structure, muscles necessary to its motions, glands for the secretion of its fluids, stomach and bowels to digest its food, eyes to direct its progress, a mouth to take in its nourishment, and organs of generation to propagate its kind!

> "How sweet to muse upon His skill display'd
> (Infinite skill!) in all that he has made.
> To trace in Nature's most minute design,
> The signature and stamp of Power Divine;
> Contrivance exquisite expressed with ease,
> Where unassisted sight no beauty sees;
> The shapely limb and lubricated joint,
> Within the small dimensions of a point;
> Muscle and nerve miraculously spun;
> His mighty work, who speaks, and it is done;
> Th' invisible in things scarce seen revealed;
> To whom an atom is an ample field."

Animalcules in general, continues Mr. Adams, are observed to move in all directions with equal ease and rapidity, sometimes obliquely, sometimes straight forward; sometimes moving in a circular direction, or rolling upon one another, running backwards and forwards through the whole extent of the drop, as if diverting themselves; at other times greedily attacking the little parcels of matter they meet with. Notwithstanding their extreme minuteness, they know how to avoid obstacles, or to prevent any interference with one another in their motions: sometimes they will suddenly change the direction in which they move, and take an opposite one; and, by inclining the glass on which the drop of water is, as it can be made to move in any direction, so the animalcules appear to move as easily against the stream as with it. When the water begins to evaporate, they flock towards the place where the fluid is, and show a great anxiety and uncommon agitation of the organs with which they draw in the water. These motions grow languid as the water fails, and at last cease altogether, without a possibility of renewal if they be left dry for a short time. They sustain a great degree of cold as well as insects, and will perish in much the same degree of heat that destroys insects. Some animalcules are produced in water at the freezing point, and some insects live in snow.

[In the American Journal of Science and Arts for April, 1830, there is a letter to the editor, from *Dr. Joseph E. Muse*, from which the following is an extract:

"When the winter had made considerable progress, without much frost, there happened a heavy fall of snow; apprehending that I might not have an opportunity of filling my ice house with ice, I threw in snow, perhaps enough to fill it; there was afterwards severely cold weather, and I filled the remainder with ice; about August the waste and consumption of ice, brought us down to the snow; when it was discovered that a glass of water which was cooled with it, contained hundreds of animalcules, I then examined another glass of water, out of the same pitcher, and with the aid of a microscope, before the snow was put in it, found it perfectly clear and pure; the snow was then thrown into it, and on solution the water again exhibited the same phenomenon; hundreds of animalcules, visible to the naked eye with acute attention, and when viewed through the microscope resembling most diminutive shrimps; and wholly unlike the eels discovered in the acetous acid, were seen in the full enjoyment of animated nature.

"I caused holes to be dug in several parts of the mass of snow in the ice house, and to the centre of it; and in the most unequivocal and repeated experiments had similar results."]

There is one remarkable circumstance, says Mr. Lobb, that we must not pass over in our contemplation of these minute animals: which is, that they are found proportionably much stronger, more active and vivacious, than large ones. The spring of a flea in its first leap, how vastly does it outstrip any thing of which animals are capable! A mite, how vastly swifter does it run than a race-horse! M. de L'Isle has given the computation of the velocity of a little creature scarcely visible by its smallness, which he found to run three inches in half a second: now, supposing its feet to be the fiftieth part of a line, it must make 500 steps in the space of three inches; that is, it must shift its legs 500 times in a second, or in the ordinary pulsation of an artery!

The modes of propagation among these animalcules are various, and the observation of them is extremely curious. Some multiply by a transverse division; and it is remarkable, that though in general they avoid one another, it is not uncommon, when one is nearly divided, to see another push itself upon the small neck which joins the two bodies in order to accelerate the separation. Others, when about to multiply, fix themselves to the bottom of the water; then becoming first oblong, and afterwards round, turn rapidly as on a centre, but perpetually varying the direction of their rotatory motion. In a little time, two lines forming a cross are perceived: after which the spherule divides into four, which grow, and are again divided as before.* A third kind multiply by a longitudinal division, which in some begins in the fore part, in others in the hind part; and from others a small fragment detaches itself, which in a short time assumes the shape of the parent animalcule. Lastly, others propagate in the same manner as the more perfect animals.

The same rule seems to hold good in these minute creatures, which is observable in the larger animals, namely, that the larger kinds are less numerous than such as are smaller, while the smallest of all are found in such multitudes, that there seem to be myriads for one of the others. They increase in size, like other animals, from their birth, till they have attained their full growth: and when deprived of proper nourishment, they in like manner grow thin and perish.

And, if the extreme minuteness of the parts of animalcules is not merely surprising, but far above our utmost conception, what shall we say to those various species, to which the mite itself, in point of size, is, as it were, an elephant? Naturalists suppose another species, or order, of invisible animalcules, namely, such as escape the cognizance even of the best microscopes, and give many probable conjectures concerning them. Reason and analogy give some support to the existence of an infinite number of these imperceptible creatures. The naked eye, say some, takes in from the Elephant to the Mite; but there commences a new order, reserved only for the microscope, which comprehends all these from the Mite to those twenty-seven millions of times smaller; and this order cannot be said to be exhausted, if the microscope be not arrived at its last degree of perfection.

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Among the Egyptians, all the natives of the water were in some degree esteemed sacred. In many parts the people did not feed upon them. The priests in particular never tasted this kind of food; and the reason why they abstained from it, was the sanctity imputed to this class of creatures. For they were sometimes considered as sacred emblems: at other times worshipped as real deities. One species of fish called Oxurunchus, had, according to Strabo, a temple, and divine honors paid to it. A fish called Phagrus, was, according to Clemens Alexandrinus, worshipped at Syene. The Lepidotus and Eel, were, as we find from Herodotus,

* M. de Saussure, in a letter to Bonnet, says, "Infusion-animalcules multiply by continued divisions and sub-divisions. Those roundish or oval animalcules that have no beak or hook on the fore part of their bodies, divide transversely. A kind of stricture of strangulation begins about the middle of the body, which gradually increases, till the two parts adhere by a small thread only. Then both parts make repeated efforts, till the division is completed. For some time after separation, the two animals remain in a seemingly torpid state. They afterwards begin to swim about briskly. Each part is only one half the size of the whole: but they soon acquire the magnitude peculiar to the species, and multiply by similar divisions. To obviate every doubt, I put a single animalcule into a drop of water, which split before my eyes. Next day, I had five; the day after, sixty; and, on the third day, their number was so great, that it was impossible to count them."—La Palingenesie Philosophique, par C. Bonnet, tom. i. pp. 428, 429.

objects of adoration; being each sacred to the god Nilus. This is ridiculed by Antiphanes, who says, that an Eel among the Egyptians was reverenced equally with their gods.

The Jews were under a divine prohibition not to make an idolatrous graven image or likeness of any aquatic animals. However strange this idolatry may appear, yet, such was its extent, that it prevailed not only in Syria, but in the borders of Lebanon, also at Ascalon, Ashdod, and Joppa, cities within the precincts of the tribes of Dan and Judah. Hence we see the propriety of the judgments inflicted upon the Egyptians. "And the Lord spake unto Moses, Say unto Aaron, Take thy rod, and stretch out thine hand upon the waters of Egypt, upon their streams, upon their rivers, and upon their ponds, and upon all their pools of water, that they may become blood. —Against all the gods of Egypt I will execute judgment.—And the fish that was in the river died: and the river stunk." This was a punishment particularly well adapted to the state of that blinded and infatuated people: as it showed them the baseness of those elements which they reverenced, and the insufficiency of the gods in which they trusted. And this remarkable display of the Divine displeasure was the means of affording knowledge very salutary to the Israelites; as it served to warn them not to fall into the same or any similar act of idolatry, when they had seen it thus debased and exposed, and attended with such instances of accumulated evil.*

Father Lamy remarks, that the principal parts of Fishes are the gills, scales, and fins. Some have scales, and no fins; others have neither scales nor fins. Upon which is founded the distinction which Moses makes of clean and unclean fishes. Such as have neither scales nor fins are thought unclean. The authority for this is what the Lord commanded Moses to communicate to the children of Israel. "These shall ye eat of all that are in the waters: whatsoever hath fins and scales in the waters, in the seas, and in the rivers, them shall ye eat. And all that have not fins and scales in the seas, and in the rivers, of all that move in the waters, and of any living thing which is in the waters, they shall be an abomination unto you: they shall be even an abomination unto you; ye shall not eat of their flesh, but you shall have their carcases in abomination." The physical reason for this distinction may be, because those which have fins and scales are the most nourishing; and the others, which are without fins and scales, being, in general, very difficult of digestion,—such as the Conger, Eel, &c, which are too gross and fat for many stomachs. Among the Romans, no fishes were suffered to be offered up in sacrifice, or served up to the table of the gods, but such as were scaly.

In this distinction, direction, and prohibition, concerning fishes, there is a further meaning. Dr. Spencer says, "God ordained this

* See Bryant's Observations upon the Plagues inflicted upon the Egyptians, Part I.

distinction of meats, that the puerile nation of the Hebrews might be led by an application of this law to the first elements of sanctity and actual purity. And this conjecture is founded upon the reason God himself has assigned for this institution; for after he had delivered the law about separating the clean from the unclean animal, he immediately adds, 'Be ye holy, for I the Lord your God am holy.' Which words St. Peter applies not to legal but to evangelical sanctity, such as we should aspire to through the whole course of our lives. I must not deny that the text of Leviticus, in the outward letter, requires only a sort of legal sanctity, extending merely to corporeal purification: but it is agreeable to the umbratic nature of that law, that we should believe those words to have contained a more sacred meaning at the bottom, and to have directed the Jews to a sort of purity properly so called, and conformable to that of the Divine nature itself, under the figure of external purification." Indeed without a view to the moral purification of the soul, an institution merely affecting the body would be but of minor importance.

This distinction then being founded upon the moral principles of good and evil, no doubt the peculiarities of the animals themselves will serve to furnish instruction. A celebrated writer on this subject remarks:—The progressive motion of fishes is owing to the tail: for so may a boat be driven forward by the agitation of a single oar from the stern. The fins serve to keep a fish upright, and support it while it is stationary in any part of the water. The centre of gravity being above the middle region of the body, a fish floats unnaturally with its back downwards, when the fins are taken off. The scales of fishes, which are very hard, bright, and radiated, compose a sort of armor, which serves for their defence, and adds at the same time an appearance of light and purity. The fishes thus distinguished differ as much in their way of life from the smooth and slimy inhabitants of the waters, as in their color and appearance; for they are generally disposed to raise themselves from the bottom, and swim about with agility in the superior regions of the water; while the Eel buries itself in the mire, and all the crustaceous tribe lie scrabbling upon the ground. Fishes of the Eel or snake kind are disturbed by thunder and storms, and swim about when the waters are thick and turbulent: but as soon as the elements are at rest again, they presently slide down to their native mud.

Thus the mind, when polluted with impiety, and bowed down with unbelief, cannot be raised to the contemplation of evangelical truth, unless it is alarmed by the fear of Divine judgments; on which occasion profligate sinners are sometimes most violently agitated, hurrying themselves as fast as they can into a state of repentance. But as this is a temporary repentance, excited merely by a fear of suffering, the effect abides no longer than the cause continues to operate; and so their terrors and their penitence vanish together. When there was alarming thunder and destructive hail in the land of Egypt, and fire from the Lord ran along the ground, even Pharoah could recollect himself, and say, "I have sinned this time: the Lord is righteous, and I and my people are wicked. But when he saw that the rain, and the hail, and the thunders were ceased, he sinned yet more, and hardened his heart, he and his servants." Such is the fruitless issue of that involuntary repentance, which has no principle of Divine grace to support it. The moral of this distinction is obvious: the whole being a figurative monition, that a sordid and groveling way of life was to be abhorred by those who professed to serve God; whose mind being under the direction of revealed truth, and influence of the Holy Spirit, their affections were to be raised from vice to virtue, from pollution to purity, from things temporal to things eternal. There are many persons who bury themselves in the mud like the Eel, drown their senses in eating and drinking, or waste their precious time in sleep and idleness;* utterly disregarding all serious reflection, devotional elevation, holy rectitude, and spiritual enjoyment. Our Saviour, who spake many things to the Jews in parables, says, "The kingdom of heaven is like unto a net that was cast into the sea, and gathered of every kind: which, when it was full, they drew to shore, and sat down, and gathered the good into vessels, but cast the bad away." This was spoken to fishermen, who had been called from their employment by our Lord, and to whom he said, "I will make you fishers of men." They had hitherto been laboring to catch fish, but hereafter they were to catch men: thus their secular calling is turned into a spiritual channel. The word σωγηνη is said to mean *a drag-net*, the particular use of which is to drag fishes up from the bottom of the water. The similitude between that occupation from which, and that employment to which our Saviour called them, consists in these particulars:—the sea in which they were now to fish is the world, the fishes they were to catch are Jews and Gentiles, the net with which they were to catch them is the Gospel, and they themselves were to be fishermen. Or thus:—by the *net* may be understood the Gospel; by the *sea* into which it is cast, the unconverted world; by *casting* the net into the sea, the preaching of the Gospel; by *those* that cast the net into the sea, ministers; by the *fishes* enclosed, the hearers; by the net *gathering of every kind* of fishes, profane persons as well as sincere Christians; by the net being *full* and *drawn to shore*, a set time coming when the Gospel shall have fulfilled that for which it was sent, the mystery of God being finished; by the *good* being *gathered into vessels* as valuable and precious, and the *bad cast away* as vile and contemptible, that separation which shall be made at the final close of time between merely nominal and real

* See Jones's Disquisition concerning clean and unclean Animals.

Christians, casting the former into hell, and bringing the latter to heaven.

This parabolical method of conveying important instruction, by which heavenly things are represented and set forth by expressions borrowed from earthly things which are familiar to us, was very ancient, as appears from Jotham's parable, and much in use among the Jews. It engaged the attention, because it was pleasant; it assisted the memory, which is apt to retain what is conveyed in this form; it excited inquiry after the meaning of what was thereby intended: and, consequently, was likely to be rendered beneficial to the hearers. Father Quesnel remarks, The net of God's word, animated by his Spirit, draws souls out of the abyss of sin and error, to Christian faith and piety. The net and vessel of the visible church receives both the good and bad fishes, true Christians and hypocrites. This is neither the time, nor the place of distinction; all must continue mixed together till the great day of separation. A man's being in the church will not infallibly assure him of salvation: as yet there is time to become such as we ought to be. But the moment will come, when all desires and endeavors to this purpose will be attended only with despair. And who knows but this moment may be just at hand. Our faith is very weak if we can think of being separated from the righteous without shuddering. Our love of salvation is very faint, if we do not endeavor earnestly to separate ourselves in this world from the wicked, by the holiness of our lives and conversation.

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## *Section* II.—On Fowls.

Number of Species—Superiority and peculiar Construction—Skill in building their Nests—Power and season of Propagation—Dexterity in providing Food—Instinct—Migrations—Insects—Religious Improvement.

Not any part of nature is destitute of inhabitants. The woods, the waters, the depths of the earth, have their respective tenants; while the transparent and elastic air, and those regions where man can never soar, but with much art and at considerable risk, are occupied with the most beautiful creatures. Every order of animals is fitted for its situation in life; but none more apparently so than birds. Though inferior to beasts in the scale of nature, yet they hold the next rank, and far surpass fishes and insects, both in the structure of their bodies, and in their sagacity.

The number of species in this order of animals is very numerous, amounting to above eight hundred. As some degree of classification appears necessary, they have therefore been arranged into eight orders. The 1st is the *Struthious*, or Ostrich order, or those which never rise from the earth. This includes the Ostrich, the Cassowary, the Dodo, the Solitary, and the Nazarene. The 2d is the *Rapacious* order. This includes the Eagle, the Condor, the Vulture, the Falcon, the Shrike, or Butcher-Bird, and the Owl. The 3d is the *Gallinaceous*, or Poultry order, which is without both the talons and the hooked bill of the rapacious kind. This includes the Bustard, the Cock, the Turkey, the Pintada, or Guinea-Hen, the Grous, the Peacock, the Pheasant, the Curassow, the Partridge, and the Quail. The 4th is what some authors have termed the *Columbine* order. This includes the Dove, or Pigeon, with its varieties. The 5th is the order of *Pies*. This includes the Crow, the Roller, the King-Fisher, the Cuckoo, the Wood-Pecker, the Oriole, the Nuthatch, the Bee-Eater, the Wryneck, the Creeper, the Hornbill, the Parrot, the Ani, the Wattle Bird, the Grackle! the Bird of Paradise, the Beef-Eater, the Curucui, the Barbets, the Jacamer, the Tody, and the Humming Bird. The 6th is the *Passerine*, or Sparrow kind. This includes the Starling, the Thrush, the Chatterers, the Grosbeaks, the Bunting, the Finch, the Fly-Catchers, the Lark, the Wagtail, the Warblers,* the Titmouse, the Swallow, the Goatsucker, the Coly, the Tanager, and the Manakins. The 7th is the *Cloven-footed* Water-Fowl, including those with pinnated feet. This includes the Heron, the Ibis, the Curlow, the Snipe, the Sandpiper, the Plover, the Oyster-Catcher, the Pratincole, the Rail, the Gallinule, the Boatbill, the Umbre, the Jacana, the Sheathbill; and with pinnated, or finned feet, the Phalarope, the Coot, and the Grebe. And the 8th is the *Web-footed* Water-Fowl. This includes the Avoset, the Courier, the Flamingo, the Auk, the Guillemot, the Diver, the Tern, the Petrels, the Gull, the Mersanger, the Duck, the Pelican, the Albatross, the Skimmer, the Penguin, the Tropic Bird, and the Darter. These eight orders take in the several species belonging to each, some of which are very numerous; the Duck genus alone embraces one hundred species, differing much both in size and plumage. Thus we see in birds also, that God has shown his wisdom and his power, in the gradation from the vast Ostrich, and Cassowary, to the Humming-Bird, which in size is not much larger than the Bee.

> "The *ourissia*, bee-like in its size,
> *Humming* from flower to flower delighted flies,
> And in a wondrous living rainbow drest,
> Shifts all its colors on its wings and breast."

Of all animated beings, this little bird is the most elegant in form, and superb in colors. The emerald, the ruby, and the topaz,

* Nicholas, in his voyage to New-Zealand, vol. i, p. 334, says, "The morning of the 10th of January, 1815, was announced to our enraptured ears by the swelling notes of the woodland choristers, and never either before or since did I hear such delightful harmony. Rising together at an early hour, we fancied ourselves for the moment in some enchanted ground, while the forest seemed to ring with the mellow warblings of nature, and a thousand feathered songsters poured their soft throats in responsive melody. There was, however, one bird that was distinguished from all the rest, as well by the compass and variety of its notes, as by their incomparable sweetness. This bird, which has been brought to Port Jackson, and highly prized there, is called by the colonists the *organ-bird*, and is, I believe, peculiar to New-Zealand: the notes of the Nightingale, however exquisite, are, in my opinion, much inferior to the song of this bird; and I never thought before that either the grove or forest could boast of such a vocal treasure."

sparkle in its plumage, which is never soiled by the dust of the ground. In Mr. Bullock's Museum, Piccadilly, there is a case containing more than one hundred *Humming-birds;* and in the "Companion" to this delightfull repository of natural history, an interesting account is given of this little creature, that flutters from flower to flower, breathes their freshness, wantons on the wings of the cooling zephyrs, sips the nectar of a thousand sweets, and resides in climes where reigns the beauty of eternal spring.

The legs, the wings, the bones, even all parts of their bodies, are much lighter, firmer, and more compact in birds than in other animals. Their lungs are extended over all the cavities of their bodies. Carniverous birds, like carniverous quadrupeds, have but one stomach, where their food is moistened or swelled; a gizzard, which is a very hard muscle, almost cartilaginous, and which they commonly fill with small stones, where the food is afterwards ground, in order to its complete digestion. In birds there is no ruminating: but in such as are not carniverous, the food is immediately swallowed into the crop, or anti-stomach (which is observed in many, especially piscivorous birds,) where it is moistened by some proper juice, and then transferred to the gizzard, by the working of whose muscles, assisted by small pebbles, swallowed for that purpose, it is ground small, and so transmitted to the intestines.

Birds we find supplied with a corney substance, instead of teeth and lips. Their bills are cut into various shapes, adapted to their different habits. The sharp edge and tempered point of the Sparrow's beak, enables it to pick every seed from its concealment; breaking the grain to obtain the kernel. The hooked beak of the Hawk separates, like a dissector's knife, the flesh from the bones of the animals on which it preys. The spoon-bill of the Goose enables her to graze, and collect food from the bottoms of the pools. Birds of the Crane kind, which seek their food among the waters, having no web-feet, are supplied with long legs for wading, or long bills for groping, and usually both: these are admirably adapted to the shallow pools of water, or sides of rivers, which they frequent. But in birds living by suction, they are serrated, or tooth-like; these do not serve the purpose of teeth, but act as a seive, or strainer, separating nicely from mud some nutriment conducive to the preservation of life.

The sense of seeing in birds is remarkably acute; and though their want of external ears is supplied by only two small orifices or ear-holes, yet they do not appear deficient in hearing. The scent of some species is exquisitely delicate. Men who attend decoys where ducks are caught, generally keep a piece of turf lighted, on which they breathe, lest the fowls should smell them and fly away. The voice of birds is much louder in proportion to their size, than that of other animals; for in fact, the bellowing of an Ox is not heard at a much greater distance than the scream of a Peacock.

The covering of birds is perhaps one of the most beautiful. Their feathers are light, smooth, and warm, inclining backward, downy at the stem, overlapping at their tips, beautifully variegated, and forming a raiment, varying in circumstances, so as always to suit the habits of the bird. The construction of a single feather is "a mechanical wonder.". We see at the stem, a tough, light, pliant, and elastic material, only found in feathers; also the pith, which feeds the feathers, a substance peculiar to that purpose; likewise the beard, which grows on each side of the stem, and is stripped off when making pens, the separate threads of which are called filaments, or rays. These appear stronger when pressed perpendicularly to their plane, than when rubbed either up or down in the line of the stem; and this arises from the laminæ, of which these beards are composed, being flat, and placed with their flat sides towards each other. Hence, though they are easily made to approximate each other, yet they require more force in a contrary direction, having to encounter the impulse of the air, which requires more strength. We find also, that these threads, in their natural state, unite; and cannot be parted without force, although not joined by any glutinous adhesion, but by a mechanical contrivance. And, if separated by force or accident, when brought together they immediately reclasp, resuming their former smoothness. These threads are interlaced with each other, by means of a vast number of fibres, or teeth, which they protrude on each side; fifty of these have been counted in 1-20th of an inch: they are curved after a different manner from the filaments on which they grow. Those which proceed from the side toward the beginning of the quill-end, are shorter, firmer, and turn upward. Those on the side toward the extremity of the feather, are longer, more flexible, and bent downward. They therefore act thus; when the two laminæ are pressed together, so that the long fibres are forced far enough over the short ones, their crooked parts fall into the cavity made by the crooked parts of the others, just as a latch enters the cavity of a catch on the door post. All this beautiful structure may be seen by the microscope. In the Ostrich, whose feathers, or other filaments, hang loose like down, this mechanism is wanting. But as this bird does not fly, and requires assistance only in running, perhaps this formation is best adapted for that purpose. Small birds, which do not migrate in the winter season, have the inner side of their feathers black, because this is the warmest color: hence the heat of the bird is prevented from escaping.

The feathers of birds appear to be nourished and preserved in a remarkable manner; especially those that much frequent waters, for they have a larger supply of oily substance, with which to trim them. Lest the feathers should be injured by exposure to the air, every bird is furnished with a gland situated on the rump, containing a proper quantity of oil, which it presses out with its beak, and with which it occasionally anoints them. In water fowls, this oil is so plentiful, that it even imparts a degree of rancidity to the flesh; and by it, their plumy coat is rendered completely water-proof.

As God made the fowls "that they might fly in the firmament of heaven," so has he adapted the form of their bodies, and the structure and disposition of their plumage, for that very purpose. The head and neck in flying, are drawn principally within the breast-bone, so that the whole underpart exhibits the appearance of a ship's hull. The wings are used as sails, or rather oars, and the tail as a helm or rudder. By means of these, the creature is not only able to preserve the centre of gravity, but also to accelerate its speed through the air, either straight forward, circularly in any kind of angle, as well as upward or downward. Though the greatest part of the aërial creation are adorned with feathers, yet has the Deity enabled several to fly without them; such as the Bat, one species of Lizard, two sorts of fishes, and numberless kinds of insects.

The skill with which birds erect their houses, and adjust their apartments, is inimitable. The caution with which they conceal them from the searching eye, or intruding hand, is admirable. They fix their nests on the pliant branches that wave aloft in the air, or are suspended over the flowing stream: by these means the vernal gales rock their cradle, and the murmuring waters lull their young; while both concur to terrify their enemies, and have a tendency to prohibit their approach. Some hide their downy offspring from view, amidst the shelter of entangled furze. Others, with wary solicitude, place them in the centre of a thorny thicket. And thus, by a variety of expedients, they are generally as secure, as if intrenched behind an impregnable mound.

> "Some to the holly-hedge
> Nestling repair, and to the thicket some;
> Some to the rude protection of the thorn
> Commit their feeble offspring: the cleft tree
> Offers its kind concealment to a few,
> Their food its insects, and its moss their nests.
> Others apart, far in the grassy dale,
> Or roughening waste, their humble texture weave.
> But most in woodland solitudes delight,
> In unfrequented glooms, or shaggy banks,
> Steep, and divided by a babbling brook,
> Whose murmurs soothe them all the live-long day,
> When by kind duty fixed. Among the roots
> Of hazel, pendent o'er the plaintive stream,
> They frame the first foundation of their domes;
> Dry sprigs of trees, in artful fabric laid,
> And bound with clay together. Now 'tis nought
> But restless hurry through the busy air,
> Beat by unnumbered wings. The Swallow sweeps
> The slimy pool, to build his hanging house
> Intent. And often, from the careless back
> Of herds and flocks, a thousand tugging bills
> Pluck hair and wool; and oft, when unobserved,
> Steal from the barn a straw: till soft and warm
> Clean and complete, their habitation grows."

If the Swan has large sweeping wings, and a copious stock of feathers, to spread over his callow young; the Wren supplies by contrivance what is wanting in her bulk. Though small, she has to nurse a very numerous issue; therefore with surprising sagacity designs, and with wonderful diligence finishes her nest, being a neat oval, bottomed and vaulted over with a regular concave, within made soft with down, without thatched with moss, and having only a small aperture left for her entrance.

"It wins my admiration,
To view the structure of that little work,
*A bird's nest.* Mark it well within, without.
No tool had he that wrought, no knife to cut,
No nail to fix, no bodkin to insert,
No glue to join: his little beak was all,
And yet how neatly finished!"

By this means, the animating heat of her body is greatly increased during the time of incubation. And her young no sooner burst the shell, than they find themselves screened from the annoyance of weather, and comfortably reposed, till they gather sufficient strength and plumage in their warm recess, to make their first essay into the wide expanse.

As to the succession of this class of animals, some are endued with a remarkable power of propagating, while others are confined within narrow limits. In general, the least animals, and those which are useful and serve for nourishment to the greatest number of other animals, are the most prolific. The Hawk kind generally lay not more than two eggs, or at most four; while the Poultry species produce from 50 to 100. The Diver, or Loon, which is eaten by a few animals, lays also two eggs; but the Duck kind, the Moorgame, Partridges, &c, and small birds, lay a very great number. If we suppose two pigeons to hatch nine times a year, they may produce in four years 14,760 young!

Birds generate in that particular season which supplies them with a stock of provisions, sufficient not only for themselves, but for their increasing families. They hatch their young when new-born insects swarm on every side. So that the caterer, whether it be the male or female parent, needs only alight on the ground, or make a short excursion into the air, to find a repast ready dressed for the tender charge at home. The love they have for their off-spring, while helpless, is invincibly strong.* They nurse them with the greatest care, caress them with affectionate notes, put food into their mouths, cherish and keep them warm, teach them to pick, eat, and gather food: whereas, the moment they are able to provide for themselves, this anxious care vanishes as though it had

* A Martin recently fixed her nest directly over the window of the Inn at Rampside, in Low Farnes. After her young were hatched, she became a very troublesome visitant, by throwing the cleansing of her nest upon the window. The servant-maid, with more attention to cleanliness than humanity, removed the little inconvenience by destroying the nest with a broom. The young birds of course fell to the ground; in the mean time the parents collected a great number of their own species, who quickly built a second nest, sufficiently commodious for the reception of the distressed family, and the young were safely conveyed to their new lodgings by the parents and their assistants.

never been. The Hen, while catering for her little brood, would fly at a mastiff in their defence: yet, in a few weeks, leaves them to their own protection, not regarding them any more than others of the same species.

They also provide their food with admirable art, which dexterity they bring into the world with them. Some birds, though not aquatic, live on fish: and must necessarily find it more difficult to seize their prey than Water-fowl. From whence do they derive this natural instinct? They stand on the brink of the liquid element, and when a shoal of fish comes (which they can discover at a distance,) they pursue them, skim along the surface, suddenly dive into the water, and carry off a fish.* Who gave the birds of prey their piercing sight, undaunted courage, and the destructive weapons, without which they could not possibly subsist? Who points out to the Stork the place where she may find frogs† and insects for her support? In order to procure these, she must seek them not only in meadows, but also in the furrows of fields; and continue her search till the approach of morning, when the other birds awake and begin to quit their places of retreat. What amazing strength must the Condor have, seeing it can carry away a sheep, a deer, and even prey on the ox itself! How can we reconcile that maternal instinct which causes the quail to adopt little birds of every species, which she not only takes under her protection, but bestows on them her tenderest cares! What cunning does the Crow use to secure the prey, which she cannot devour at once? She hides it in places such as other Crows do not frequent, and when hungry again, how well does she know where she has deposited it!‡

* Dr. Edmonston, in his view of the Zetland Islands, says, "The white-tailed Eagle, or *Erne*, boldly attacks fishes of the largest size. Several desperate combats have been witnessed between this bird and the Hallibut. The former strikes his claws into the fish with all his force, determined not to relinquish his hold, and, although but rarely, is sometimes drowned in the attempt to carry off his prize. When he has overcome the Hallibut, he raises one of his wings, which serves as a sail, and if favored by the wind, in that attitude drifts towards the land. The moment he touches the shore, he begins to eat out and disengage his claws; but if discovered before this can be effected he falls an easy prey to the first assailant."

† Bellonius says, "The Storks come to Egypt in such abundance, that the fields and meadows, are white with them. Yet the Egyptians are not displeased with this sight; as frogs are generated in such numbers there, that did not the Storks devour them, they would over-run every thing. Besides, they also catch and eat Serpents. Between Belba and Gaza, the fields of Palestine are often desert on account of the abundance of Mice and Rats; and were they not destroyed by the Falcons that come here by instinct, the inhabitants could have no harvest."

‡ Dr. Edmonston says:—"The crows generally appear in pairs, even during winter, except when attracted to a spot in search of food, or when they assemble for the purpose of holding what is called the *Crow's court*. This latter institution exhibits a curious fact in their history. Numbers are seen to assemble on a particular hill or field, from many different points. On some occasions the meeting does not appear to be complete before the expiration of a day or two. As soon as all the deputies have arrived, a very general noise and croaking ensue, and, shortly after, the whole fall upon one or two individuals, whom they persecute and beat until they kill them. When this has been accomplished, they quietly disperse."

On the subject of Gulls, Dr. Edmonston says:—"In the affectionate care of their offspring, these Gulls display great sagacity and even foresight. When the cradle at Noss is about to be slung, the gulls, aware of the approaching capture of their young, are unremitting in their efforts to carry them off. From the first moment that they observe preparations making to enter the holm, they become noisy and restless,

——'and chide, exhort, command,
Or push them off,'

so that if bad weather delay the arranging of the cradle, but for a few days, scarcely any are left to be taken away.

"This bird is a great enemy to the fowler, by intimating to other birds his approach. One of

There are also several birds, which, when food begins to fail, hide themselves in the earth, or in caves, in a torpid state, during the winter. We are assured, at least, that before the approach of this season, the Strand-Swallows conceal themselves in the earth; the Wall-Swallows repair to the holes of trees and old buildings; and the House, or Common Swallows seek for ponds, where they fasten themselves in pairs, cling to roots or weeds, continue without motion, and apparently without life, till the return of spring, when they are re-animated, and return from that state of torpidity.

The infinitely wise Creator has given different instincts to birds; none of which is superfluous, or useless, but each is indispensably necessary to the preservation and well-being of the animal. The motion of birds not only requires strength and well-formed pliant limbs, but also instinct to direct their movements. They have each two feet; but their bodies do not rest perpendicularly on them, for they project both before and behind; and yet a chick will stand upright and run about almost as soon as it leaves the shell. Young Ducks, just hatched by a Hen, know their own element, and swim about in the water without example or instruction. Other birds know how to rise up from their nests into the air, balance themselves, pursue their course, make equal strokes with their wings in true time, stretch out their feet to equipoise their bodies, use their tails like an oar or rudder, to direct their flight, and make long journeys from their native country to unknown regions.

The migration of birds is truly astonishing! Very few spend the winter with us: the Yellow-Hammer, the Chaffinch, the Crow, the Raven, the Sparrow, the Wren, the Partridge, the Robin, and the Fieldfare, are the principal. Most of the others either

them is an inseparable attendant on the *Scarfs*, when they assemble on the rocks for the purpose of drying and resting themselves; and they seem sensible of the good offices of this voluntary guardian, by quietly receiving it among them, and obeying its friendly admonitions.—On the approach of a person from the shore, or of a boat, the Gull having first testified marks of anxiety and apprehension, flies off before either have approached within gunshot, and all the Scarfs, except those who are young and inexperienced, follow. It not merely contents itself with giving them warning in due time, but urges their departure by repeated calls, and sits down in the water, at a considerable distance from the spot from which it fled, as if intending to point out the place where they may consider themselves in safety; and they generally all repair to the same place. To the Seal this bird is of essential service. These animals frequently lie upon the rocks for hours in succession, and so well acquainted are some sportsmen with their haunts, that they raise small bulwarks, or *rests*, to conceal their approach, or wait their arrival behind a rock. The Gull, however, frustrates all these precautions, by first flying over the head of the hunter, and then screaming close to the Seal; and, when the latter is not disposed to avail himself at once of this friendly intimation, I have known them *strike him on the head* with their feet. As soon as he slips into the water they appear to be perfectly satisfied, as if they then conceived him in a situation to protect himself.

"The Gull seems to consider itself the natural guardian of the coast. If it spies a person at a distance, walking in a cautious manner, in the neighborhood of any bird, it instantly repairs to the spot, and by a keen acute cry, different from the common note, endeavors to inform it of the approaching danger. Ducks and Curlews know the hint quite well, and almost always take advantage of it, and fly off long before the fowler can arrive within gun-shot of them. On these occasions it often comes with a sweep, as if intending to strike the person, who by that means is kept in a state of constant alarm and irritation; but if it do not immediately fly off, after having succeeded in accomplishing the object of its mission, this officious interference not unfrequently draws the vengeance of the fowler on itself, and it falls the victim of its own good intentions. This Gull is not satisfied with having alarmed birds on any particular occasion. It does indeed fly to a distance and sit down, but after its anxiety has been once roused, it never loses sight of the fowler, but follows him at a distance wherever he goes, and unless by pretended inactivity the sportsman can quiet the apprehension of his enemy, it is in vain to think of getting within reach of any bird that is naturally shy and of a timid disposition. The scream of this bird is peculiarly wild, and indicative of anxious impatience."

retire to some invisible resort, or leave us entirely. Some kinds of birds, without taking any high flight, or setting off in troops, draw gradually towards the south, to seek those seeds and fruits which are most congenial to their taste; but they speedily return. Others, which are termed "birds of passage," collect at certain seasons in large flocks, and fly off to other climates; they even cross the seas, and make excursions of a surprising length. The best known birds of this description are, the Quail, the Swallow, the Wild-Duck, the Plover, the Snipe, and the Crane, with some others, which subsist on worms. In spring, the Cranes pass from Africa into Europe, in order to enjoy a more temperate climate. They migrate in flocks like clouds; and sometimes, their strength being nearly exhausted, alight on ships, and are taken without any difficulty. Swallows act in a different way: while some continue in Europe, and seclude themselves from our view as already observed, others cross the seas. Wild-Ducks and Cranes also repair at the approach of winter to milder climates. They all assemble on a certain day, and take their flight together. They commonly arrange themselves in two lines, united in one point like an inverted Λ, with a bird at the head, and others following in the lines: whose beaks always rest on the tails of those preceding. The leader holds only a temporary commission: and having relinquished his charge, rests himself, and is replaced by another. But all birds of passage do not take their departure in flocks: for there are some which travel alone; and others with their females and young. It has been computed that they may easily go 200 miles in six hours each day, supposing they can take rest at intervals, or during the night. According to this calculation, they may pass from our climates to the Equinoctial line in seven or eight days! This conjecture has been verified; for Swallows have been seen on the coast of Senegal on the 9th of October, which was eight or nine days after their leaving Europe.

These migrations are wonderful in every point of view! Doubtless the difference of heat and cold, and want of food, apprize them of the necessity of changing their abode. But what reason can be assigned for their departure at the appointed time, when the season is sufficiently mild, and food still in abundance, to invite their continuance among us? How do they know that other climates will afford them necessary food and warmth? By what operative power are they impelled to make this exit at the same period, as if preconcerted by mutual agreement? How can they, notwithstanding the darkness of the nights, the perplexity of the road, and the remoteness of the countries to which they are destined, still hold on in a direct course? Nature does not teach them all this art, industry, and penetration, which so much surprise us: if we separate nature from its great Author, it is then a word destitute of meaning.

> "Nature is but a name for an effect,
> Whose cause is God."

It is He alone who gives wisdom to the fowls of the air.

God's superintendence over birds is particularly noticed by our Saviour. "Behold the fowls of the air; for they sow not, neither do they reap, nor gather into barns; yet your heavenly Father feedeth them." God extends his providential care to all his creatures, not only to those which are domesticated and receive their supplies from men, but also to the fowls of the air. By a natural instinct they know how to select that kind of food which is suitable for aliment, and where to procure it; but they are without any particular solicitude and forecast: nor have they need of these, because God takes care to provide for them. St. Luke mentions the Ravens, which are carniverous creatures. "Consider," says he, "the ravens: for they neither sow nor reap; which neither have storehouse nor barn: and God feedeth them." God asks Job, "Who provideth for the raven his food?" There are but three things which concern such creatures; how their craving appetites may be satiated, where they may repose, and by what means they may be protected from the incursions of their enemies: and for all these God has amply provided. He takes care of their food: "he giveth food to the young ravens which cry," and are the most helpless of all creatures. Naturalists observe, that the Raven exposes her young ones as soon as they are hatched, leaves them to provide for themselves, and struggle with hunger as soon as they emerge into life; so they certainly would perish, if Providence did not interfere in their behalf. But God makes them his charge, and supplies their voracious cravings in due time, whether by the insect, the reptile, or the dew from heaven. He protects their rest, and renders their habitations places of refuge and safety. "The trees of the Lord are full of sap: the cedars of Lebanon which he hath planted; where the birds make their nests: as for the Stork, the fir-trees are her house."

The meanest classes of sensitive beings are endued with the faculty of instinct: a sagacity which is neither derived from observation, nor awaits the finishing hand of experience; which without a tutor teaches them all necessary skill, and enables them, without a pattern, to perform every needful operation. And what is more remarkable, it never misleads them, either into erroneous principles, or pernicious practices: nor ever fails to aid them in the most nice and difficult of their undertakings.—The inhabitants of the hive subsist as a regular community.

> ——"As *bees*
> In spring-time, when the sun with Taurus rides,
> Pour forth their populous youth about the hive
> In clusters; they among fresh dews and flowers
> Fly to and fro, or on the smoothed plank,
> The suburb of their straw-built citadel,
> New rubbed with balm, expatiate and confer
> Their state affairs: so thick the aëry crowd
> Swarmed and were straitened."

Their indulgent Creator has given them all implements necessary either for constructing combs, or composing honey. Bees have each a portable vessel, in which they bring home their collected sweets: and have the most commodious storehouses, wherein to deposit them. They readily distinguish every plant, which affords materials for their business; and are complete practitioners in the arts of separation and refinement. Aware that the vernal bloom and summer sun are but for a season, they improve to the utmost every shining hour, and lay up a stock sufficient to supply the whole society, till their flowery harvest shall return.

Insects, which some persons may consider as so many rude scraps of creation, ought to be classed among the most polished pieces of Divine workmanship.

> ——" In the vast and the minute
> The unambiguous footsteps of the God,
> Who gives its lustre to an insect's wing,
> And wheels his throne upon the rolling worlds."

"The first state in which insects appear, is that of the *ovum* or egg; from the egg is hatched the insect in its larva or caterpillar state. The larva, or maggot, crawls on many feet, and is extremely voracious, devouring the herbage, and stripping trees of their leaves. When the time arrives in which the larva or caterpillar is to change into the next state, namely, that of chrysalis, or *pupa*, it ceases to feed; and having placed itself in some quiet situation for the purpose, lies still for several hours; and then by a kind of laborious effort, frequently repeated, divests itself of its external skin, or larva coat, and immediately appears in the very different form of a chrysalis or *pupa*. From this state emerges, at length, the insect, in its complete or ultimate form, from which it can never change; nor can it receive any further increase of growth. This last stage is denominated *imago*."

> " Waked by his warmer ray, the reptile young
> Come winged abroad; by the light air upborne,
> Lighter, and full of soul. From every chink,
> And secret corner, where they slept away
> The wintery storms; or rising from their tombs,
> To higher life; by myriads, forth at once,
> Swarming they pour; of all the varied hues
> Their beauty-beaming parent can disclose.
> Ten thousand forms! ten thousand different tribes!
> People the blaze."

Many of them are decked with the richest finery. Their eyes are an assemblage of microscopes. The common Fly, for instance, perpetually surrounded with enemies, having neither strength to resist, nor a retreat to secure herself, has need to be very vigilant, and always on her guard: but her head is so fixed that she cannot turn it to see her danger; Providence, therefore, to supply this apparent defect, has given her more than a legion of eyes, insomuch that a single Fly is supposed to have no less than eight thousand. Nay, it is asserted that the common Dragon-fly is furnished with

25,000 of these diminutive lenses! By the help of this truly amazing apparatus, she sees on every side, with the utmost ease and speed, though without any motion of the eye, or inflection of the neck. The dress of insects is a vesture of resplendent colors, bespangled with an arrangement of the brightest gems.

"The little *gnat*, in beauties, may compare
With all his rival brothers of the air;
Transparent feathers, purple, green and gold,
His wings, small feet, and gay-fringed tail enfold.
Four sharpened spears his head with weapons arm,
And his pearled eyes with liveliest graces charm.
In down of ev'ry variegated dye
Shines, fluttering soft, the gaudy *butterfly*.
That powder which thy spoiling hand disdains,
The forms of quills and painted plumes contains;
Nor courts can more magnificence express,
In all their blaze of gems and pomp of dress."

The expansion of their wings displays the finest texture imaginable, compared to which lawn is as course as sackcloth. The cases, which inclose their wings, glitter with the finest varnish, are scooped into ornamental flutings, studded with radiant spots, or pinked with elegant holes. Not one but is endued with weapons to seize his prey, and dexterity to escape his foe, to despatch the business of his station, and enjoy the pleasure of his condition. It is affirmed that the female of the common house-fly is capable of producing 20 millions 80 thousand 320; hence we cannot wonder at their swarming so much in autumn.

[Our author has devoted very few remarks indeed to *insects;* yet the history of this class of creatures is as interesting as any other, and is attracting considerable attention. Their history is very far from being complete: their *number* is not known. They inhabit the air, water, and earth. This family of creatures is called *insects*, because of the *articulations* of the body, so as to appear notched, or intersected. A brief notice of some of their principal parts follows, which is chiefly taken from No. VIII, of the Family Library, published by J. & J. Harper, New-York.

*Mouth.*—All insects either *divide* their food, or *suck* it. In those which divide their food, the parts of the mouth are, an upper lip, and an under lip fixed to a piece called the chin; between these two there are four lateral pieces, two on each side; the two upper are called mandibles, the two lower, jaws. The mandibles, or upper jaws cut the food: the lower jaws divide and masticate it.

The mouth of those insects which suck their food, is elongated into a tongue or proboscis. This is a tube attached to the head. In some it is composed of two pieces connected by a joint; for if it were constantly extended it would be too much exposed to accidental injuries: therefore, in its indolent state it is securely doubled up by means of this joint. In some species, as the butterfly, the proboscis, when not in use, is coiled up like a watch-spring. In some it is shut up in a sharp-pointed sheath, which is of firmer texture than the proboscis, and by which the insect pierces the food, and then opens it within the wound to allow the proboscis to perform its office by extracting the juice.

*Antennæ.*—These are very slender arms resembling hairs, which project from the heads of almost all insects. There are generally two to each insect, which diverge somewhat. The insects can move them in all directions, and when they are seen doing this it commonly suggests the idea that these antennæ are *feelers*. However, their functions are not certainly known: some suppose them to be organs of sense.

*Eyes.*—These are generally found in the head of insects. Their real number is, usually, two: the surfaces of which are cut into many small faces; more than seventeen thousand have been counted in the butterfly. Each face on the insect's eye is considered as a crystalline lens, concave within, and convex without. They have no eye-lids.

*Thorax, or throat.*—This is the second division of the body, and is placed directly behind the head. To the thorax are attached the wings and legs: commonly three legs on each side. Two membranes compose the wing, placed one above the other. Cords, or small nerves, are found in the upper one. The expansion of the wing is owing, as is supposed, to the introduction of a fluid, at the will of the insect, into hollow vessels which are detected in the composition of the wing.

*Abdomen.*—This is the third division of the insect, and is immediately connected with the thorax by articulation: it is composed of rings from one to fifteen. Most of these rings have an open pore placed laterally, through which air has access to the fluids in the body. In some insects the last ring contains the anus; in others, the organs of generation; or the means of defence, as a sting.

*Muscles.*—These are said to be disposed in bundles, the fibres of which are not connected by a cellular membrane: they are fixed to the hard parts, which are to be moved by horny tendons.

The thorax contains the muscles which move the head up or down, and those also which move the wings and the feet. In some the muscles amount to four thousand. The muscular power of some of these insects is astonishing, as may be known by the distance they can leap: as the flea, and others, which leap two hundred times their own length. If man could do this he would leap at a single effort, more than one thousand feet.

All insects are supposed to have a knotted nervous system. The knot nearest the head is composed of two lobes, from which nerves pass to the eyes, antennæ, and mouth.

These are the principal common parts of insects. It would be a delightful task to enter into a minute description of their genera, species, habits, modes of life, subsistence, defence, attack, &c. Only two or three can be noticed, which must be taken as a specimen of the whole.

*The* Bee.—This insect has attracted the attention of the observing in all ages. On a pleasant summer's day the hive presents the appearance of a busy, and populous city—the gates appear to be crowded with many workmen—some going to search for food, and others returning with it—some building—some tending the young—some cleansing the dwelling, and others carrying out the dead, and, apparently, performing some honorable sepulchral rites, &c.

*The hive.*—The interior of a bee-hive is itself a world of wonders. It is not, as is commonly supposed, the same in the form of its construction in all hives, it varies according to circumstances. Yet there are some general principles which seem to be common to all honey-combs: they do not touch each other, but always are sufficiently far apart to allow room to work on the opposite faces of each comb. The combs are placed vertically in the hive, and each complete comb is composed of two layers of six-sided cells, united by a common base. These two layers of six-sided cells are not united by a common base with a *flat* bottom to each cell: but the hexagonal tube terminates at the bottom in a *three-sided pyramidal cavity.* The angle, formed at the apex of this pyramidal cavity, is 70° 32′—and the angle formed at the base of the hexagonal tube, or cell, is 109° 28′. By this construction Reaumur has demonstrated, that the bee has formed his comb on the only plan which could produce cells of a determinate size, equal and similar, in the strongest manner, occupying the least space, and requiring the least quantity of matter.

The wax, out of which the cells are formed, is not the same simple substance as honey, extracted from the flowers: it seems to be elaborated by the bees in their bodies, and deposited under their bellies in the form of scales. It is produced from a nectar obtained from flowers, which is swallowed by the bee in the greatest possible quantity, after which the bee hangs motionless in the hive for twenty-four hours, during which time the wax is elaborated and deposited under the belly in thin scales resembling talc.

Some of the cells are filled with honey, and some are found to contain the young bee in the condition of lava.

The bees which inhabit a hive may be regarded as a community, which is found to be divided into three classes: the queen—the males—and the workers, which are of no sex.

*The Queen.*—She is the common mother of the hive, and deposits all the eggs from which the young ones come: she appears to be in size between the males and workers, but longer than either.

The attention or reverence, with which the queen-bee is regarded, is very remarkable. Upon withdrawing the queen from a hive the workers are thrown into the greatest consternation; they desist from work, run wildly through the hive, and refuse all nourishment. This they do for twenty-four hours, after which time a new queen will be received kindly, if offered them; but previously, they pay no attention to a strange queen, though introduced among them.

If no queen can be found, Schirach discovered, and Huber has confirmed it, *that the bees have power to create a queen,* in the following manner. They build some *royal* cells (for there are different kinds) into which they put the common worker-worm, i. e. the grub which produces the work-bee, and feed the insect with royal food, which is more pungent than the common bee-food; and in a few days they have a queen-bee produced, instead of a work-bee; then all is well.

The queen is always attended with a train, which wait upon her, do her homage, caress and feed her, by presenting her with honey. If they lose their own queen, and a stranger queen is introduced, after twenty-four hours, they commence their reverence for the new sovereign by surrounding her, caressing her, feeding her, and opening a way for her when she moves.

Their devotions to their queen do not cease if she become sterile, or die. Their veneration and tender attentions appear to increase towards the dead body of their queen. It is a well known fact, that the community perishes if they cannot procure a queen by any means.

*The combats of the queens.*—The bees seem to be purely monarchial in their constitution of government. This will appear from the following extraordinary facts:

If a strange queen be introduced into the hive where there is a queen, the working-bees immediately seize upon her, and detain her a prisoner: as soon as this is done, another party hastens away to the reigning queen and surround her. They then force the queens towards each other, in order to make them decide the sovereignty of the hive in mortal combat. The conquerer is cheerfully taken for the reigning sovereign.

Nor is it difficult to bring the rival queens to an engagement: so soon as they recognize each other they rush furiously to the combat, and the one or the other quickly inflicts a mortal wound by piercing the belly of the antagonist between the rings, by means of the sting.

So exclusive is the passion of the queen for sovereignty, that she puts to death the young queens, so soon as she ascertains them to be such. This she does even in the cells, before they have come forth.

*The male bees.*—These seem not to have attracted much interest. They are not very numerous in the hive; generally not exceeding an hundred or two. They are the largest in size, and live perfectly idle.

*The working bees.*—These, as their name imports, perform the labors of the hive. The details of their labors cannot be admitted here.

There is one question, in regard to bees, which is difficult and curious: their senses. From the best observations, and experiments, it would seem as if the antennæ, or feelers, were the principal organs of sense. Upon taking away the queen, in about an hour some one bee discovers it, and becomes instantly agitated, and runs furiously about the hive: the first companion he meets they cross their feelers mutually, the discoverer giving his neighbor a gentle tap with the feeler, and he in turn commences running furiously about the hive, communicating the intelligence in a similar manner; until the whole hive is in an uproar.

Huber introduced a queen to a hive, after twenty-four hours absence of their own queen. The working bees which were nearest immediately approached and touched her with their feelers, and passing their trunks over every part of her body, gave her honey. Then these gave place to others which treated her in a similar manner; and all, with a vibration of their wings, arranged themselves around their new sovereign.

From some experiments of Huber, it seems that the antennæ, or feelers of bees are the organs of communication. He thinks they have no organ for hearing. Their power of vision is very clear and strong. Anciently, in New-England, the honey-hunters are said to have found the nest of wild bees in the following manner: they placed a plate of honey in the woods, and when the bees came to get it, they caught two or three of them, the bee-hunter would let one go, and observe his course, by a pocket compass, as he flew to the nest: he would then walk off at a right angle a few hundred yards, and let another bee go, and observe the course: the angle, or point at which these two lines, described by the flights of the bees, met, the hunter knew to be the place where the bee-nest was.

The manner in which bees take their rest is a matter of curiosity. Some attach themselves to a part of the hive, by their fore-feet, and extend their hind-feet down: the next bee by his fore-feet takes hold of the hind-feet of the first bee, and thus suspends himself; others attach themselves in like manner, until they form clusters, or festoons. In this condition they take their rest.

It will be interesting to learn something of the *sting* of the bee. It is situated in the lower end of the ringed-body: it is composed of three parts: the sheath, and two darts which are enclosed in it, very small and penetrating. The darts are barbed. When the bee strikes with its sting, the sharp and hard point of the hollow sheath strikes and penetrates first, and the two darts are immediately thrust into the incision made by the sheath; and at the same time the bee injects a poisonous liquor into the wound, which causes the pain and inflammation. In some instances the sting is struck in so deeply the bee cannot extricate it: in that case the wound is more painful, but the loss proves fatal to the bee.

Destructive combats frequently take place between different hives; and many perish on both sides. Occasionally single combats, or duels, take place, which always prove fatal to one or the other. Instances are known, in which the bees of one hive plunder the bees of another. In this case a battle generally ensues. And what is more astonishing still, sometimes the hive-bees will, five or six of them, surround an *humble-bee*, and rob him of his honey, as he is returning home of an evening. Indeed a whole volume might be written, and the natural history of the bee not be exhausted.

Ants.—This insect has justly rivalled the bee in the admiration of the philosopher, and, on some accounts, is considered a more interesting creature. The instinct of this creature does not appear so strikingly as that of the bee: but it exhibits other and higher qualities, approaching to the cardinal virtues of man: such as love, courage, patience, perseverance, &c. The proof of all these will be found in the few brief remarks which follow.

There are various kinds of ants: the fallow ant; the sanguine ant; the legionary ant; the white ant, &c. There are some traits common to all: They live in communities; build cities, or ant-hills; and are divided into general classes, with their appropriate grades and employments, somewhat similar to bees; there are males, females, and neuters, or workers.

They also resemble the bees in their respect for their matrons or queens; though they differ in this respect; they admit of the presence of an indefinite number of queens, which produces no ill consequences whatever. They all are equally caressed, and attended.

There is a very marked difference between the ant and bee. The queens, or matrons of the bees remain in their respective hives, and their presence is necessary to the industry and contentment of the communities. But the matrons or queens of the ants act differently. The male and female ants have wings; the neuters or workers have not. These generally swarm together between July and September. They rise from the ant-hill together, in immense numbers; sometimes the ants of a whole district collect together and rise in the air, and seem only to be sporting; but at this time the females become fecundated. The quantity of ants with wings is so great sometimes, as, says Dr. Bromley, to form a column on the water five or six miles long, eight or ten feet broad, and six inches deep, when they happened to fall into the river.

In this general destruction of the winged ants, some females escape, which quickly divest themselves of their wings, form an ant-hill, and found a new colony by depositing their eggs in it.

It is also well ascertained that the working ants do not permit all the females or queens to escape, but detain some as prisoners, by cropping their wings. They pay every attention to these royal prisoners guarding them diligently, and feeding them liberally. When these females drop their eggs, the workers take them up carefully, and deposit them in their proper places.

These are some of the principal traits common to the ant tribe. A few brief remarks may be made on the principal species.

*The fallow ant.*—The wars of this insect is the principal thing which can be noticed here. We have a minute detail, of one long and disastrous battle, by Huber. This battle took place between the inhabitants of two neighboring ant-hills: they met half way: the battle was commenced by single combatants; then they fought in pairs on elevated ground; and finally the battle became general. The attack is generally made by seizing each other by the mandibles, and rearing up on their hind feet so as to bring their abdomens forward, from which they eject a pungent poison upon their adversaries, in order to destroy them. This circumstance gives rise to a pungent smell on the spot. During the combat they are frequently grappled so closely together as to fall on their sides; and others coming to their assistance the group is locked fast in the struggle.

During the action some are found leading away prisoners; others going as couriers to bring fresh troops to the fight, and some in the immediate vicinity of the hills keeping guard, and transacting the common business of the community.

The battle occupied a space of about three feet square, and lasted until the approach of night: then each party retired; but was on the spot next morning at dawn of day, and re-commenced the battle with greater fury, and carnage. It finally terminated without subverting either republic.

It was very remarkable, says Huber, that these ants, in promiscuous combat, should know their own party. In a few cases, for a moment, friends assailed, but rectified the error, instantly, by caressing.

*The legionary ant.* Though the natural history of this insect, throughout, is very interesting, there is place for but one principal fact: i. e. their practice of making the *formica fusca*, or negro ant, a slave. This curious fact was first discovered by Huber, and has since been confirmed by Latreille, and is now admitted readily by naturalists.

A campaign, for the purpose of procuring slaves, was observed closely by Huber on the 17th of June, 1804. The column was first seen crossing the road, being about ten inches long and four broad. He followed them until they approached the nest of the negro ant. The centinels on duty gave the alarm, and the ants rushed out, and made a spirited resistance to the invaders, but were finally driven into their house. The legionary ants then rushed forward, attacked the hill, and took the little city by assault. They remained in it but a few minutes, and returned, each one carrying in his mouth a larva, or young negro ant, and scampered home in confusion.

They never take the old ants captive, but the young, in a state of infancy, and thus raise them in a state of slavery. The consequence is that they are submissive and affectionate, and perform with cheerfulness and fidelity all the domestic duties of a legionary city. They provide house and food for their masters, attend them, and serve them in every possible way.

*The sanguine ant* is also a slave dealer, and in the same manner as the legionary. Nor is the negro ant the only victim: the *mining ant* is also reduced to a state of slavery by the legionary, and sanguine ants.

There remains to be stated another circumstance connected with the natural history of ants, which would scarcely be credited, were it not tested by such names as Linnæus, Huber, and Latréille: that is, *they keep milch-cows.* There are certain insects, from which they extract a sweet saccharine fluid for food, as we do milk from cows. The principal insects which are thus used, are the plant-louse, and the gall-insect. Linnæus, and after him other naturalists, call these insects the *milch-cows of the ants.*

The fluid issues from the body of the insect through little tubes placed above the abdomen on either side. When no ants are present the plant-lice emit this liquor from their bodies by a jerking motion: when they are in attendance they suck the juice with great avidity. But what is still more astonishing, the ants compel their milch-cattle to yield their milk, by gently patting them on each side with their antennæ, or feelers. This is properly milking them.

In addition to this the ants take care to appropriate these milch-cattle to themselves, by collecting them in herds, guarding and feeding them. They sometimes make an enclosure around them, or around the tree or plant on which they find them, and thus secure them. Some herds are owned in common by the ant-hill; and others appear to belong to individuals.

The *yellow ant* is known to remove these plant-lice from the plants, and domesticate them in their hillocks for service in winter.

In conclusion, in regard to ants we may mention their ravages committed on property. In the East and West Indies they are very destructive. They undermine houses in such a manner as to cause them to fall. Some species will devour the wood of a building of small size, in a single night. And it is remarkable that they make their ravages *internally*. One would not observe that they had assailed a beam of timber, unless he should take means to examine its interior. They will devour even the exterior of the timber when they have first coated it over with mud or clay in order to conceal their work. They devour furniture of all kinds, and completely consume the trees which fall in some countries. The extent of the damage which they can do, is incalculable.

These remarks will show what interest the natural history of insects can inspire. It is not permitted to extend the subject further in a note.]

The distinction between *clean* and *unclean* Fowls, made in the Scriptures, serves to point out the difference between the two classes of *saints* and *sinners* among the human race. Those Fowls were accounted clean, which are gentle in their nature, as the Dove, and musical in their notes, as the Lark; which qualifications are not to be found among birds of prey, as the Ostrich, Eagle, Vulture, Hawk, Cormorant, Raven, Owl, Bat, &c. All these, so far as their instincts and properties are discovered to us, agree so well with the different characters of men, to whom in Scripture they have a symbolical allusion, that none but the infinitely wise Creator could have distinguished and applied their several peculiarities with so much simplicity, brevity, and propriety.

Several of the unclean Fowls feed on filth and dead carcases; whose "young ones" also "suck up blood, and where the slain are, there are they." Dr. Buchanan, when at the distance of fifty miles from Juggernaut, says, "We know that we are approaching Juggernaut, by the human bones which we have seen for several days strewed by the way. The Vultures seem to live here on human prey: they exhibit a shocking *tameness*. The obscene animals will not leave the body sometimes till we come close to them. Yesterday a woman devoted herself to the idol: this morning, as I passed the place of skulls, nothing remained of her but her bones." The unrenewed nature of man is no more offended with evil, than a vulture is with human flesh, or a crow is with carrion, on which it feeds with delight.

The unclean Fowls persecute and devour those of a more gentle nature. The Eagle, נשר *nesher*, is from *nasher* to *lacerate, cut*, or *tear to pieces;* hence the *Eagle*, a most rapacious bird of prey, has its name from tearing the flesh of animals it feeds on: and for this purpose, birds of prey have, in general, strong crooked talons and a hooked beak. The Eagle is a cruel bird, exceedingly ravenous, and almost insatiable. This propensity in birds of prey to seize, tear, and devour, is expressive of the violent and malevolent dispositions of some persons, who hate and endeavor to injure those who live in the fear of God, and keep his commandments. Such were the heathens, whom St. Paul has described as "cruel" and "unmerciful, full of envy, murder, and debate," given up to the vilest passions, and all the uncleanness of "dead works."

The want of *natural affection*, and a *right understanding* of Divine things, among ungodly persons, is strikingly exhibited in the character of the Ostrich. This foolish bird, though it has wings, is not able to raise itself from the earth, and is void of that instinctive tenderness, which other creatures feel for their offspring: "which leaveth her eggs in the earth, and warmeth them in the dust, and forgetteth that the foot may crush them, or that the wild beast may break them. She is hardened against her young ones, as though they were not hers; her labor is in vain without fear; because God hath deprived her of wisdom, neither hath he imparted to her understanding." The Ostrich lays from thirty to fifty eggs, not placed, like those of some other birds, upon trees, or in the clefts of rocks, but in the sand, forgetting the danger to which they are exposed from the feet of travellers or wild beasts. On the most trivial occasion, she forsakes her eggs, or her young ones, to which, perhaps, she never returns; or, if she does, it may be too late, either to restore life to the one, or preserve the lives of the other. The prophet, applying this want of affection, says, "The daughter of my people is cruel, like the Ostriches in the wilderness." She is likewise inconsiderate and foolish in her private capacity, says Dr. Shaw, particularly in her choice of food, which is frequently highly detrimental and pernicious to her; for she swallows every thing greedily and indiscriminately, whether it be pieces of rags, leather, wood, stone, or even iron. To secure herself, she will thrust her head into the shrubs, though her body, which, when standing upright, is from six to eight feet in height, from the top of the head to the ground, be exposed. She has a little head, and scarcely any brain: hence historians tell us, that the emperor Heliogabalus, to gratify his luxurious taste, together with other delicacies, such as the combs of Cocks, the tongues of Pheasants and Nightingales, the eggs of Partridges, the heads of Parrots and Peacocks, the brains of Thrushes, had likewise served up to him, at one entertainment, the heads of six hundred Ostriches for the sake of the brains; because, being so very small, a less number would not have been sufficient to make a dish. What an affecting emblematical representation is this singular bird of the moral qualifications and habits of ignorant and wicked men! not to mention the superstitious practice of offering children to Moloch and other diabolical deities; the custom of exposing new-born infants in the woods to perish with hunger, or be devoured by wild beasts; a practice still tolerated among the idolaters of China.

The heathen, who "did not like to retain God in their knowledge, but became vain in their imaginations, and their foolish heart was darkened," were in this respect, symbolically represented by the tribe of Owls and Bats, and other birds of night, all of which the law pronounced to be unclean. In the Owl we have a striking image of the sceptic, who loves darkness rather than light, and is more proud of his artificial ignorance than any man ought to be of the most useful knowledge: who could never find Divine truth, because he never loved it; as the Owl is offended with that glory which the sun diffuses over the natural creation. As the day has no charms for the Owl, so revealed religion has nothing wise or wonderful in its nature and design with the unbelieving philosopher; who brings with him to the word of God all that prejudice with which the Owl flies out of its retreat into the sun-shine. Yet he has his admirers; as the hooting of the Owl is music in the ears of another of the same species. This emblematical bird, when exposed to the light of the sun against his will, lets down a conspicuous membrane over his eyes, to guard them from the inconvenient splendor of the orb of day; as the infidel draws a dark veil of evil reasonings and blasphemous objections over his heart, to intercept and weaken the effulgent rays of heavenly truth. The Owl has a natural aversion from the light; and if he breaks through his ordinary rule, and settled habit, so as to appear in the day-time, he is pursued and reprimanded by other birds, as one that is a disgrace to their kind. But the birds which thus express their indignation against the Owl, never kill him, being unarmed and inoffensive in their nature.* So an infidel should not be put to death for his detestable and demoralizing principles; but all Christians should agree in giving public notice of him, and showing the world what he is. For internal realities do not always comport with external appearances. The outward appearance of the Owl seems to promise a great degree of gravity and wisdom, while its principles and manners are opposite to the common sense of other birds, and its office in the creation reduces it to the rank of a common mouse-trap. So the philosophers it represented made a pompous display of reason and learning, all of which, so far as they applied these to divinity, were no better than ignorance and folly. "Professing themselves to be wise, they became fools;" and by an unaccountable fatality chose this very bird as the emblem of their wisdom; which was accordingly held in great veneration at Athens, the principal seat of heathen learning, as the symbol of Minerva, the tutelar goddess of that city.

The Bat is a sort of monster, partaking of the nature of both a bird and a beast, having feet or claws growing out of its pinions,

* Hasselquist, speaking of the *Strix Orientalis*, or Oriental Owl, says, "It is of the size of the common owl, living in the ruins of old deserted houses of Egypt and Syria; and sometimes in inhabited houses. The Arab in Egypt calls it *Massasa*, the Syrians *Bana*. It is very ravenous in Syria, and in the evenings, if the windows be left open, it flies into houses, *and kills infants*, unless they are carefully watched; wherefore the women are much afraid of it."—Travels, p. 196.

and contradicts the general order of nature by creeping with the instruments of its flight. What a contrast between this creature and the Lark!

"Up-springs the Lark,
Shrill-voiced and loud, the messenger of morn;
Ere yet the shadows fly, he, mounted, sings
Amid the dawning clouds, and from their haunts
Calls up the tuneful nations."

Nothing can be more pleasing, observes Goldsmith, than to see the Lark warbling upon the wing; raising its note as it soars, till it seems lost in the immense heights above us; the note continuing, the bird itself unseen; to see it then descending with a swell as it comes from the clouds, yet sinking by degrees as it approaches its nest, the spot where all its affections are centered—the spot which has prompted all this joy. While the Lark thus mounts on triumphant wings, soaring up into the heavens with a song of praise to its Creator, this little black animal lies sleeping in holes and cracks of decayed edifices; and if disturbed by any accident, drops down and crawls upon the earth. When darkness prevails, it comes forth from its concealment to haunt the cemeteries of the dead, and desolate places; as if it purposely avoided the society of all cheerful birds, and took a delight in associating with Owls and Beetles in dark and solitary abodes. "The bat is called עטלף *âtalaph*," according to Parkhurst, "from עט *ât* to *fly*, and עלף *âlaph*, *darkness* or *obscurity*, because it flies about in the *dusk of the evening*, and in the *night;* so the Septuagint νυκτερις, from νυξ, the *night*, and the Vulgate, *vespertilio*, from *vesper*, the evening."

These birds of the night but too appropriately symbolize with persons who love darkness rather than light, because their deeds are evil. Dr. Shaw, speaking of Ostriches, says, "In the lonesome part of the night they frequently make a very doleful and hideous noise, sometimes resembling the roar of the Lion; at other times the hoarser voices of other quadrupeds, particularly the Bull or Ox." He adds, "I have often heard them groan as if in the greatest agonies." Thus—

"The slaves of excess, Their senses to please,
Whole nights can bestow,
And on in a circle of riot they go;
Poor prodigals, they The night into day
By revellings turn,
And all the restraints of sobriety scorn.

The drunkards proclaim At midnight their shame,
Their sacrifice bring,
And loud to the praise of *their* master they sing:
The hellish desires Which satan inspires,
In sonnets they breathe,
And shouting descend to the regions of death."

# CHAPTER VII.

## SIXTH DAY.

### *Section* I.—On Quadrupeds and Reptiles.

Quadrupeds in general—Motion—Habits—Rumination—Proportion—Tastes—Clothing—Weapons—Proportionate Number—Faculties—Reptiles—Religious Improvement.

On the *sixth day* all terrestrial animals were formed. "And God said, Let the earth bring forth the living creature after his kind, cattle, and creeping thing, and beast of the earth after his kind, and it was so. And God made the beast of the earth after his kind, and cattle after their kind, and every thing that creepeth upon the earth after his kind." According to Dr. A. Clarke, the words נפש חיה *nephesh chaiyah*, translated *living creature*, are a general term used to express all creatures endued with animal life, in any of its infinitely varied gradations, from the half-reasoning elephant down to the stupid potto, or lower still, even to the polype,* which seems equally to share the vegetable and animal life. The word חיתו *chaiycto,* translated *beast,* and by Mr. Parkhurst, rendered *wild beasts,* seems to signify all wild animals, as the Lion, the Tiger, the Panther, the Lynx, the Hyæna, &c, and especially such as are *carnivorous*, or subsist on flesh. בהמה *behemah*, which we translate *cattle*, probably means those of the domestic species, such as are *graminivorous*, or live on grass and other vegetables; and are capable of being tamed, and applied to domestic purposes The word properly means *beasts,* and is so understood by the Seventy, whose interpretation of the words of Job is, "Behold the beasts with thee, they eat grass like oxen." According to Ab, Ezra, and the Targum, it is the "name of any great beast." But R. Levi says, that it is "an animal peculiarly called by that name."

The Hebrew *behemah*, says Buxtorf, is taken in the singular number for the Elephant, because of its vast greatness. Ainsworth says, the word generally implies all large beasts; and of this classification the Elephant is called Behemoth. "Behold now *Behe-*

* The *marine* Polypus is different in form from the fresh-water Polype; but is nourished, increased, and may be propagated after the same manner. When it produces its young, they issue from its sides, as branches from a tree; these young shoots are no sooner detached from their parents, than they become separate Polypuses, and fish for prey.

It seems that every part of this animal possesses a principle of life. If it be cut into three pieces, it is so far from being destroyed, that it becomes three polypuses: the head produces a body and tail; the body, a head and tail; and the tail, a head and body. When a Polypus is cut in two lengthways, these close themselves, the wounds are healed in a few moments, and in the course of some hours they will eat greedily. If these Polypuses be again cut into four, or six pieces, these divisions of the animal will also become Polypuses; but they will not be matured, nor capable of eating, for some days. If this creature be turned like a glove, by pushing the tail into the body until it come out of the mouth, after such an operation it will still eat, and continue to produce young ones; so strong and vigorous is the principle of life which it possesses.

There are other insects which possess similar properties; and it is certain that nearly all plants which are produced from suckers, have no part which may not become either a stem or branch, and which will germinate, and furnish one, or even many plants.

*moth*, which I made with thee; he eateth grass as an ox." The word here is plural, and signifies beasts; but in this passage one particular beast is meant, for it is usual with the Hebrews or Jews to express great and excellent things by words in the plural number. Though some later and very learned men take the Leviathan to be the Crocodile, and the Behemoth to be a creature called the Hippopotamus, or river-horse, yet says Henry, "I confess I see no reason to depart from the opinion, that it is the Elephant that is here described, which is a very strong, stately creature, of a very large stature, above any other, and of wonderful sagacity, and of such reputation in the animal kingdom, that, among so many four-footed beasts as we have had the natural history of, Job chap. xxxviii, xxxix, we can scarce suppose this should be omitted."*

The Elephant may be thus denominated from its great bulk and strength. He is the largest of all land animals. Pliny tells us, that the Elephants in India are thirteen feet and a half high, and have two teeth of such enormous size that the Indians use them for posts to their houses: those of the male being six or seven feet long, while those of the female do not exceed one foot.

"Peaceful, beneath primeval trees that cast
Their ample shade o'er Niger's yellow stream,
And where the Ganges rolls his sacred wave,
Or mid the central depth of blackening woods,
High rais'd in solemn theatre around,
*Leans the* HUGE ELEPHANT."

His strength is also equal to that of many beasts. "His bones are as strong as pieces of brass; his bones are like bars of iron." Some historians say, that in time of war people used to erect wooden towers on the backs of Elephants, and from these elevated forts men combated with their enemies. It is said that Antiochus had a great number of these huge animals with towers constructed upon them, in each of which were thirty-two men armed. "He is the chief of the ways of God:" that is, a signal instance of Divine power and wisdom, the most excellent of all mere animals, in size, strength, understanding, and sagacity. None of the beasts is more prudent, says Strabo: none of them approaches nearer to man in his capacity, says Pliny. "He moveth his tail like a cedar." As his tail is not proportional to the bulk of his body, many understand by this term his proboscis or trunk. The original word זנב here rendered *tail*, signifies properly the extreme part of a thing; hence it is as applicable to his trunk, which hangs like a tail, though placed at the opposite extremity of his body. This he "moveth" with amazing dexterity, and, at pleasure, can stretch it out, and erect it like a "cedar" growing out of a mountain.—"Behold, he drinketh up a river, and hasteth not: he trusteth that he can drink up Jordan into his mouth." He being naturally of a

* For the contrary opinion, see Fragments appended to Calmet's Dictionary, pp. 114—117.

hot constitution, and generally inhabiting hot climates, requires much liquid. His "drinking up a river," is a hyperbolical expression implying his ardent thirst: and "hasteth not," signifies his reluctance to quit the stream till his parching desire be fully satiated. His "trusting" that he can drink the river "Jordan" dry, is also an hyperbolical term to express his copious draughts. "He eateth grass as an ox, the mountains bring him forth food;" which he gathers, collects, and conveys to his mouth with his long trunk. He resides "where all the beasts of the field play." So harmless is this strong animal, that the inferior part of the brute creation are not intimidated at his presence, but graze with him upon the mountains, and sport themselves about him in the plain, apprehending no danger from him. How wondrous are the works of God! in which are no less evinced the effects of his power, than the displays of his wisdom. The word *cattle*, also includes Horses, Kine, Sheep, Dogs, &c.

Quadrupeds enjoy many advantages above the lower tribes of the animal creation. They rank higher than the class of Birds, by bringing forth their young alive; they are superior to that of Fishes, by respiration through their lungs; they are exalted above the order of Insects, by a circulation of red blood through their veins; and they differ almost from every other description of creatures, being either wholly or in part covered with hair.

What admirable wisdom is displayed in the *motion* of animals, suited to their various occasions! Reptiles, to which a clod, a plant, a tree, or a hole, will afford the means of supporting life, and which protracted privations of food do not materially affect, require no legs to make extensive excursions, but their vermicular motion is adequate to every essential purpose. Beasts, whose necessities call for a larger sphere, possess accordingly a swifter motion; and this is imparted in various degrees, suitable to their range for food, and adapted to accelerate their speed in escaping from their enemies.

In the motion of animals, from the largest Elephant to the smallest Mite, the whole body is exactly balanced. The head is not too heavy, nor too light for its kindred parts, nor they for it. The bowels hang not loose, nor are so placed as to over-balance, or upset the system; but well-braced, and accurately distributed to maintain an equipoise. The most active members also are admirably well fixed, in respect to the centre of gravity, being placed in the very point which best serves to support and convey the body. Every leg bears its share of the weight.

The *mouths* of animals are nicely adapted to their different habits of life. The Ox, the Deer, the Horse, and the Sheep, have full lips, rough tongues, broad cutting teeth, corrugated cartilaginous palates, which qualify them for browsing, either by gathering large mouthfuls where the grass is long, or biting close where it is short. In those which subsist on flesh, the teeth are sharp, and calculated to hold and divide their food. The bore of the gullet in animals is answerable to their necessities. In a Fox, which feeds on bones, it is very large. But in a Squirrel it is exceedingly small, which prevents him from disgorging his meat in his descending leaps: and it is equally contracted in Rats and Mice, which run along walls with their heads downward.

In all animals, the strength and size of their *stomachs* are proportioned to the nature and quantity of their food. Those whose aliment is more tender and nutritive, have them smaller, thinner, and weaker: whereas they are large and strong in those whose food is less nutritive, and whose bodies require greater supplies. Carnivorous beasts have their stomachs small and glandular, as flesh is the most nutritious. Those that derive their support from fruits and roots have them of a middle size: while on the contrary, Sheep and Oxen, which feed on grass, have the largest stomachs; and those which ruminate have in general no less than four; in Africa, where the plants are nutritive, some of this class have only two. Yet the Horse, Hare, and Rabbit, though graminivorous, have comparatively small stomachs. The Horse is made for labor, and both he and the Hare are constructed for quick and continued motion; for these the most easy respiration, also the freest action of the diaphragm, is requisite. But this could not be, did the stomach lie heavy and cumbersome upon it, as in Sheep and Oxen.

Another very remarkable circumstance is, that those animals which have teeth on both jaws, possess but one stomach; whereas most of those which have no *upper teeth*, or no teeth at all, have three stomachs. For the meat which is first chewed, is easily digested; but that which is swallowed whole, requires a stronger concoctive power.

The Horse eats night and day, slowly, but almost continually: whereas the Ox eats quickly, and takes, in a short time, all the food nature requires; and then lies down to ruminate. This difference arises from the different conformation of these animals. The Ox, of whose stomachs the first two form but one capacious bag, can, at the same time, receive grass into both of them, without inconvenience, which he afterwards ruminates and digests at leisure. The Horse, whose stomach is small, and can receive but a small quantity of grass, is filled successively in proportion as he digests it; and it passes into the intestines, where is performed the principal decomposition of the food. Chewing the cud is but a vomiting without straining, occasioned by a re-action of the first stomach on the food which it contains. The Ox fills the first two stomachs, the paunch, and the bag, which is but a portion of the paunch. This membrane acts with force on the grass it contains; it is chewed but a little, and its quantity is greatly increased by fermentation. Were the food liquid, this force of contraction would occasion it to pass by the third stomach, which only communicates with the other by a narrow conveyance, and cannot admit such dry food, or, at least, can only admit the moistened parts. The food must, therefore, necessarily pass up again into the œsophagus, the orifice of which is larger than the orifice of the conduit, and the animal again chews and macerates it, and moistens it afresh with its saliva: he reduces it to a paste, sufficiently liquid to enter into this conduit, through which it passes into the third stomach, where it is again macerated before it goes into the fourth; and it is in this last receptacle that the decomposition of the hay is finished, which is reduced to a perfect mucilage. What chiefly confirms this explication is, that as long as the animals suck, and are fed with milk and other liquid aliments, they do not chew the cud; and that they chew the cud much more in winter, when they are fed with dry food, than in summer, when they eat tender grass.

All the parts of the same animal are adapted to each other. So, for instance, the length of the neck is always proportioned to that of the legs. Though the Elephant has a short neck; because the weight of his head and teeth would otherwise have been insupportable; but, then, he is provided with a trunk, which abundantly supplies the defect. In other beasts, the neck is always commensurate to the legs; so that they which have long legs have necks proportioned; and so vice versa, as is observable in Lizards of all kinds, even from the Eft to the Crocodile. And creatures that have no legs, as they want no necks, so they have none. This equality between the length of the neck and legs is peculiarly seen in beasts that feed on grass, in which these are very nearly equal; because the neck must necessarily have some advantage, for it cannot hang perpendicularly, but must incline a little.

These creatures, while feeding, bend their heads downward for a considerable time, which would be very laborious and painful to the muscles, were it not for a very stiff, strong cartilage, placed on each side of the neck, capable of stretching and shrinking again as need requires, which butchers call pax-wax. The one end of this is attached to the head, and the next vertebræ of the neck; and the other is knit to the middle vertebræ of the back: and by the assistance of this, animals are able to hold the head in that inclining posture all day long. The head being placed at the end of a long lever, in a direction nearly perpendicular to the joints of the neck, would be in constant danger of dislocation from its own weight, had not such a substance been added, which, by its great strength and toughness, retains the parts together, while, by its pliancy, it offers no obstruction to the free motion of the neck and head.

The members of animals are exactly adapted to their manner of living. A Swine, whose natural food is chiefly the roots of plants, is provided with a snout; long, that he may thrust it to a convenient depth in the ground without injuring his eyes; and strong and suitably formed, for rooting and turning up the earth: therefore the retiring under-jaw works after the manner of a plough-share, and makes its way to the food: and besides, his scent is extremely acute in discovering such roots as are fit for him. Hence in Italy, the usual way of finding truffles, or subterraneous mushrooms, is by tying a cord to the hind leg of a pig, and driving him into pastures. They who attend then mark where he stops and begins to root, and digging there, are sure to find a truffle. So in pastures where there are earth-nuts, though their roots are deep in the ground, and the leaves are quite gone, the Swine will find them by their scent, and root only in the places where they grow.*

In some animals the head is long, in order to give room for the olfactory nerves, as in Dogs, which hunt by scent. In others, it is short, as in the Lion, to give him the greater strength. In beasts of prey, as Lions, Tigers, Wolves, they have the trumpet-part or concavity of the ear standing forward, to meet the sound of the animals before them, which they pursue or watch. The ears of animals of flight are turned backward, to apprize them of the approach of the pursuing enemy, lest he should assail them unseen. Beasts of prey have their feet armed with claws, which some can sheath and unsheath at pleasure. The Babyrouessa, or Indian Stag, a species of Wild-Boar, found in the East Indies, has two *bent* teeth more than half a yard long, growing upward, and, which is very singular, from the upper jaw. These instruments are not wanted for defence, that service being provided for by two tusks issuing from the under jaw, and resembling those of the common Boar: nor does the animal thus use them. They might seem therefore both superfluous and cumbersome: however, they have their utility; for this animal sleeps standing, and, in order to support its head, hooks its upper tusks upon the branches of trees.

In the Mole we find a most scrupulous attention to the habits of the animal. It has short legs, feet armed with sharp nails, a pig-like nose, a velvet coat, a small external ear, a sunk protracted eye, all which are conducing to utility and safety. Its feet are like so many shovels, placed in so peculiar a manner as to enable the animal to remove the earth on each side, and throw it backwards. The cylindrical figure of the Mole, as well as the compactness of its form, arising from the terseness of its limbs, proportionably lessen its labor; because its bulk requires the least possible quantity of

* "Some time ago, a person in the Isle of Wight, digging the ground for the foundation of an out-house, discovered the nest or magazine of a field-mouse. It was of large dimension, and was stored with acorns, which were laid up in the neatest and most compact manner imaginable. These were so numerous that he was induced to count them, and found, in the whole, no fewer than *eight hundred and two*. How wonderful are those faculties with which the beneficent Creator of the world has endowed his creatures, for the purpose of providing for wants which they have no power to foresee, and yet, without which provision, they must, during the severity of winter, be inevitably destroyed!"—New Monthly Magazine, July, 1814, p. 531.

earth to facilitate its progress. The structure of its face and jaws is similar to those of a Swine, and equally adapted to work in the ground. The nose is sharp, slender, tendinous, and strong. The plush covering, which, by the smoothness, closeness, and polish of the short piles that compose it, rejects the cohesion of almost every species of earth, defends the animal from cold and wet, and from the impediment which it would otherwise experience by the adhesion of mould to its body. Being subterraneous, of all animals it comes out from soils of all kinds the brightest and cleanest. But its eyes are most to be admired. This animal occasionally visiting the surface of the earth, self-security required a perception of light. The Mole did not need large eyes to compass a great range of vision; and prominent eyes would have been less easily defended, whilst working under ground. To reconcile these inconveniences, these eyes are scarcely larger than the head of a corking pin; and these globules are so sunk in the skull, and sheltered with the velvet of their covering, that any contraction of the eye-brows, not only closes up the apertures, but offers a cushion to prevent any sharp or protruding substance from injuring them. These apertures in their open state, are like pin-holes in velvet, scarcely pervious to loose pieces of earth.*

The different *tastes* of animals show the wise economy of nature. Oxen delight in low grounds, because they afford the most palatable food. Sheep prefer barren hills, on which is produced a particular kind of grass called festuca, which they highly relish. Goats climb up the precipices of mountains, that they may browse on the tender shrubs; and accordingly have their feet constructed for jumping. Horses, not in a state of domestication, chiefly resort to woods, and feed on leafy plants. Nay, so various are the appetites of animals, that there is scarcely any plant which is not chosen by some, and left untouched by others. The Horse resigns the Water-Hemlock to the Goat; the Cow gives up the Monks-Hood to the Horse; for that on which some animals grow fat, others abhor as poison.—Hence no plant is absolutely poisonous, but only respectively. Thus the Spurge, that is noxious to man, is a most wholesome nourishment to the Caterpillar. That animals may not destroy themselves for want of knowing this law of nature, they are guarded by such a delicacy of taste and smell, that thus they can easily distinguish what is pernicious from what is wholesome; and when different animals subsist on the same plants, one kind always leaves something for the other, as the mouths of all are not equally adapted to lay hold on the grass; hence there is sufficient food for all.† The leaves and fruits of trees are intended as food for some animals, such as the Sloth and Squirrel; the latter of which has feet adapted

* See Dr. Paley's Natural Theology, pp. 296—299.

† To this may be referred an economical experiment well known to the Dutch, that when eight Cows have been in a pasture, and can no longer get nourishment, two horses will do very well there for some days; and when nothing is left for the Horses, four Sheep will live on it.

for climbing. The Camel frequents the sandy and burning deserts, in order to obtain the barren produce of those soils. How wisely has the Creator provided for him! he is obliged to traverse those trackless wastes where frequently no water is found for many miles. Other animals, so circumstanced, would perish with thirst: but he can endure it without much inconvenience; his belly being full of cells, where he reserves water for many days.*

Quadrupeds are furnished with such *clothing* as is suitable to their various offices. To beasts, hair is a commodious covering, which, together with the texture of their skins, fits them in all sorts of weather to lie on the ground, and to render service to man. The thick and warm fleeces of others are a good defence against the cold and wet, and also a soft bed; and to many, a comfortable shelter for their tender young. All the animals near Hudson's Bay are covered with a close, soft, warm fur; and, what is very surprising, and shows the wisdom and goodness of Divine providence, the Dogs and Cats which are taken thither from England, on the approach of winter, change their appearance, and acquire a much longer, softer, and thicker coat of hair than they originally had.

Many animals are armed with *weapons* of self-defence, some of which are used for the destruction of others. Nay, we scarcely know an animal which has not some enemy to contend with. Wild beasts are the most pernicious and dangerous enemies. But, that they may not, by too atrocious a butchery, destroy a whole species, even these are circumscribed within certain bounds. As to the most fierce of all, it deserves to be noted, how few they are in proportion to other animals. The number of them is not equal in all countries. These fierce animals sometimes destroy one another. Thus the Wolf devours the Fox. The Dog infests both the Wolf and Fox. The Tiger often kills its own male whelps. And wild beasts seldom arrive at so great an age, as animals which live on vegetables. For they are subject, from their alkaline diet, to various diseases, which tend to accelerate their death: while the Elephant, which feeds on vegetables, is fifty or sixty years before he attains his full strength, is in the highest state of vigor at about a hundred, and lives two or three hundred years. But, though animals are infested by their peculiar enemies, yet they frequently elude their violence by stratagems and force. Thus the Hare, by her doublings, often confounds the Dog. When the Bear attacks Sheep and Cattle, these flock together for mutual defence. Horses join heads together, and fight with their heels. Oxen join tails, and fight with their horns. Swine unite in herds, and boldly oppose themselves to any attack, so that they are not easily overcome: and, what is remarkable, all of them place their young, as less able to defend themselves, in the middle, that

* The Arabians, when travelling, and in want of water, frequently kill their camels to obtain a supply, which, though taken out of the animal, they find perfectly good.

they may remain safe during the battle. Some animals consult their safety by night. When Horses sleep in woods, one by turn remains awake, and, as it were, keeps watch. When Monkeys, in Brazil, sleep on trees, one of them keeps awake, in order to give the sign when the Tiger creeps toward them; and in case the guard should be caught asleep, the rest tear him in pieces.

Divine Providence is evidently displayed in keeping a just proportion amongst all the different species of animals: this prevents any one of them from increasing too rapidly, to the detriment of others. For the produce of the ground would be insufficient for the support of the animal creation, were their increase not regulated and limited by the over-ruling power of God. To which we may add, that, if some animals did not feed on others, the earth would be annoyed with putrified bodies. Therefore, when an animal dies, Bears, Wolves, Foxes, &c, expeditiously take the whole of it away. But if a horse die near a public road, in a few days he is swoln, burst, and at last filled with innumerable grubs of carnivorous Flies, by which his flesh is soon entirely consumed, and so does not become a nuisance to passengers by his poisonous stench. Thus the earth is not only kept clean from the putrefaction of dead carcases, but at the same time, by this economy of nature, the necessaries of life are provided for many animals.

Though animals should not die a violent death, still their powers only continue for a limited time: they have their determinate periods of growth, perfection, and decay: hence it becomes necessary that one race should succeed and replace another, and for this purpose they are endowed with a power of procreation. The formation of the fœtus, the manner of its existence, and the growth of its parts, are great secrets of nature; and in all viviparous animals, the *milk* found in the female parent is a maintenance ready for the young animal, the moment it enters the world. We have here, the nutritious quality of the fluid—the organ for its reception and retention—the excretory duct, annexed to that organ—and the determination of the milk to the breast, at the particular juncture when it is about to be wanted. The advanced pregnancy of the female has no intelligible tendency to fill the breasts with milk. The lacteal system is a constant wonder: and it adds to other causes of our admiration, that the number of the teats or paps in each species is found to bear a proportion to the number of the young. In the Sow, the Bitch, the Rabbit, the Cat, the Rat, which have numerous litters, the paps are numerous, and are disposed along the whole length of the belly: in the Cow and Mare, they are few.* And the teats of animals which give suck are exactly adapted to the mouth, particularly to the lips and tongue, of the suckling progeny. Herodotus observes, that the most useful animals are the most fruitful in their generation: whereas the species

* Dr. Paley's Natural Theology, p. 278.

of those beasts that are fierce and mischievous to mankind are but scarcely continued. The historian instances in a Hare, which is always either breeding or bringing forth; and a Lioness, which bears but once and then loses all power of conception.

It is evident that animals have not only a princple of self-motion, but are endued with a degree of understanding; and have a will, including various passions. What then produces the disparity between men and brutes, the line which they cannot pass? It is not understanding: who can say that brutes have not this? We may as well assert that they have not sight, nor hearing. But the difference consists in this: man is capable of knowing and enjoying God; the inferior creatures are not. This is the specific difference between the two: the great gulf which the brute cannot pass over.

We meet with a striking instance not only of industry, but *understanding* in Beavers. In the northern parts of America, during the months of June and July, they assemble, and form a society, which generally consists of more than two hundred. They always fix their abode by the side of a lake or river; and in order to make a stagnant water above and below, they erect, with incredible labor, a dam or pier, perhaps fourscore or a hundred feet long, and ten or twelve feet thick at the base. When this dyke is completed, they build their several apartments, which are divided into three stories. The first is beneath the level of the mole, and is for the most part full of water. The walls of their habitations are perpendicular, and about two feet thick. If any wood project from them, they cut it off with their teeth, which are more serviceable than saws: and by the help of their tails, they plaster all their works with a kind of mortar, which they prepare of dry grass and clay, mixed together. In August or September, they begin to lay up their stores of food; which consist of the wood of the birch, the plane, and of some other trees. Thus they pass the winter, in the enjoyment of ease and plenty.*

In the Dog we perceive evident marks of sagacity, recollection, affection, and revenge. *Sagacity*:—In the year 1760, whilst one Richardson, a waterman of Hammersmith, was sleeping in his boat, the vessel broke from her moorings, and was carried by the current under a west country barge. Fortunately, the man's dog happened to be present; and the sagacious animal awaked him, by pawing his face, and pulling the collar of his coat, at the instant when the boat was filled with water, and on the point of sinking; by which means he had an opportunity of saving himself from inevitable death.† *Recollection*:—A Dog, which had been the favorite of an elderly gentlewoman, some time after her death, on seeing her picture, when taken down from the wall, and laid on the floor to be cleaned, discovered the strongest emotions. He had

* Dr. Percival's Instructions, p. 23. † See Annual Register, vol. iii, p. 90.

never been observed, Dr. Percival believed, to notice the picture previously to this incident. Here was evidently a case of remembrance, or of the renewal of former impressions. *Affection*:—A few miles from Aberdeen, as a gentleman was walking across the Dee, when it was frozen, the ice gave way in the middle of the river, and he sunk; but, by grasping his gun, which had fallen athwart the opening, kept himself from being carried away by the current. A dog, who attended him, after many fruitless attempts to rescue his master, ran to a neighboring village, and took hold of the first person he met. The man was alarmed, and would have disengaged himself: but the Dog regarded him with a look so kind and significant, and endeavored to pull him along with so gentle a violence, that he began to think there might be something extraordinary in the case, and suffered himself to be conducted by the animal; who brought him to his master in time to save his life.* *Revenge*:—A pack of ravenous Fox-Hounds were half starved in their kennel, to render them more furious and eager in the chace: and were severely lashed every day by a merciless keeper, that they might be disciplined to the strictest observance of his looks and commands. It happened that this petty tyrant entered the kennel without his scourge. The dogs observed his defenceless state; and, instantly seizing him, at once satisfied their hunger and revenge by tearing him to pieces.†

The Monkey tribe is very numerous, and usually divided by naturalists into three classes. Those which have no tails are termed Apes, and such as have very short ones, Baboons; but by far the most numerous class consists of those which have long tails, and are known by the general name of Monkeys. Were we to dissect and examine the several component parts of any one creature which God has made, we should find a perfection among its several powers, and an adaptation of its construction to its situation in the grand scale of existence, far surpassing human wisdom.

At the Cape of Good Hope, Baboons are under a sort of natural discipline, and go about whatever they undertake with surprising skill and regularity. When they undertake to rob an orchard or vineyard (for they are extremely fond of grapes and apples,) they go in large companies, and with preconcerted deliberation. Part of them enter the inclosure, while one is set to watch: the rest stand without the fence, and form a line reaching all the way from their fellows within to their rendezvous without, which is generally in some craggy mountain. Every thing being thus disposed, the plunderers within the orchard throw the fruit to those that are

* Dr. Beattie's Dissertations, Moral and Critical.

† Dr. Percival's Instructions, p. 8.

The Chinese consider the flesh of this animal as a dainty, and public shambles are erected for the sale of it. In Canton particularly, there is a street appropriated to that purpose; and, what is very extraordinary, whenever a dog-butcher appears, all the dogs in the place pursue him in full cry. They know their enemy, and persecute him as far as they are able.—Goldsmith's History of the Earth.

without as fast as they can gather it; or, if the wall or hedge be high, to those that sit on the top; and these hand the plunder to those next them on the other side. Thus the fruit is pitched from one to another all along the line, till it is safely deposited at their head-quarters. They catch it with amazing dexterity; and while the business is going forward, a profound silence is observed. Their centinel, during the whole time, continues on the watch, and when he perceives any one coming, instantly sets up a loud cry, on which signal the whole company scamper away. Nor are they willing to go empty-handed; for if they are plundering a bed of melons, for instance, they go off with one in their mouths, one in their hands, and one under their arms. If the pursuit be vigorous and close, they drop first that from under their arms, then that from their hands; and if it be continued, they at last let fall that which they had kept in their mouth.* There is another species of Monkey in the West Indies, of the size of a Fox. These are in great numbers in the woods, and make a loud and frightful noise. But it is common for one only to make a noise, and the rest to form a mute assembly round him. Marcgrave says, "I have frequently seen great numbers of them meeting about noon: at which time they formed a large circle, and one placing himself above the rest, began to make a loud noise. When he had sung thus by himself for some time, the rest all remaining silent, he lifted up his hand, and they all instantly joined in the chorus. This intolerable yell continued, till the same Monkey, who gave the signal for the beginning, lifted up his hand a second time. On this they were all silent again, and so finished the business of the assembly."

Thus we see, wherever we turn our eyes, the various species of creatures which God has made. Every element is stocked with inhabitants, the sea with fishes, the air with fowls, and the earth with quadrupeds and creeping things. All these different provinces are richly replenished with food for the support of all the innumerable creatures that live in them. And what surprising skill and sagacity do some in the brute creation discover; such as might make many, who pride themselves in their reason, to blush and be confounded! Who does not admire the exquisite contrivance of birds in building their nests? the subtlety of several creatures in seeking their proper food? and of others in securing and defending themselves? The art of the Spider in weaving and spreading her nets, to ensnare and entangle her prey? the sapience and industry of the Bee in building her combs, and filling them with pleasant food? and the care and foresight of the Ant, in laying up her store against winter? In the meanest reptile, the Divine wisdom and power are conspicuously displayed.

The word רמש *remes*, translated *creeping thing*, and rendered *reptile* by Parkhurst, includes all the different genera of serpents,

* Wesley's Philosophy, vol. i, p. 233.

worms, and such animals as are not pedaneous. What a disparity among animals! While some are of an enormous size, and stalk about in the greatness of their strength, others are of a delicate and diminutive appearance, bordering on comparative insignificance. But Divine "skill and power are not less displayed in the beautiful Chevrotin, or Tragulus, a creature of the Antelope kind, and smallest of all *bifed* or cloven-footed animals, whose delicate limbs are scarcely as large as an ordinary goose quill; nor the Shrew Mouse, perhaps the smallest of the many-toed quadrupeds. In the *reptile* race we see also the same skill and power; not only in the immense snake called Boa Constrictor, the mortal foe and conqueror of the Royal Tiger, but also in the Cobra de Manille, a venomous serpent, not much larger than a common sewing needle."

The Lizard tribe are distinguishable at first sight from other oviparous animals. They have no shields, like the Tortoises, and are furnished with tails, which are wanting in Toads and Frogs. They are covered with scales, of greater or less rigidity, or with a kind of warts or tubercles. Some of the species are scarcely more than two inches in length, whilst others extend even the length of twenty-six feet. The larger ones live on animals, which they seize by stratagem, and the smaller ones on insects. The aquatic species undergo a metamorphosis, from a tadpole to a perfect state. Most of them are produced from eggs, but some are brought forth alive. In many of the species the color and form are exceedingly beautiful. They principally inhabit the warmer regions of the globe, and many of them serve mankind for food.

As according to the economy of nature, the Lion seems appointed to the dominion of the immense deserts of the torrid zone, the Eagle to rule as sovereign of the air, and the Whale to have the pre-eminence in the seas; so the Crocodile* and the Alligator appear to rule over the shores of the large rivers of tropical climates. All the rivers of Guinea are pestered with vast shoals of the former, M. Adanson having seen in the great river Senegal more than two hundred swimming together; and the latter are natives of the warmer parts of America.—The Guana, which grows to the length of four or five feet, is very common in Surinam, the woods of Guiana, Cayenne and Mexico, and in many parts both of Africa and Asia; but is now become scarce in the

* For a description of the *Crocodile*, given by Divine inspiration, see Job chap. xli. It is a great question among learned men, says Mr. Benson, what creature is meant by לויתן, *leviathan*. Our translators were evidently uncertain respecting it, and therefore have given us the original term untranslated. The Seventy, however, have rendered it δρακων, *the dragon*; but that is far from being correct. The dragon is a genus belonging to the order of amphibia reptilia. There are two species, 1. The volans, or flying dragon, with the wings entirely distinct from the fore-legs, which is found in Africa and the East Indies. 2. The præpos, with the wings fixed to the fore-legs, which is a native of America. They are both harmless creatures; and feed on flies, ants, and small insects. The word לויתן, *leviathan* is supposed to be derived from לוי, *l vi*, *joined*, or *coupled*, and תן, *than*, or תנין, *thannin*, *a dragon*, that is, a *large serpent*, or *fish*, the word *thannin* being used both for a land-serpent, and a kind of fish. And "after comparing what Bochart and others have written on the subject, it appears to me," says Parkhurst, "that the compound word לויתן, *leviathan*, *the coupled dragon*, denotes some animal, partaking of the nature both of the land serpents, and fishes, and, in this place, signifies the *crocodile*, which lives as well under water as on the shore."

West Indies, in consequence of being much sought after for the table.—The Nimble Lizard, measuring from the tip of the nose to the end of the tail about six inches, is known in almost every part of the temperate regions of Europe. The Green Lizard and the Nimble Lizard, are considered by Dr. Shaw as varieties of the same species. The Green Lizards are considered by the inhabitants of Carolina as very useful animals, in consequence of destroying flies, and other troublesome and noxious insects. They will sometimes remain motionless for half a day, waiting for insects; and when one appears, they spring at it with the swiftness of an arrow. They are so familiar as to enter the houses without fear, and, in pursuit of prey, ascend the tables whilst families are eating, and even leap on their clothes. They are so beautiful and cleanly, as to be suffered to run across the tables, and even the plates, without exciting the least alarm or disgust.

The Chameleon is a native of India, the Indian Islands, Africa, some of the warmer parts of Spain and Portugal, and several of the countries of South America. Its usual length is about ten inches, and the tail nearly the same. All the motions of this creature are extremely slow, so that when travelling from one branch of a tree to another in pursuit of food, it may rather be said to lie in ambush among the leaves, in order to catch such insects as may come within the reach of its long adhesive tongue, than go in search of prey. When walking on the ground, it steps forward in a cautious, groping manner, seeming never to lift one foot till it is well assured of the firmness of the rest. From these precautions, its motions have a singular appearance of gravity, when contrasted with its diminutive size, and the activity that might be expected in an animal so nearly allied to some of the most active in the creation. Each of its eyes is covered with a rough membrane, which is divided by a narrow horizontal slit, through which the bright pupil, as if bordered with burnished gold, is seen. The eyes have this singular property, of looking at the same instant in different directions. One of them may frequently be seen to move when the other is at rest; or one will be directed forward, whilst the other is attending to some object behind; or in the same manner upward and downward. The property of changing its color is singular, and has led to various conjectures as to the cause.

Serpents are distinguishable from those already mentioned, by their total want of feet. The banded Rattle-Snake, found both in North and South America, is the most dreaded of all serpents. Providence has given to man a security against its bite; for it generally warns the passenger by the rattling of its tail, as well as by its odor, which is extremely fetid. When it has been irritated, or the weather is very hot, its poison being introduced into a wound, often proves fatal in a short time. If not provoked, it is inoffensive, being so much alarmed at the sight of men, as always, if possible, to avoid them, and never commencing an attack. The Great Boa, which is the largest of all the serpent tribe, is frequently from thirty to forty feet in length, and of a proportional thickness. It is a native of Africa, India, the largest Indian Islands, and South America, where it chiefly resides in the most retired situations in woods and marshy retreats. We are assured, that one of these serpents killed and devoured a buffalo, in the island of Java. It is happy for mankind that their rapacity is often the means of their own punishment; for whenever they have gorged themselves in this manner, they seek a retreat where they may lurk for several days and digest their meal, become unwieldy, stupid, helpless, sleepy, and may be approached and destroyed with safety.*

The snake tribe comprises nearly two hundred species, which differ from each other both in size and habit, and about one-fifth of the whole have been discovered to be poisonous. "The deserts of Arabia," says Adanson, "are entirely barren, except where they are found to produce serpents; and in such quantities, that some extensive plains are almost entirely covered with them." The apparatus of poison in the Viper is very similar to that of the Rattle-Snake, and all the other poisonous serpents. The *fang* of a Viper is a wonderful instance of contrivance. It is a perforated tooth, loose at the root: in its quiet state, lying down flat on the jaw, but furnished with a muscle, which with a jerk, and by the pluck, as it were, of a string, suddenly erects it. Under the tooth, close to its root, and communicating with the perforation, lies a small bag containing the venom. When the fang is raised, the closing of the jaw presses its roots against the bag underneath; and the force of this compression sends out the fluid, with a considerable impetus, through the tube in the middle of the tooth. By this singular apparatus, the animal is enabled to inflict on its enemies a most deadly bite, and infuse into the wound the most deleterious liquid. Yet, though in the mouth, this, in the quiescent state of the reptile, does not interfere with its ordinary office in taking its food.†

No less curious is the clothing of Reptiles. How well adapted are the rings of some, and the contortions of the skins of others, not only to guard the body sufficiently, but enable them to creep, perforate the earth, and perform all the functions of their stations, better than any other covering! Virgil gives the following description of a Sicilian serpent:

> "Scarce had he finish'd, when, with speckled pride,
> A serpent from the tomb began to glide;
> His hugy bulk on sev'n high volumes roll'd;
> Blue was his breadth of back, but streak'd with scaly gold;
> Thus riding on his curls, he seem'd to pass
> A rolling fire along, and singe the grass.
> More various colors through his body run,
> Than Iris, when her bow imbibes the sun."

* Bingley's Animal Biography, vol. ii, p. 410, &c.
† Dr. Paley's Natural Theology, p. 286.

Even the tegument of the Earthworms is made in the completest manner, for effecting a passage in the earth, wherever instinct directs their motions. Their bodies are composed of small rings, and have a curious apparatus of muscles, which enables them with great strength to extend or contract the whole body. Each ring is likewise armed with stiff, sharp prickles, which they can open or close at pleasure. And under their skins is a shining juice, which they emit, as occasion requires, to lubricate their bodies, and facilitate their passage into the earth. By all these means they are enabled, with ease and speed, to work themselves into the ground, which they could not do, if they were covered with hair, feathers, scales, or such clothing as any of the other creatures.— One of the most singular properties of the serpent tribe is that of casting their skins from time to time. The beauty and lustre of their colors are then highly augmented. The old skins have a tarnished and withered appearance, and are forced off by the growth of the new. When this takes place, so complete is the, spoil or coat-skin, that even the external coat of the eyes themselves make a part of it.

Among creeping things, the Spider engaged the attention of Solomon who observes, that he is one of those "little things on the earth, that are exceeding wise." This creature subsists on flies, wasps, and similar insects, without having wings to pursue them; a circumstance apparently of great difficulty, yet provided for by a resource, which no stratagem nor effort of his own could have produced, had not both the external and internal structure of this animal been specifically adapted to the operation. What surprising skill and sagacity does the Spider discover in weaving and spreading her nets to ensnare and entangle her prey! How wonderfully artificial is her web, or *house!* How astonishingly curious its architecture! With the fine and delicate threads she spins out of her bowels, how thin a web does she weave, constructed for the purpose of procuring food! It is fastened according to the rules of mathematics, for its lines are drawn exactly from the centre at parallel distances.* When this net is spread, that she may the more effectually secure her prey, she cunningly conceals herself in her covert, to evade the discovery of flies. It is from the accuracy of this geometrical workmanship, that this cunning artist is immediately apprized of the approach of a fly, or any other insect of the like nature, when she sallies forth and seizes on her prey. She is furnished with a very sharp hooked forceps, placed near the mouth. with this weapon she seizes and pierces the flesh of such insects as entangle themselves in her web; and, at the same instant, by

* Aristotle asserts that *spinning* and *weaving* were first learned from the spider. Thence it has its Greek name *αραχνης*, Latin *Aranea*, French *Araignée*, from the Hebrew *Aragncvit*, *texuit*, or *Arach*, *textura*. And it is not improbable that our English word *Spider* is but a corruption of *Spinner*, for *Spinn* is the German word for *Spider*. With this agrees that poetic fancy, that *Arachne* an excellent *spinster*, was by *Pallas* turned into a *Spider*. Pallas was the goddess of wisdom, war, weaving, spinning, and the liberal arts; and she was invoked by almost every artist, particularly such as worked in wool, embroidery, painting, and sculpture.—Edward's Demonstration, &c.

means of a small white proboscis, she infuses a deadly juice into the wound, which, in a moment, kills the animal. This poison must be very deleterious; for flies, and many other insects, may be mutilated by depriving them of their legs, wings, and even cutting their bodies through the very middle of their abdomen, and, in that condition, will survive several days.—The Centipeds, the Scorpion, and the Tarantula, are all provided with poisonous weapons.

*Appendix to the Chapters on **Plants**, **Fishes**, **Fowls** and **Quadrupeds**.*

[If we will attentively examine the *fossil remains of fishes, animals, birds, and vegetables*, so abundantly preserved entombed in the crust of our earth, we shall easily see the necessity of looking into the sepulchres of these primitive creatures if we would freely describe the "Mosaic Creation." Many of their genera and species are now extinct: and those which remain seem to have dwindled down to mere *dwarfs* in comparison with their prototypes.

It is a matter of great satisfaction, that these interesting remains of the primordial world are so well preserved. They are called by one *the medals of creation:* they reveal the ancient condition of our earth; the successive events; and the attending organic appendages of sensitive beings: and it is a matter of great pleasure to the Christian, that what they disclose so clearly on this subject agrees expressly with the Bible.

The class of animated beings called *pisces*, or *fishes*, is not so well known in regard to their *genera*, and *species*, as the classes of quadrupeds and birds.

From the fossil remains of each, and their position in the crust of the earth, it is well ascertained, that their genera were created successively, and that the most ancient genera are extinct. The same is true in regard to vegetables. It is equally true, that, connected with the successive creation, was a *successive improvement* in the delicacy and complexity of their structure and parts. There was also a reduction in the *size* of fishes, and quadrupeds, and a great reduction in the *amount* of vegetation, as well as the size of many of the plants.

These periodic variations in all early organized bodies, were evidently owing to the variations of the state of the surface of our earth, and the surrounding atmosphere. The Divine Being appears to have created the different genera suited in constitution to the condition of the world at the time. The cause of their successive extinction appears to have been successive catastrophes, which altered the constitution of our earth and atmosphere.

All these facts taken together indicate, that, in the early periods of the earth, the soil, water, and air were better calculated to sustain the simply huge, and inconceivably powerful and fierce creatures of the animal kingdom, than the delicate and beautiful beings of the present period. The same is eminently true in regard to vegetables, specially their *quantity*. They were of trunks, and spreading branches so huge as to exceed belief, did we not see them well preserved in a fossil state. Their quantity also was immense; hence the amount of vegetable coal found in the earth.

These facts clearly indicate that, in the early periods of our earth, the surface was moist, perhaps, marshy for a long time, gradually drying, and passing to a habitable state: the air was very moist and gross, and the temperature of the earth was much higher than at present. Hence the huge and abundant vegetable productions. These general facts shall be confirmed by a few remarks in regard to each class.

*Fishes.*—Under this class is included, here, *testaceous*, and *crustaceous* creatures, as well as *fishes* commonly so called. The most ancient of this family seem to be entirely extinct, and their remains are found in great abundance in the lower transition rocks. There are many localities were fossil fish, of various kinds, are found abundantly. They are sometimes found in the heart of mountains, thousands of feet above the level of the sea. Their localities are so numerous they need not be mentioned. They are found in all possible *positions*, and in every degree of *preservation*—some are *contorted*, and *crushed;* indicating sudden violence. Others are inhumed in the very act of swallowing their prey, and in every easy and natural position; indicating that they expired without violence. Some of these, which are thus quietly buried, are of the most active species; thus proving the suddenness of the catastrophe.

So extensive are the depositions of *shell-fish*, that whole beds of rock, in some cases, appear to be composed of them; and, indeed, in some instances, mountains are composed principally of these rocks filled with organic remains.

From these facts, it is allowed by all, that the sea once covered these localities; and when it is recollected that some of the rock strata, composed of the exuviæ of these marine creatures, are *hundreds* of feet thick, the conclusion will be irresistible, that the sea covered them for a long time, and that these rocks which contain them *were deposited at the bottom of the sea*, which have since become dry, by the retiring of the waters, or by some subjacent force upheaving the bed of the sea, and of course these deposits which had been made at its bottom—when these fossil remains are found in mountain mases they have been upheaved—when in low lands, where the rocks lie *in situ*, the sea has exposed them by retiring.

*Amphibious Creatures.*—There are yet a few animals of this class; but they can scarcely be called the types of the ancient races, now extinct, whose remains have lately been discovered, and attracted so much attention in Europe. They are principally of the *crocodile*, and *saurian* (or lizard) families. Their size, and indicated power, ferocity, and fierceness, are astonishing beyond measure. Their structure clearly indicates their proper element was wet, marshy, and reedy places, such as the crocodile delights in at this time: thus indicating that they were in the earth as the ancient chaotic seas retired, and was leaving the earth dry.

If a *single* skeleton only, of any one of these creatures had been found, naturalists would have pronounced it a *lusus naturæ*. But many have been found, of different genera and species: only two or three shall be mentioned here.

One of the crocodile family, as is supposed, had a spine composed of 133 vertebræ, or joints, taken together 21½ feet in length. The head was nearly 4 feet. Its species are extinct; some refer even this huge animal to the lizard family.

*The Megalosaurus.* The skeleton of this huge creature has been satisfactorily examined, and ascertained to belong to the *lizard family.* Its thigh bone is 32 inches long. It is said some have been found 4 feet. At 32 inches, the animal must have been 48 feet in length. Dr. Buckland, from some fossil remains, calculates some of them were as high as our largest elephants, and sixty or seventy feet in length. And yet this was a *lizard* of the ancient world!

*The Pterodactyle.* This is a species of the saurian family as those above. Its distinctive character is the *elongation of its fourth toe*, so as to support a membrane for the purpose of *flying:* hence its name, *wing-toed.* It is indeed a curiosity. Its species is extinct.

*The Ichthyosaurus.* This is also a reptile of the lizard kind: but because it so much resembles a *fish*; it has this name, i. e. *fish-lizard.* It has a moderate tail—long pointed muzzel armed with sharp pointed teeth; two huge eyes; breathed air; swam in the water; crawled in marshy, reedy places, but could not walk or run on land, having flat fins, or bony paddles, somewhat like seals. The skeletons indicate some of them to have been 25 feet long.

*The Plesiosaurus.* This animal, as its name imports, was rather *akin* to lizards, than decidedly of the genus. Its very peculiar characteristic is the immoderate length of its neck, and the unexampled number of *vertebræ* of which it is composed. In other respects it approaches the ichthyosaurus. Its remains indicate an animal, according to Cuvier, at least 30 feet long.

*The Iguanodon*, was of the lizard genus, three or four times as large as the largest crocodile; having jaws equal in size to the incisors of the rhinoceros, and crested with horns. (Dr. BUCKLAND.)

Many more creatures of the early periods of our earth might be mentioned, which would come expressly under the title of this volume; and the knowledge of which is durably preserved in the fossils of the earth, all of which would confirm the facts stated in the commencement of this paper, viz: that during the first and grossest periods of our earth previously to the creation of man, great numbers of genera and species of huge and misshapen animals existed, which are now extinct. For instance: the skeletons of animals of the *frog and toad* families, have been found so large, as to induce some naturalists at first to call them *human remains.* A tapir has been found the *size of an elephant;* and a species of the *sloth tribe* as long as a *rhinoceros!!*

These things will indeed appear incredible to the reader at first; but let him recollect that the evidences of these astonishing facts are contained in the solid crust of the earth, and cannot be deceptive. They may be *seen, measured, weighed, and put up so as to form the whole animal*, an object of inspection to thousands.

There are but few fossil remains of *birds* found in the earth, and these are principally in the upper tertiary strata, and in company with the fossil remains of such animals as are companionable and serviceable to man. The reason of this is obvious: the earth was not suitable for the habitation of birds until it had become comparatively dry, and the seas had retired in a great measure, and vegetation abundant. The aquatic genera appeared first, of which there are a few remains. Moreover this class of creatures could not be overtaken with any violent catastrophe, so as to bury them in a body, or in particular strata. It is, therefore, probable that birds, as a class, have preserved their genera and species from the first; and are now nearly the same in this respect, as well as in size, as in the earlier periods of the world.

*Vegetables.*—In the vegetable kingdom we are if possible, more astonished than in the animal, of the ancient periods of our earth. From their fossil remains, well and abundantly preserved, it is very evident that the vegetation of the first periods of our earth was abundant and heavy, beyond any thing which we can conceive at this time. It cannot be doubted but that the vegetative powers of the earth was very much greater than at this time, or within the memory of man. This is evident from the immense production of *vegetable coal.*

This statement may be rendered somewhat more credible when it is recollected, that the earth, in its first periods, was of a much higher temperature than now; and of course not only produced more abundantly, but *all parts* of the earth produced vegetation in abundance. This is evident from the fact, that within the arctic circle, where now reigns eternal winter, and no vegetation can be found, there was anciently successive products of heavy vegetation. (See appendix to our paper on volcanos.) This is proven by plants being found fossilized *on the spot, and in the position in which they grew; as also the leaves and fruits of plants, which are known now to be tropical, so well preserved, and in such a natural, easy position as to prove clearly they grew on the spot on which they were fossilized.*

The *flora* of the primordial world was expressly a part of the 'Mosaic creation,' and which is but little understood as yet. Some of the principal plants were of the *fern* and *palm* genera; but their size very far exceeded those now found growing. By closely examining these fossil plants, it will be found, *that they increase in size and quantity as the period of their growth is distant from the time in which man was created:* thus indicating *an increasing temperature of the earth as we ascend in time.* This also corresponds with the well known fact, *that the size of these plants now increases progressively from the polar regions to the equator.*

Our author has given a concise and edifying description of the principal families and individuals which now exist, and are found in the earth. The above remarks are intended to direct the attention to those *which have long since passed away.*]

The propriety of the distinction between clean and unclean beasts, mentioned in the Scripture, will appear on the first hearing of their names; for we find amongst the clean creatures, Oxen, Sheep, Goats, and Lambs: and on the other side, Lions, Tigers, Wolves, Foxes, Swine, Moles, and Serpents. It is evident that there is a wide difference between these two parties, with respect to their manners and ways of life.

Those only are admitted among clean animals, which "divide the hoof and chew the cud." Animals which divide the hoof are more inoffensive with their feet, than the several tribes of wild beasts, whose paws are armed with sharp claws, to seize their prey. Quadrupeds with a divided hoof tread surer than those whose hoof is entire; there being a plain mechanical reason why a foot, which presents several angles and edges, should take faster hold on the ground. They are not only surer footed, but also more orderly and regular in their progress. Sheep have a natural tendency to follow each other's steps. They approach the fold, or return from it, in a train; as well as traverse their pastures in the like order. Oxen tread in the very footsteps of their predecessors: so that a drove of them, on passing through a deep and narrow road, leave the surface divided into a regular succession of ridges and furrows, as if it were the work of art. If animals could reason and dispute as men can, this plodding practice of the Ox might possibly be ridiculed by the Ass; as the orthodox believer, who is content to tread in the steps of his forefathers, is scoffed at by the rambling freethinker, who uses it as the privilege of his nature, to deviate into by-ways, untrodden by those who were much wiser than himself. *Sure footing* is an image not improperly applied to elementary truth and science: whence it will not be unnatural to suppose, that this first character of the clean animals was intended to be expressive of rectitude and certainty of principle in moral agents. Error is various and changeable in its nature: but truth, being uniformly the same in all ages, will always be productive of sobriety and regularity in those who follow it.

The other character of clean animals is that of "chewing the cud;" a faculty expressive of that act of the mind, by which it revolves, meditates, and discourses on what it has laid up in the memory; and the word *ruminate* has the same metaphorical meaning. An animal thus employed has the appearance of abstraction in its countenance, as if it were engaged in deep meditation; and it ruminates more particularly when lying in an horizontal position, for then the food is more easily recalled into the mouth from its temporary lodgment in the stomach. This character then, is expressive of devout thought and holy conversation: for the word of God is the food of the mind, which, being laid up in the heart, should be frequently revolved; so that being properly applied to the inward man, it may contribute to a daily increase in faith, purity, and goodness.

The clean animals were also *sacred;* that is, set apart by the law for the purpose of sacrifice. The propriety of which is evident: for if the worshipper, who offered an animal to God, meant by that act to devote himself, using the animal as his substitute or proxy; then certainly it was not fit that he should represent himself by an unclean creature, whose instincts and habits would convey an odious idea of his own person and character, and consequently make his devotion appear ridiculous. In order to make a sacrifice acceptable, it was requisite that the qualifications of the offerer should correspond with those of the offering. The innocent manners of a clean victim, were a tacit reflection on an unclean offerer. When the worshippers of the true God were corrupt in their principles or morals, their oblations were no longer either proper or acceptable: which was signified to them in those words of the prophet—"He that killeth an ox, as if he slew a man: he that sacrificeth a lamb, as if he cut off a dog's neck: he that offereth an oblation, as if he offered swine's blood." The reason is added: "They have chosen their own ways, and their soul delighteth in their abominations." But there is another sense in which the institution of sacrifice is to be understood: for every sacrifice had its prophetic use, and was prefigurative of the true sacrifice of Jesus Christ; with respect to whom it was necessary that every animal, preferred to this sacred application, should be recommended by every possible character of innocence, purity, and perfection: therefore the sacrifices were taken from the tribes of Sheep, Goats, and Oxen.

The diet of the Jews being thus immediately connected with the most solemn acts of religious adoration, the daily course of their living carried with it an exhortation to purity of mind and body, and directed their faith to its supreme object, the vicarious sacrifice of the Messiah. The moral necessities of man can only be supplied by the death and benefits of a propitiatory sacrifice, the common substitute of all mankind: whence God has mercifully ordained, as well by the present condition of creation itself, as by the appointment of revelation, that the life of his body should be sustained in like manner: thereby to remind us every day, that the life of man is in a state of forfeiture; and that there can be neither the preservation, nor the remission of sins, without the shedding of innocent blood. Thus does mankind conspire in offering up a daily sacrifice, and attesting the truth of the Christian doctrine, and many persons with the same insensibility that Caiaphas uttered a similar prophecy in its favor, "It is necessary that one man should die, that the whole people perish not."

These clean and unclean animals, with respect to their several ways of life, are as opposite as their dispositions. Sheep, Oxen, Goats, Deer, &c. are formed into societies, they herd peaceably together, and are subject to the laws of government, as well for their own advantage as for the service of man. But beasts of prey roam by themselves in forests and deserts, incapable of entering into any friendly communion. They are so many single tyrants, who acknowledge no superior, but fight their way, and live in a state of hostility with the whole creation. If they ever unite in gangs, it is with the spirit of thieves and murderers, who are banded together only that they may plunder the innocent with greater security. And, like other depredators, they are all fond of darkness. When the sun goes down, the Lion stalks forth from his den: at which time the Sheep, under the direction of the shepherd, are retiring to their fold. And when the cattle are climbing up the mountains to their pasture, invited by the reviving rays of the rising sun, the tyrants of the night are warned back to their hiding-places.*

The blindness of the Mole, the petulance and immodesty of the Dog, the subtlety of the Fox, the poisonous teeth and double tongue of the Serpent, afford ample scope for reflection. The Egyptian hieroglyphics were certain visible representations of creatures, whose inclinations and actions led to the knowledge of those truths which they intended for instruction. A profane and voluptuous man was represented by a Swine, whose filthy disposition caused it to be hated by all the eastern people. A great hypocrite, or a notorious dissembler of wicked intentions, was expressed by a Leopard, because this animal acts craftily, concealing his head that he may with less difficulty catch his unwary prey; for the creatures are as much alarmed at his presence, as they are pleased with the agreeable scent of his body: when therefore they approach him, delighted with the perfume, he will cover his head with his paws, till they come within his reach. An incorrigible person was also expressed by a Leopard's skin, because its spots no art can remove. A Chamelion likewise was the hieroglyphic of a hypocrite, who can accommodate himself to any religion that will serve his turn; for this animal can change its color. A stupid, ignorant person, an enemy to religion, was signified by an Ass; and one that was not acquainted with men and things, or knew not how to acquit himself with decency and propriety in the world, was painted with the head and ears of an Ass. The Egyptians were accustomed to put the heads of animals on the bodies of men, to express the dispositions and conduct of those persons they were intended to represent. A Tiger, being a most fierce animal, signified a savage, cruel, revengeful disposition, opposed to all goodness. A Fox is notorious for his craftiness; therefore he is an emblem of a subtile person, under the influence of wicked thoughts and intentions.†

Rams, and Bullocks of Bashan, Lions, or any animal of prey, are figures frequently used by the sacred writers for cruel and oppressive tyrants and conquerors. "Hear this word, ye kine of Bashan, which oppress the poor." Bashan was a very fruitful place, a fine and fattening pasture, in which were the best fed and strongest cattle. To these, the prophet compares the great men

* See Jones's Disquisition concerning clean and unclean Animals.
† See D'Assigny on the Hieroglyphics of Egypt.

among the Israelites, especially their judges and magistrates, who were proud, insolent, wanton and mischievous, like the bulls of Bashan: who oppressed the poor, as high fed cattle push and gore the weaker sort. "The Lion is come up from his thicket, and the destroyer of the Gentiles is on his way; he is gone forth from his place to make thy land desolate: and thy cities shall be laid waste without an inhabitant." By this animal is meant Nebuchadnezzar, the king of Babylon, so termed on account of his great power and fierceness; and as the Lion is commoly in the forest among the thicket, so this terrible political ruler had his strong hold and principal seat at Babylon, which residence he left to commit awful desolation among the cities of Judah and Israel.

The prophet Isaiah, with a boldness and majesty becoming the herald of the Most High, begins his prophecy with calling on the whole creation to attend, when Jehovah speaks. "Hear, oh heavens; and give ear, oh earth; for the Lord hath spoken; I have nourished and brought up children, and they have rebelled against me." A charge of gross insensibility and ingratitude is then brought against the Jews; by contrasting their conduct with that of the Ox, and the Ass, which is the most stupid of animals. "The Ox knoweth his owner, and the Ass his master's crib: but Israel doth not know, my people do not consider." What a cutting reproof! what an indelible reproach! to have been favored with the best means of instruction, and yet to be exceeded by the herd of the stall! To perish for lack of knowedge, after having had the best means to acquire it, evinces the grossest inattention, and most censurable insensibility.

The prophet Jeremiah lamented the wickedness of the age in which he lived, and the vice and immorality that every where abounded. He saw with grief of heart the holy Sabbath profaned, the worship of God neglected, and his house and ordinances defiled. While a sorrowful witness to their gross abominations, he saw the punishments that awaited their immorality, and then wept over what he could not amend. He gave them faithful admonitions from God, but they disregarded them, and drank in iniquity like water, and drew sin as with a cart-rope: because they had been *taught* to do evil (for so the margin reads,) trained up in their evil ways, had learned to sin by precept and example, and were great proficients in vicious pursuits: from their youth their natural propensity to evil had increased by continued practice, till sinning was become habitual, and there was little hope left of amendment. Therefore he exclaims, "Can the Ethiopian change his skin, or the Leopard his spots? then may ye also do good, that are accustomed to do evil." The Ethiopian's skin is of so sable a hue, that no water can wash it white. A Leopard's skin is beautifully spotted, which is not the result of accident, but nature, and cannot be defaced. By these two similes the prophet designs to represent, not only the

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natural impossibility without Divine aid, but also the extreme difficulty of habitual sinners learning to do well, after they have long accustomed themselves to do evil. The least sin is to be avoided, the least growth of sin to be prevented ; for sin indulged in thought will beget desire, desire will break out into action, action will grow into custom, custom will settle into habit, and then, there is the utmost danger of both body and soul being irrecoverably lost.

When our Saviour sent forth his apostles to preach the Gospel, he informed them of the hardships, dangers, and discouragements they would have to encounter, in the faithful discharge of their ministry; especially after his resurrection, when they would be deprived of his personal presence; for we do not read of any great persecutions they endured while he was with them. These sufferings he foretold, that they might not be surprised at their approach ; and that, by the accomplishment of this prediction, their faith might be confirmed. "Behold, I send you forth as sheep in the midst of Wolves." Here we have a prediction of their perilous condition ; they were to be as Sheep in the midst of Wolves. And what situation more dangerous! What can sheep, that are feeble creatures, and destitute of natural armour to defend themselves, expect, in the midst of ravenous wolves, but to be rent and torn to pieces? So those, amongst whom the apostles were to be sent, would have as great an inclination, arising from their malicious dispositions, to destroy them, as wolves have from their nature to devour sheep. Wicked men are like wolves, whose nature it is to destroy and devour sheep; they are of a diabolical disposition towards the ministers of the Gospel.

Our Saviour also gave his apostles advice, how to conduct themselves in such very unpleasant and dangerous circumstances. " Be ye therefore wise as serpents," not cunning as foxes, whose aim is to deceive others ; but as serpents, whose policy is only to defend themselves, when they are in danger. A serpent's wisdom appears in a care to guard and secure its head, that it may not be hurt ; in stopping its ears against the voice of the charmer, which it does, says a certain naturalist, by laying one ear close to the ground, and stopping the other with its tail ; and in sheltering itself in the clefts of a rock, when in danger. So should Christ's ministers, in a time of peril, use all lawful means for their own safety and preservation ; they should be wary and circumspect to keep themselves from harm, either of body or soul. "And harmless as doves." Ministers should be meek, do no person any harm, bear no ill-will, be without gall, as is said of the dove ; though their enemies should be fierce and savage, like wolves, yet they must not study how to revenge the injuries done them. It should be their continual care to be inoffensive, in word and deed : wisdom and innocence should dwell together. Ministers must not be altogether doves, lest they fall into danger ; nor altogether serpents, lest they injure others ; but they must be both serpents and doves, the one for wisdom, the other for innocence.

"That thou mayst injure no man, dove-like be,
And serpent-like, that none may injure thee!"

Our Saviour likewise cautions his followers against false teachers. "Beware of false prophets." The term *prophet* in the Scripture, signifies one who foretells things to come; this is the most proper signification of the word. It also means one who expounds the predictions of the Old Testament. And sometimes we are to understand by it, one employed in the ministry of the Gospel; in this sense a prophet and a teacher are reciprocal terms. So that by prophet here our Saviour means false teachers, who, pretending authority from God, exercised themselves in the ministry, and published false doctrine, or at least represented truth in a corrupt manner, with a fraudulent intention, from base motives, and for vile ends; by whose doctrine persons were in no small danger of being seduced from their simplicity, and drawn away from the truth, sincerity, and power of godliness; into a dead and lifeless formality, and an empty show of religion and piety. Now against such men, Christ, in the days of his public ministry, warned his hearers, to prevent their deception, apprising them that they would "come in sheep's clothing." They disguised their dangerous principles and base intentions, under a show of external religion, and fair professions of love, that thereby they might deceive others. "But inwardly they are ravening Wolves." They were as dangerous to the souls of men, as ravenous Wolves are to Sheep, which watch for an opportunity to seize their prey, silently approach the sheep-fold to see whether the dogs be asleep, or the shepherd be absent: so false teachers with wretched hypocrisy and sophistry, counterfeit sincerity, humility, and sanctity; and were it not for this semblance of piety, their efforts to injure the church of God would be ineffetual. He compares these false teachers to Wolves, especially on account of their cruelty. These animals are not content to satisfy their hunger, but will destroy multitudes merely to gratify their voracious nature. So false teachers strive to injure the whole church of God, and thus destroy souls.

Our Saviour exhorted his auditory to the exercise of Christian prudence, in the dispensing of spiritual things. "Give not that which is holy unto the Dogs, neither cast ye your pearls before Swine, lest they trample them under their feet, and turn again and rend you." The deep things of God, relating to doctrines, are not to be divulged to those who are wallowing in sin; neither are the great things he has done in his people to be declared to profane, furious persecutors: but both classes of wicked men may be reproved on proper occasions. By Dogs, our Saviour means froward, perverse, malicious, revengeful, boisterous, incorrigible, and irreclaimable sinners, who scorn holy institutions, mock at every thing sacred, scoff at religion, deride the word of God, and all serious reproofs and admonitions, whether given by parents, masters, ministers, governors, and others; who are ready to persecute those who preach the Gospel, and endeavor to promote their salvation. By Swine, he means such sinners as are profane and sensual, and like Swine wallow in the mud of sin and wickedness; to whom it is as pleasant to live in their beastly lusts, as it is for Swine to wallow in the mire; and to disregard, abuse, and trample on holy things.

St. Peter, in showing what all men are in the sight of God, before they receive his grace, and what those are who turn apostates from the truth, alludes to two offensive actions of Dogs and Swine. "It has befallen to them according to the true proverb, the Dog is turned to his vomit, and the Sow that was washed to her wallowing in the mire." Blackwall says, this proverb, with great propriety and strength, marks out the sottishness and odious manners of persons enslaved to sensual appetites and carnal lusts; and the extreme difficulty of reforming vicious and inveterate habits. As a Dog, observe Bishop Patrick, when he has vomited up his meat which made him sick, is no sooner well but he returns to it, and eats it up again, forgetting how ill it agreed with him; so an imprudent person commits the same error over again, for which he formerly smarted. The evil nature remaining, and at last gaining the ascendency, in a man, who had through grace reformed his life, renders him like the loathsome and detestable Sow, as Dr. Doddridge remarks; for the Sow that was washed from the filthiness she had before contracted, having still the same unclean nature prevailing, is returned to wallow in the mire, and so makes herself as filthy as she had ever been before. And, adds Dr. Whitby, these two proverbs are expressive of the folly of those men who return to those vices they had formerly renounced.

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## *Section* II.—Man.

Body:—Its Creator—Formation—Vitality—Blood—Heart—Arteries and Veins—Digestion—Respiration—Glands—Absorbents—Nervous System—Organs of Sense—Bones—Sinovia—Muscles—Tendons—Cellular Membrane—Skin. Soul:—Its Immateriality—Freedom—Immortality—Moral Image—Adam's Dominion over the Creatures—Woman—Paradise.

All things necessary, convenient, and delightful, being prepared for the accommodation of Man: light, that he might see; air, that he might hear and breathe; dry land, on which he might walk; herbs and fruit-trees, for his gratification and sustenance; fish, fowl, cattle, and creeping things, for his service: then God proceeded to make him, as the last and greatest display of his wisdom and power, the master-piece of all sublunary creatures, whose creation alone is represented in the sacred History, as an effect resulting from a divine consultation. "And God said, Let us make man in our image, after our likeness. So God created man in his own image, in the image of God created he him; male and female created he them." It appears from the ingenious Parable of Protagoras in Plato, it was a very ancient opinion that *man* was last created after the other living creatures.

In all the former works, God only said, Let such and such things be, and they were; he spake the word, and it was done. But now, when Man was to be made, God is spoken of as calling a council, "Let *us* make man, in *our* image, after *our* likeness." This imports that Man was to be a creature different from all that had been produced, and far more excellent and wonderful in his constitution; a compound of flesh and spirit, heaven and earth, put together, the visible image of the Divine glory, and dedicated and devoted to his Creator's service. Man was the work of ELOHIM, the Divine Plurality, marked here more distinctly by the plural pronouns US and OUR; all the Three Subsistencies in the Godhead are represented as united in counsel and effort to bring into existence this astonishing creature.

Aben Ezra, a Jewish Rabbi, imagined that the souls of all men were made on the first day of the creation, and that God consulted them to obtain their consent before he would assign them bodies of flesh, hereafter to be created. This is a groundless hypothesis, derived from the Platonic philosophy; for God says, "Let us make man in our image," which shows that Adam's soul had then no existence, for in that case, it doubtless would have been in the image of God.

Some other Jewish Doctors, as Manasseh ben Israel, ridiculously conceived that God spake to the elements. But this is more absurd than the former; for the expression, "Let us make man," implies capacity of consultation in those spoken to, and real efficiency. But the elements are not intelligent beings, neither efficient, but only material parts of man.

Nor does God here speak to the angels, as the authority of the Paraphrase, which is called Jonathan's, suggests. The words of the Paraphrase are these: "God said to the angels, which ministered before him, Let us make man." It is a noted saying of the Jewish Rabbies, that God does nothing without consulting his family above: they mean, his holy angels. Several heretics, in the first and second centuries of Christianity, were of opinion, that this lower world was made by angels. This notion is likewise erroneous: God here speaks to those in whose image man was to be formed, but he was not made in the image of angels.

It is pretended by those who are enemies to the orthodox doctrine of the Trinity, that this is a figurative way of speaking, only to express the dignity of God, not to denote any plurality in him; that he here speaks in the plural number after the manner of princes, who say, We will and require, or, It is our pleasure. But this is only a far-fetched invention, to evade the doctrine of the Trinity, by persons in latter times, and no way agreeable to the first ages of the world, or the Hebrew style. Melchizedeck, Abimelech, Pharoah, and Balak, all speak in the singular number. The kings of Israel used the same style, as did Saul, David, and even Solomon in all his glory. And also the Eastern monarchs: "I (Darius) make a decree. I, even I, Artaxerxes the king, do make a decree." Nor is there in the Scriptures one example to the contrary.

Beside, how absurd it is to suppose that God would borrow his mode of speaking from a practice which did not exist! And even granting this possible, yet the cases are not parallel. For though a King, or Governor, may say *us* and *we*, there is certainly no figure of speech that will allow a single person to say, *one of us*, when he speaks of *himself*. It is a phrase that can have no meaning, unless there be more persons than one concerned. Yet in addition to US and OUR, this we find is the style in which God has spoken of himself.

There are some persons who maintain, in opposition to the clear light of revelation, that there is but one Subsistence in the Divine Nature. This was the opinion of the Sabellians, a denomination which arose in the third century; and, certain persons, in modern times, have embraced the same. These contend that God here speaks to himself, as consulting with himself, to create man, and that, though the words be plural, yet the sense is singular, as if he had said, Let *me* make man.

One of the Persons, or Subsistencies in the Godhead, here speaks to the other Two, and who more likely than the Father, who is first in the order of arrangement, as given by the sacred Writers. The Father, not the Son, is the first; the Son, not the Holy Spirit, is the second; and the Holy Spirit, not the Father, is the third. Hence, the Father, when he said, "Let us make man," addressed himself to the Son, and to the Holy Spirit, who were therein joint and equal Creators with him. "None saith, Where is God my Maker?" in the Hebrew, *Makers*, is the language used in the Book of Job, implying a Plurality of Persons in a Unity of Essence: a phraseology like that of Solomon, "Remember thy Creator," in the original, *Creators*. The prophet Isaiah adopts the same style, "Thy Maker is thine husband," in the Hebrew, *thy Makers are thy Husbands*. Thus it evidently appears, that this consultation was among the Persons in the Godhead; that all the Three, the Father, the Son, and the Holy Spirit, were concerned in man's creation; and were therein joint Creators, equal in nature, power, and efficiency.

Dr. Waterland says, that this text, *Let us make man*, has been understood of Father, Son, and Holy Ghost, or at least of Father and Son, by the whole succession of Christian writers, from the times of the apostles; which is a circumstance of considerable importance, and will impress the minds of sincere and impartial men. That the Cristian Fathers were unaimous in their judgment, that these words were spoken by the Father to the Son, or Spirit, or both, appears in their works, from which we shall adduce a few proofs.

*Barnabas* says:—"And for this the Lord was contented to suffer for our souls, though he be the Lord of the world; to whom God said, the day before the formation of the world, Let us make man after our image and similitude."*

*Hermas*:—"He was present in counsel with his Father for the forming of the creature."†

*Theophilus* of Antioch:—"He directed these words, *Let us make man*, to none other than his own Word and his own Wisdom."‡

*Irenæus*:—"His Word and Wisdom, his Son and Spirit, are always present with him, to whom also he spake, saying, *Let us make man*, &c."§ Again:—"Man was fashioned after the image and likeness of the uncreated God, the Father willing his creation, the Son ministering and forming him, the Holy Ghost nourishing and increasing him."‖

*Tertullian*:—"Nay, because his Son is ever present with him, the second person, his Word; and the third, the Spirit in the Word; therefore he spake in the plural, *Let us make man in our image*."¶

*Novatian*:—"Who does not acknowledge the Son to be the second person after the Father, when he reads that it was said to the Son by the Father, *Let us make man*."**

*Origen*:—"To him also spake he (the Father,) *Let us make man after our image*."††

*Athanasius*:—"Who is this that God converses with here? To whom are these notifications and determinations of his pleasure directed? Not to any of the creatures already made; much less to those things which were not yet created; but, undoubtedly to some person, who was then present with the Father, to whom he communicated his councils, and of whose agency he made use in the creation of them. And who could this be but his eternal Word? With whom can we conceive the Father holding his conference, but with his Son, the divine Logos, that Wisdom of God, that was present with him, and acted with him, in the creation of the world, who was in the beginning with God, and was God? and who saith of himself, *When he prepared the heavens, I was there; when he appointed the foundations of the earth, then was I by him, as one brought up with him*."

*St. Augustine*:—"Had God said no more than, *Let us make*

* Epist. cap. v. † Simil. ix, sect. 13. ‡ Ad. Autol. lib. 2, p. 96.
§ Lib. iv, cap. 37, et lib. v. c. 15. ‖ Lib. iv, cap. 75. ¶ Adv. Prax. c. 12.
** Cap. 21, 25. †† Cont. Cel. lib. i, p. 63.

*man*, it might, with some color, be understood as spoken to the angels, whom the Jews pretend he employed in framing the body of man, and other creatures; but seeing it immediately follows, *after our image*, it is highly profane to believe, that man was made after the similitude of angels; and that the similitude of God and angels is one and the same."

*St. Ambrose* speaks to the same purpose:—"God would not speak thus to his servants, because it is not to be thought, that servants were partners with their Lord, in his works of creation; or the works with their Author. And, supposing this should be admitted, that the work was common to God and angels, yet the image was not common."

Nay, the second Council of Sirmium, which was held in 351, pronounced an anathema on all those who denied this. The words of the Council are these:—"If any say, that the Father did not speak to the Son, when he said, *Let us make man*, but that he spake to himself, let him be accursed."*

*Epiphanius*:—"This is the language of God to his Word, and Only-begotten, as all the faithful believe."† And again he says, "Adam was formed by the hand of the Father, and the Son, and the Holy Ghost."‡

I observe more at large from *Irenæus*, that he rejects the notion of the Jews and Heretics, who supposed God spake to his angels. For disputing against Heretics, who attributed the creation of the world to angels, and powers separate from the one true God, he says thus:—"Angels did not make us, nor did they form us; neither was it in their power to make the image of God: none but the Logos could do this; no powers distinct from the Father of all things: for God did not want their assistance in making the things which he had ordained. For his Word and his Wisdom, the Son and the Holy Ghost, are always with him; by whom and with whom, he made all things freely, and of his own accord; to whom also he spake in these words, *Let us make man in our image and likeness*."§

The testimony of Dr. Kennicott will be respected by those who are lovers of the truth. "God, says he, being about to create man, is introduced saying—*Let* us *make man in* OUR *image, after our likeness*; in consequence of which the historian tells us—*so God created man in his own image, in the image of God created he him.* It is evident then, that God created man in his own image; this is mentioned thrice by way of emphasis, and to prevent, if possible, all possibility of misconstruction. Now what God did, was certainly what he proposed to do; God created man in his own image, that is, in the image of the Godhead, and therefore God proposed to create him in the image of the Godhead. But if God proposed to create him in the image of the Godhead, the pro-

* Socrat. lib. ii. c. 30, where the Creed may be seen at large.
† Hæres. 23, n. 2.
‡ Hæres. 44, n. 4. See Bibliotheca Biblica on the place.
§ Lib. iv, cap. 37.

posal must have been made to the Godhead; because the words are—*Let us make man in* OUR *image.* And if the proposal be here made by God to the Godhead, it is absurd to suppose it made to the same Person that makes it; and consequently reasonable to think it made to the other two persons in the Unity of the Godhead."*

The creature now to be made is man.† *And God said, Let us make man.* It is evident that God, by introducing the creation of man with this peculiar phraseology, intends to impress the mind with a sense of something extraordinary in his formation. The word אדם *Adam*, which is translated *man*, is intended to designate the *species* of animal, which is vastly superior to all the rest. Though the same kind of organization may be found in Man, as appears in the lower animals, yet, as one observes, there is a variety and complication in the parts, a delicacy of structure, a nice arrangement, a judicious adaptation of the various members to their great offices and different functions, a dignity of mien, and perfection of the whole, which are sought for in vain in all other creatures.

Man is a compound creature, consisting of two distinct essential parts, body and soul. The union of these constitutes man, for neither of them when separated can be so denominated. The body was made before the soul, and formed out of the earth, or, as עפר *âpher* implies, the *dust.* "The Lord God formed man of the dust of the ground." He afterwards pronounced, ***Dust thou art.*** This led Solomon to affirm, "All are of the dust." The Apostle adds, "The first man was of the earth, dusty," as Ainsworth renders it. And we are said to "dwell in houses of clay," and to have our "foundation in the dust." Of the soul it is said, "God breathed into his nostrils the breath of life:" רוח חיים *ruach chayim*, the breath of LIVES; i. e. animal, intellectual, and spiritual. While this breath of God expanded the lungs, and set them to play, his inspiration gave both spirit, understanding, and felicity. Thus we see that the soul and the body are not the same thing; the one is of the earth, the other is from God. The Rabbins say, "The form of the soul is not compounded of the elements, &c, but is of the Lord from heaven. Therefore when the material body, which is compounded of the elements, is separated, and the breath perishes because it is not found, but with the body, and is needful for the body in all its actions; this form (i. e. the soul) is not destroyed, &c, but continues for ever. This is that which Solomon by his wisdom said, "Then shall the dust return unto the earth as it was; and the spirit shall return unto God who gave it."

* Two Dissertations, &c. pp. 29, 30.

† Among the numerous traditions of the New-Zealanders, says Nicholas, there is one which is very remarkable. It refers to the creation of man, and has been handed down from father to son, through all generations. They believe the first man to have been created by three gods, Mowhee-rangaranga, or Toopoonah, or grandfather, Mowheermooha, and Mowheebotakee; but give the greatest share in the business to the first-mentioned of these deities.

As the formation of man's body was effected previously to the infusion of his soul, we shall attend to the same order, in attempting to elucidate this important and very interesting subject. The word יצר jitzer, rendered *he formed*, observes Mr. Benson, is not used concerning any other creature, and implies a gradual process in the work, with great accuracy and exactness. It is properly used of potters forming vessels on the wheel; and Rabbi D. Kimchi says, that, when used concerning the creation of man, it signifies the formation of his members. Bishop Patrick intimates, that the body of man was made not of *dry*, but *moist* dust; and that this agrees with the Hebrew JITZER, *formed*, which is used concerning potters, who make their vessels of *clay*, not of *dry* earth. Diodorus Siculus says, "Man was made out of the *slime*, or *mud*, of the Nile." The word of the Lord once came to Jeremiah, saying, "Arise, and go down to the potter's house, and there I will cause thee to hear my words. Then I went down to the potter's house, and, behold, he wrought a work on the wheel. And the word of the Lord came to me, saying, Behold, as the clay is in the potter's hand, so are ye in mine hand!" A scene like this is presented to our imagination by the words of Moses; the Lord God *formed*, moulded, or modelled man, as a potter does; we see the work, observes Bishop Horne, as it were upon the wheel, rising and growing under the hands of the Divine Artificer!

But, to give the thing a stronger impression on the mind, we will suppose, says Judge Hale, that this figure rises by degrees, and is finished part by part, in some succession of time; and that, when the whole is completed, the veins and arteries bored, the sinews and tendons laid, the joints fitted, and liquor (transmutable in blood and juices) lodged in the ventricles of the heart, God infuses into it a vital principle, whereupon the liquor in the heart begins to descend, and thrill along the veins, and a heavenly blush arises in the countenance, such as scorns the help of art, and is above the power of imitation. The image moves, it walks, it speaks; it moves with such a majesty, as proclaims it the lord of the creation, and talks with such an accent and sublimity, as makes every ear attentive, and even its great Creator enter into converse with it: were we to see all this transacted before our eyes, I say, we could not but stand astonished at the thing; and yet this is the exact emblem of man's formation.

The human body is an excellent piece of workmanship, the shape and contexture of it admirable, evidently superior to that of all other animals, and the brightest visible display of the wisdom of the Divine Architect. The erect posture, figure, stature, use of every part, and symmetry of the whole, cannot but excite admiration. The fabric of the eye, the texture of the brain, the configuration of the muscles, the disposition of the nerves, the construction of the bones; the veins and arteries, spread throughout the system, the former to return the blood to the heart, and keep that mysterious engine playing, which throws the vital fluid through the latter with prodigious force, to animate and invigorate every part; and many other important particulars, which we shall now proceed to mention and illustrate, are not only manifest proofs of the great excellence of this system, but also of the skill, contrivance, and consummate wisdom of God.

When we take a general view of the animal world, we find the numerous individuals which compose it, differing considerably in the phenomena which their economy exhibits. Man, and the higher orders of animals, are characterized by the constant performance of many complex and active functions; as respiration, digestion, circulation, &c. Torpid or hibernating animals display this singular peculiarity, that these functions are performed for several months, and suspended for several months, alternately. In another modification of animated matter, namely the egg, the evidences of vitality would not be exhibited, were not certain agents applied to evolve them, and, when thus called forth, they cannot be resumed after long suspension.

Although we are ignorant of the nature of the cause which regulates the uniform performance of this series of phenomena, thus more or less extensively displayed in the economy of different animals, we are nevertheless convinced that such a cause must exist, and are hence naturally led to distinguish the phenomena by some appropriate term. Thus observing that the human body, and the bodies of animals which bear it resemblance, possess locomotive powers, can regulate their actions, and are capable not only of resisting the laws which govern inanimate substances, but are enabled to act upon these substances in direct opposition to these laws, we employ the terms life, vitality, and vital power, to express the phenomena which thus distinguish animate from inanimate matter; and in order simply to determine the import of those terms, we may take a general view of those powers which a living animal body possesses, and which cease with its existence.

When we compare the living with the dead body, the most striking circumstance we observe is, that the former was surrounded by the same chemical agents which are capable of producing the decomposition and destruction of its soft parts after death; hence it becomes evident, that its component elements must have been sustained and preserved by some superior power, which ceases to act at the moment of its dissolution.

Of all the phenomena which enter into the general idea of life, this power of self-preservation, or the capability of resisting the laws which govern inanimate matter, appears the most essential. Without this principle we can form no conception of life, since it evidently exists without interruption till the moment of dissolution. It is this principle which, communicated to an egg, enables it to resist for a certain period the powers of heat, cold, and putrefaction; a principle of which the addle or barren egg is entirely devoid. Thus we find from Mr. J. Hunter's experiments, that an impregnated egg is longer in freezing than an addle egg, and every one knows that the former remains sweet or free from putrefaction much longer. This principle, which we may consider the most simple state of existence, is limited in its duration; and for its maintenance, the performance of no active function is necessary. Hence it continues in the egg either quiescent for a certain time, and is gradually destroyed; or, by the agency or stimulus of heat, it acquires the accession of the power of action, which assimilates inanimate matter into a living form, and, at length, exhibits in the chick all the phenomena of a more perfect state of existence, which may be distinguished by the term active life. In this state, many other phenomena of vitality are exhibited. Besides the power of self-preservation, an internal principle of support and reparation, and the power of performing the important actions of circulation, respiration, digestion, &c, which are subservient to this principle, is given to animals. These form the features of what we call life, as it appears in man, and the higher orders of animals, and certainly constitute its most useful, though not most essential part. For how little superior is an egg, or a torpid animal, to vegetable or inanimate matter, till the former contain a living chick, the latter become an active animal? Thus, though life may subsist under the quiescent form of self-preservation, it requires the accession of certain principles, and a power of performing various important actions, to display its chief characters. The economy then of an egg, and of a perfect animal, such as man, may be considered as examples of the most simple and extensive phenomena of vitality. These, however, are more or less perfectly exhibited in the different orders of animals. It belongs, for instance, to the economy of certain animals, which at one time of the year perform active functions, to become torpid at the approach of winter. In these creatures, respiration, digestion, and every function which characterizes active life, is suspended; as in the egg, the principle of self-preservation, that latent spark of vitality, alone remains, by which we distinguish torpidity from death. This condition, however, is not of long continuance; at the approach of summer's warmth, the power of action is again called forth, active functions are superadded to the principle of self-preservation, and life, before quiescent and obscure, now resumes its most perfect form; or, in other words, the animal just now inert and motionless, respires again; its heart beats, its blood circulates, its muscles resume their accustomed motions, and it leaves its winter quarters in search of food. Having now assumed the nature of an active animal, the performance of the functions characteristic of that state (which we shall now proceed to describe) becomes requisite; and, first, the circulation of a fluid which we call *blood*.*

This fluid differs in its appearance in the different orders of animals, though, in its essential properties there is little variety; the appearance of the blood in man, and the more perfect animals, is that of a red fluid, having a certain degree of viscidity, not being limpid like common water. Though it appears to be a homogenous fluid whilst circulating, or at the moment it escapes from its vessels, it is composed of three parts, essentially differing from each other; of *particles*, upon which the color of the blood depends; of *coagulating lymph*, which has the property of becoming spontaneously solid under certain circumstances, and from which various structures in the body are formed; and of a limpid fluid called *serum*, which dilutes the coagulating lymph, and fits it for circulating through blood vessels of a very minute size. In some of the lower orders of animals, however, the color of the particles of the blood is green, in others white, corresponding with the color of the animal; in others there is no color whatever in the blood, so that it is either void of particles, or they are transparent, so as not to be seen. But this deficiency must be considered as making no great difference in the blood itself, as its particles do not appear to be its most essential part. Many microscopical observations have been made to determine the size of a single particle of the blood, and according to the observations of several philosophers, the diameter of a single particle in man has been computed at the 3,000th part of an inch. The size of the particles in red blooded animals, is found not to correspond with the size of the animal. They are as large in the mouse as the elephant, larger in some insects than in man, smaller in the ox. They are in prodigious numbers, so as to give color to the blood, and of all its parts appear to be renewed the most slowly; thus when animals are frequently bled, the flesh becomes paler and paler.†

The next part of the blood, or coagulating lymph, is of the greatest

* Moses says, "the *life*, נפש nephesh, of the flesh is in the *blood*." And St. Paul affirms, "God hath made of *one blood* all nations of men." This sentence of Moses, which, in conjunction with that of St. Paul, contains a most important truth, had existed in the sacred Scriptures for 3,600 years, before it arrested the attention of any philosopher. This is more surprising, as the nations in which philosophy flourished, were those which especially enjoyed the Divine oracles in their respective languages. That the blood actually possesses a *living principle*, and that the life of the whole body is derived from it, is a doctrine of Divine revelation, and which the observations and experiments of the most accurate anatomists have served strongly to confirm. The proper *circulation* of this important fluid through the *whole* human system, was taught by Solomon in figurative language, Eccles. xii, 6; and discovered, as it is called, and demonstrated by Dr. Harvey in 1628; though some Italian philosophers had the same notion a little before. This distinguished anatomist was the first who fully revived the Mosaic notion of the *vitality* of the blood; and which correct view was afterwards adopted by the justly celebrated Mr. John Hunter, whose strong reasoning and accurate experiments have served to sanction and give publicity to a fact so long unknown to mankind. The doctrine of Moses and St. Paul proves the truth of the doctrine of Harvey and Hunter: and the reasonings and experiments of the latter, illustrate and confirm the doctrine of the former.—See Dr. A. Clarke on Lev. xvii, 11.

† As an instance of this I may mention the case of a gentleman who was subject to frequent attacks of asthma, to such a degree, that if he were not relieved immediately by bleeding, he was in danger of suffocation: by being so frequently bled in that state, his blood at length became so pale as scarcely to stain a linen cloth, in consequence of the particles of the blood being so slowly renewed.

importance. This constituent part becomes apparent, when blood is drawn from a vein into a cup, from its power of spontaneously coagulating into a solid mass, which appears red from a mixture of red particles: the color of the lymph however is transparent. This coagulation of the blood differs very essentially from the coagulation of inanimate substances, and is considered by many physiologists to be the last exertion of a living principle, which the blood is supposed to possess. This opinion, although not capable of absolute proof, is rendered extremely probable from a variety of facts, and by none more than the analogy between the coagulation of the blood, and the contraction of the muscles at death. These two actions appear to be influenced in some degree by the same causes. Thus, sudden death from lightning, or a blow upon the stomach, prevents the muscles from becoming rigid after death, and prevents also the coagulation of the blood. Under these circumstances it remains fluid. Besides violent death, several circumstances influence its tendency to coagulate and become solid, such as a great loss of blood—inflammation—pregnancy in females, and other causes.*

The third important part of the blood is the serum. This is limpid like water, and remains permanently fluid, unless certain substances are employed to coagulate it, such as alcohol, alum, or a certain degree of heat. It dilutes the other parts of the blood, so as to reduce the whole to a proper state of fluidity. It is secreted, or naturally separated from the blood, and poured out by exhalent vessels in various cavities and parts of the body, as the chest, abdomen, cellular membrane, &c. It facilitates the easy motion of the various organs upon each other, and, when accumulated in large quantities, forms the fluid of dropsies.

Besides these constituent parts, a quantity of water always circulates with the blood, varying according to the quantity of fluids taken in, and regulated in its proportion by the kidneys. Thus if a large quantity of water is taken into the stomach, particularly if it contain a little spirit in the form of punch, the kidneys are stimu-

* Two of these causes are peculiarly important and interesting. When an animal has lost a considerable quantity of blood, and faints in consequence, the power of the blood to coagulate quickly is greatly increased.—When, for example, a sheep is bled to death, if you receive a cupful of the blood which first issues from the throat, and a cupful of the last, you will find that the latter will coagulate sooner, and become much more solid than the first portion. By way of experiment, the large artery of the thigh of a dog has been divided and laid open; the animal bled till he fainted, and on recovering had no return of the bleeding. On examining the artery, its divided end was found plugged up by coagulated blood, and much contracted in its diameter; this natural means, however, of checking hæmorrhage, we shall afterwards find, is assisted by the contractile power possessed by the vessel from whence it is effused. Hence it appears that fainting is favorable to checking hæmorrhages, as far as it puts a temporary check to the circulation, and should always be encouraged to a certain degree. Another cause which influences the coagulation of the blood, is inflammatory diseases. Under such circumstances it remains much longer in a fluid state, but coagulates at length more firmly. This coagulation of the lymph is the first step towards its conversion into various parts of the body, or the union of divided parts. When, for example, the coagulating lymph is thrown out upon inflamed internal parts of the body which lie in contact, as the intestines or lungs, it becomes solid, and connects them loosely together. Blood vessels shoot into it, and convert it at length into cellular membrane, forming what are called adhesions, and in a similar way it is converted into the nature of various parts of the body. We may therefore say, that the coagulating lymph is the most important part of the blood, inasmuch as it is subservient to the formation of various organs in the body. Many parts, particularly the muscles, very nearly resemble it in their nature.

lated to an increased action, so as to separate from the blood the redundant quantity. A variety of other substances also are occasionally introduced into the blood, along with the aliment, alkaline substances producing their effect upon the nature of the urine, rhubarb on bile giving it a yellow color, and turpentine or asparagus altering its odor; all these substances, before passing off by urine, must have been mixed with the blood, from whence the urine is formed, being in fact its excrementitious part.*

It is necessary for the blood thus formed, to pass to every part of the body, that it may be converted into the nature of these parts, and thus become subservient to their growth; that fluids, serving important purposes in animal bodies, may be separated or secreted from it; and that the temperature of the body may be equably maintained. The blood, however, has no power of motion in itself; if it be not propelled by certain parts of the body, it remains quiescent like any extraneous fluid.

In two very numerous classes of animals, insects and zoophites, the motion of the blood is very simple; they are nourished like vegetables, by the absorption of the fluid, which is prepared in their alimentary canal, and have no circulation properly so called.

But in man, and the higher orders of animals, a complex apparatus for the motion of the blood becomes necessary, consisting of an heart, arteries, and veins. The *heart* may be considered as the chief agent in circulation, the general reservoir, and source from whence the blood flows. It is composed of two principles, one a principle of reception, the other a principle of propulsion. That cavity of the heart, which is called its auricle, receives the blood from the veins; the cavity called its ventricle, propels it through the arteries.

Although the heart in all animals is formed on the same general principle, and for the same purpose, yet the economy of some animals admits of a greater simplicity in the conformation of this organ, than others. The most simple kind of heart is composed of one cavity, with a tube entering into it, by which it receives the blood, and another passing out of it, by which the blood is conveyed over the body. The next simple heart is composed of two cavities, an auricle, which receives the blood, and propels it into a ventricle, which diffuses it over the body. Another kind of heart is composed of three cavities; two auricles, and one ventricle; one auricle receiving the blood from the lungs, the other from the body generally; the blood from these two sources is mixed together in a single ventricle. This structure we find in some amphibious animals, in which it is not necessary that the blood should circulate with so much influence from the oxygenous part of the atmosphere, as in

* Substances may even be introduced into the blood directly. By way of experiment, Ipecacuanha, or a small portion of Emetic Tartar, or Jalap, have been infused into the veins: the result of this has been found to be, that they have produced the same effect as if introduced by the stomach; the former produced vomiting, the latter purging.

other animals. Accordingly we find the heart adapted to transmit only one half of the blood through the lungs at each circulation, whilst in more perfect animals the whole mass passes by this route. The last kind of heart is formed of four cavities, two auricles and two ventricles, and is the most perfect apparatus as it is found in man, and quadrupeds generally.—It must, however, be considered as composed of two distinct parts, or two simple hearts adhering together, and performing distinct parts of the circulation; and one part intended to receive the blood from the body, and circulate it through the lungs; the other part to receive the blood from the lungs, and propel it over the rest of the body. It is better suited to the economy of some animals, as the cuttle fish, that these parts should be separated to a considerable distance from each other. The reason why the heart is formed of two parts in most animals is, that it is necessary that the blood should receive the impulse of the heart twice, first to propel it through the lungs, next to propel it over the rest of the body.

The blood is conveyed from the heart to every part of the body, by means of elastic tubes, called *arteries*. These arise from the ventricles of the heart by two large trunks, which branch out in every part of the body, into arteries of great minuteness, conveying the blood from the heart to its most distant parts, so that it is impossible to wound any part of the body with the finest point, without opening one of these vessels. This gives a good idea of their minuteness.

From the minute termination of the arteries, begins a second set of vessels, the *veins*, which, having a contrary course, return the blood from every part of the body into the auricles of the heart.

The larger arteries and veins, near the heart, differ very much from each other in their structure and action. This difference, however, does not descend to their minute ramifications, which must be considered as having the same structure, and performing the same office, the one passing into the other by such imperceptible degrees, that we cannot mark where the one terminates or the other begins.

If we consider these tubes as subservient to the circulation of the blood, we shall see the necessity of certain principles entering into their structure. As the blood is forcibly thrown from the heart, these vessels must be distended; one of their properties therefore, must be a capability of being distended, which is given to them by elastic matter entering into their composition. As the vessels, however, are not to remain in a distended state, a power of reaction is added, which arises also out of their elasticity, and assists in propelling the blood forwards.

Thus the elastic matter allows the vessels to be distended to a certain degree, and also reduces them to a smaller size. But it is necessary that the heart shall be assisted considerably, in the circulation of the blood, by a contractile power of the vessels themselves; and the same quantity of blood is not to circulate in the same body at all times, for animals are liable to frequent injuries, by which the quantities of blood in their bodies may be very suddenly reduced. Hence the vessels have given to them a further power of contraction to assist the heart, and accommodate themselves, under certain circumstances, to a smaller quantity of blood. For this purpose, a muscular structure is added to them, which is present in largest proportion in the smaller arteries; by this means, they are enabled so far to withstand the power of the heart, as to shut their cavities, and prevent the escape of blood when divided, forming one of the means by which the effusion of blood is spontaneously checked in living animals. And it may be remarked, that this power, for the purpose of self-preservation, is extended to larger arteries in the brute creation; for Mr. Hunter found, that the flow of blood from the large artery in the neck of an ass was checked by an exertion of this power, whilst every one knows that its division in man is fatal.

Besides these parts, arteries have an internal lining, which is perfectly smooth, and of considerable density, that the blood may circulate with as little resistance, and be contained as completely as possible within its proper channels.

The same observations will apply to the veins, though some of their properties are less strongly marked. They possess an elastic power capable of distension and reaction, a muscular structure endowed with contractility, and an internal lining over which the blood circulates with as little resistance as possible. By these powers the blood is circulated through every part of the body with great velocity. According to the best calculations, the heart alone exerts a power equal to the pressure of 51½ pounds, which propels the blood through the arteries at the velocity of 149 feet in a minute; in which time it expels from its cavities about 160 ounces.

Thus all animals are provided with an organ for propelling the blood, by certain channels, to the different parts of the body; but, as the functions of these parts are various, they require to be visited by very different proportions of blood, according to their activity or powers of life. Some parts of the body may be said to be inert, and merely possessed of a principle of life, to connect them with the other organs of the body, as parts of a living system, and to enable them to go through certain processes in their healthy and diseased states. Other parts are formed for active functions, and possess great sensibility. It is accordingly observed, that a smaller quantity of blood is distributed to bones, tendons, and similar inert parts, than to muscles and glands, whose exertions are more considerable.

This then is the general apparatus in perfect animals, by which the blood performs its circulation through the various parts of the body, but during its course it is subject to constant exhaustion from various sources. It is converted in its passage into the nature of all the component parts of the body, and has the different secreted fluids derived from it, and these processes go on with more activity in a young, than an adult person: hence we see the necessity of a constant supply of materials to the blood, and this in the greatest proportion at an early period of life.

Animals are furnished with the means of this supply, by their power of converting animal and vegetable substances into the nature of blood, by a process called *digestion*. Some animals are led by their nature to live on vegetable food, others on animal food only, whilst others can subsist on either, or any mixture of both.* The digestive powers of man fit him for any proportion of animal or vegetable foods, and are the most perfect of all animals. Other creatures may be said to be confined to a certain district, but the curiosity of man is to lead him over the whole world, and frequently place him in situations where only one kind of food is attainable.

The first change which takes place in the food, in order that it shall be converted into the nature of the blood, is its division into smaller parts, by the teeth or gizzards of animals. It is then passed into the stomach, where it remains for some time exposed to the action of a fluid, formed in the stomach, which is called gastric juice. This possesses a very strong power of coagulating and dissolving various animal and vegetable substances. As far as we know, it acts on the principle of any other solvent, for it produces the same change in substances out of the body, or even within the body after death. It frequently happens, for instance, when a person has been killed, by accident, in full health, that, on inspection, the stomach is found dissolved, and reduced to a gelatinous mass in several parts, arising from the action of the gastric juice, which had been formed in it before death. The gastric juice, however, cannot act upon living substances: hence the stomach resists its action, and worms sometimes reside and are even generated in the stomach. Every substance capable of being acted upon in the stomach, is reduced, by the solvent power of the gastric juice, into a pulpy mass, which has been called chyme, the exact chemical properties of which have not been ascertained; in this state it is by degrees transferred into the beginning of the small intestines, where it is mixed with the bile and pancreatic fluid, and undergoes

* Mr. Hunter, however, found that this natural inclination might be changed by education, for he taught an Eagle, which is a carnivorous animal, to subsist on farinaceous food alone. The plan he adopted was this: he began by abstracting the flesh meat, and substituting bread and butter, till at length the meat was entirely taken away; he then by degrees diminished the quantity of butter, till at length the animal fed on bread alone. It appears, however, from experiment, that this transition cannot be made suddenly, as the gastric juice of the animal is not adapted to act upon an opposite kind of food. It has been found that a quantity of pear or apple introduced into the stomach of a Buzzard Hawk was not digested, but remained unacted upon when the fowl was killed for inspection many hours afterwards; yet the stomach of this animal habitually digested bone.

a change into a milky fluid, which is called chyle. It is then diffused by an undulating motion of the intestines over their inner surface, that it may be absorbed, and carried into the general mass of blood.

As far as has yet been ascertained by experiment, the chyle of animals, most opposite to each other in their food, structure, and habits of life, is so much alike as to have no distinguishable difference. The chyle of a Dog, or Wolf, differs in nothing from that of a Sheep or an Ox. This would appear surprising, were it not ascertained that almost every alimentary matter undergoes a chemical change before it is converted into chyle, and that the ultimate analysis of either animal or vegetable matter presents us with the same elements as those of the blood, which, though only three or four in number, are capable of forming the various substances of which the body is composed, by combining with each other, and in different proportions. There is, however, this difference observable in the chyle, that in reptiles and insects it is transparent like lymph.

The lacteals are the vessels by which the chyle is absorbed from the intestines: they form small processes on the internal surface of the intestines like the pile of velvet, which are hence called villi. A small portion of chyle being received into their open mouths, is propelled by successive contractions of these vessels into their large trunk, the *thoracic duct*, from whence it is poured into a great vein near the heart, and, by circulating through the lungs, probably receives its final change into blood; and this change would seem to be easily effected, as the chyle already possesses the principal properties of blood, being formed of particles swimming in a thinner fluid, and having a power of coagulating spontaneously.*

This is the apparatus by which the food is digested in man so as to replenish the blood: but the digestive organs of different animals exhibit considerable varieties, some being more simple, others more complex in their structure, adapted to the kind of food with which the animal is nourished. Ruminating animals, or animals which chew the cud, such as the Cow, have several stomachs, and the food undergoes mastication several times, at each time being passed into a different stomach, before being finally acted upon by the gastric juice, after which it is transmitted through a long tract of intestines. This is an example of the most complex

* Dr. A. Hunter says, "When we consider the delicacy of the internal structure of the stomach, and the high and essential consequence of its office, we may truly say, it is treated with too little tenderness and respect on our parts. The stomach is the chief organ of the human system, upon the state of which all the powers and feelings of the individual depend.

"The stomach is the kitchen that prepares our discordant food, and which, after due maceration, it delivers over by a certain undulatory motion, to the intestines, where it receives a further concoction. Being now reduced into a white balmy fluid, it is sucked up by a set of small vessels, called lacteals, and carried to the thoracic duct. This duct runs up the back-bone, and is in length about sixteen inches, but in diameter it hardly exceeds a crow quill. Through this small tube, the greatest part of what is taken in at the mouth passes, and when it has arrived at its greatest height, it is discharged into the left subclavian vein; when mixing with the general mass of blood, it becomes, very soon, blood itself."

digestive organ fitted to act upon hard and fibrous food, which must be subjected to the action of several menstrua preparatory to its being acted upon by the gastric juice.

In birds who live on grain as has been noticed, we meet with a different apparatus to prepare it to be acted upon by the gastric juice. The food first passes into the crop, which forms a kind of reservoir from whence it may pass by degrees into the gizzard, by which the grain is ground into small particles, before it is transmitted into the stomach: and it is surprising with how great power the gizzard acts for this purpose. The Abbé Spallanzani introduced a garnet, which is a very hard and angular stone, into the gizzard of a Wood-Pigeon, and, in the course of a day, it was ground perfectly smooth, by the action of the gizzard. He also introduced a leaden ball stuck full of tin points, and another with fine lancets, into the gizzard of a Turkey, and in about 18 hours, the whole of the points were rubbed down. The gizzard also possesses an amazing power of compression. Raumeur introduced into the gizzard of a Turkey tubes of tinned iron, seven lines in length, and two in diameter, closed with solder at each end; some were indented by the action of the gizzard, and others crushed flat. Similar tubes, introduced into the teeth of a vice, required the weight of about 440 lb. to produce the same effect. The gizzard thus reduces into small particles whatever food the animal selects, that it may be more readily acted upon by the gastric juice in the stomach; for the gastric juice acts like any other solvent, and therefore acts most advantageously when the food is reduced into small parts.—The digestive organs of some of the lower orders of animals form a striking contrast to these. In the most simple apparatus with which we are acquainted, the stomach and the intestines are composed of a simple bag which has but one opening, which serves both to receive the food, and discharge the excrement. It composes in fact the whole bulk of a fresh-water Polypus. In these animals the chyle is absorbed by small vessels in the sides of the bag, and is conveyed to every part of the body.

Thus we find that the supply of materials to the blood is commensurate to its exhaustion, that in young animals where a more active process of formation is going on, a larger proportion of food is requisite, and more chyle formed; this, however, is not all that is necessary to prepare the blood for its important purposes within the body. The blood, by passing through the various parts of the body, is so changed by the abstraction of certain properties, as to render it unfit for circulation, which implies the necessity of an organ, which may restore to the blood its requisite qualities. This office is performed by *respiration*, that function in animals by which the blood receives the influence of atmospherical air.

There is a great variety in the structure of the organ for exposing the blood to the air, suited to the mode of life in different animals.

In man and quadrupeds generally the lungs serve this purpose; they are composed of a number of blood vessels spread out upon minute air cells, which communicate with and receive the air by means of the trachea or windpipe, in consequence of the expansion of the chest by certain muscular powers. These vessels and cells are connected together by cellular membrane, so as to form a spongy mass called lungs, which are commonly placed in the chests of animals.—But besides this kind of organ, which in birds is very large, they have air bags, or appendages to the lungs, diffused through various parts of the body; even some of their long bones contain nothing but air, and communicate with the lungs. It was from a knowledge of this fact that Mr. J. Hunter made a Turkey breathe by its wings, by making an opening into their large bones, and closing the animal's mouth.

In Fish, the gills serve the purpose of lungs. They are composed of a number of processes arising from cartilages, having distributed upon them minute blood-vessels, which receive the influence of air contained in water: and hence distilled water, which contains little air, destroys fish, in the same manner as the exhausted receiver of an air pump does a breathing animal.

There is another mode of conveying air for the use of the blood in many insects, by means of a number of tubes or spiracula: these receive the external air, and, by ramifying in the body of the animal, convey its influence to the blood. Thus these animals may be said to respire like vegetables, throughout the whole of their surface, by vessels which introduce the air at different points into their bodies. In some insects the rectum forms the principal organ of respiration, and, in the class of animals called Zoophites, there are no visible organs of respiration.

These different modifications, in the respiratory organs of the higher and lower orders of animals, are all formed with the same intention, viz. that the blood may be exposed more or less to atmospherical air. In consequence of this the blood undergoes a process similar to combustion, which extracts from it a part of its carbon, in the form of carbonic acid, and by this means increases the relative proportion of its remaining elements. The inspired air at the same time is deprived of a part of its oxygen, which is the elastic fluid which commonly supports respiration. All the corresponding effects produced upon the blood are not yet fully explained. But by this means the color of the blood is changed from a dark to a florid red, it acquires the power of exciting the action of the heart, and is fitted for its various purposes within the body.* By these organs, respi-

* Dr. O. Gregory observes, "Animal heat is preserved *entirely* by the inspiration of atmospheric air! The lungs which imbibe the oxygen gas from the air, impart it to the blood; and the blood, in its circulation, gives out the caloric to every part of the body. Nothing can afford a more striking proof of creative wisdom, than this provision for the preservation of an equable animal temperature. By the decomposition of atmospheric air, caloric is evolved, and this caloric is taken up by the arterial blood, without its temperature being at all raised by the addition. When it passes to the veins, its capacity for caloric is diminished, as much as it had been before increased in the lungs: the caloric, therefore, which had been absorbed, is again given out; and this slow and constant

ration is performed more or less extensively in the different orders of animals, corresponding in a great degree, to their activity, digestive powers, and the heat maintained in their bodies. Birds, whose extensive respiratory organs consume a larger quantity of air, are capable of greater exertion; make more frequent meals than quadrupeds, and maintain a superior temperature. Quadrupeds hold a middle place between birds and reptiles. Respiration appears in the class of reptiles, as Frogs and Toads, to be a subordinate function only; they can exist without it nearly as long as they please; at the same time they make very long fasts, and the heat of their bodies is more variable and lower than quadrupeds; hence they are called cold blooded animals. Their other habits accord well with their organs of respiration. They generally live in impure air, their motions are languid, and they pass a great part of their existence in a state of torpidity.

A subordinate use of respiration in most animals, is the formation of the voice: for this purpose there are membranes stretched across the narrow part of the windpipe, which are thrown into a state of vibration by the current of air: the vibrations thus produced, being modified by other accessory parts, produce the voice. In many animals, however, it is produced by a very different mechanism. Some animals employ the friction of certain elastic parts of the body, as Grasshoppers and Crickets; others employ the vibration of certain parts in the air, whilst others impress a rapid motion on portions of air inclosed in certain parts of their bodies.

There is a particular part of the heart in man, intended merely to propel the blood, which passes through the lungs to receive the influence of the air; this is the right ventricle; from whence the blood passes, by the pulmonary artery, through the minute vessels expanded on the air cells, and is changed from a dark to a florid color: it is then returned back to the left ventricle, by the pulmonary veins, and is propelled over the rest of the body, where it is again changed (by the abstraction of certain properties) to the dark color peculiar to venous blood: the blood is lastly conveyed by the veins to the right side of the heart from whence it set out, having passed through two circles.

The blood thus prepared by the lungs for circulation, passes in different quantities to different parts of the body, according to their activity, and has various fluids formed from it, which are called secreted fluids, as gastric juice, milk, bile, &c. The parts of the body forming many of these fluids, are very peculiar in their structure, and are called *glands*. They consist in an arrangement of

evolution of the caloric in the extreme vessels over the whole body, is the source of that uniform temperature which we have so much occasion to admire. Dr. Crawford ascertained, that whenever an animal is placed in a medium the temperature of which is considerably high, the usual change of arterial venous blood does not go on: consequently, no evolution of caloric will take place, and the animal heat will not rise much above the natural standard. How pleasing it is to contemplate the arrangements which the Deity has made for the preservation and felicity of his creatures, and to observe that he has provided for every possible exigency!"—Lessons, Astronomical and Philosophical, 4th edit. p. 87.

vessels, endowed with a mode of action, with which we are unacquainted, by which the component parts of the blood are disposed to enter into new combinations, and to form compounds differing from the blood itself. Thus the vessels are arranged on the inside of the stomach, in such a way, as by their action to form gastric juice from the blood; on the same principle, milk is produced from the blood which circulates in the breast, or bile in the liver. As gastric juice, milk, and bile, differ very much from each other in their properties, we must infer, that there is a considerable variety in the action, by which these vessels form these fluids from the blood; and this is necessarily connected with a variety in arrangement, which is the case in all the glands of the body. In one gland, for example, the blood-vessels form a minute net-work; in another, are convoluted at their extremities; in a third, a large branch suddenly divides into a number of small branches, like the hairs of a painter's brush; in a fourth, they are disposed in an arborescent form, each gland differing from every other in the mode of distribution of its blood-vessels, and forming different products from the blood.

The substances formed by many of the glands of the body, are applied to useful purposes, within or without the body. An instance of the former we have in the bile formed by the liver, or the gastric juice formed by the stomach; and of the latter, in the milk.—Other secreted fluids are rejected as excrementitious: the best example of this is the urine formed by the kidneys. This gland separates from the blood a great variety of substances, which might otherwise prove noxious by circulating along with it; many of these have occasionally very curious chemical properties, and under a certain state of the body, the altered secretion of this organ is very remarkable, in as far as it produces a large quantity of a familiar substance, which in this instance is composed within the body. In the disease called diabetes, for example, a patient sometimes makes four or five gallons of urine in the 24 hours, in which is dissolved a considerable quantity of matter, like common sugar or treacle, probably to the amount of two or three pounds.

Besides these fluids formed from the blood, each by an appropriate glandular apparatus, there are watery fluids constantly secreted in various parts of the body; and, that these may not accumulate, or remain after they have performed their office, it is necessary for the body to be furnished with vessels, whose powers of removal may keep pace with the deposition of these fluids. This introduces the system of vessels called *absorbents*, which are distinct in their office and nature from the blood-vessels, and are widely diffused over the whole body. In every part of the body a limpid fluid is thrown out for the purpose of easy motion, moistening the cellular membrane, which connects the various parts of the body to each other, and lubricating the contents of all the cavities of the body; this fluid is thrown out in the form of vapor by the exhalents, which belong to the arterial system, whilst the lymphatic absorbent vessels, by their action, remove what is not convenient for the function of the part; and these two actions, of deposition, by the exhalents, and absorption, by the lymphatics, go on during health, so nicely balanced, that when we open into any of the great cavities of the body, as the belly or chest, the quantity of fluid we find is extremely small. When, however, the balance between these two orders of vessels is destroyed, when the exhalents throw out more fluid than usual, and the lymphatics only absorb their natural quantity; or the exhalents deposit their natural quantity, whilst the lymphatics absorb less than natural, accumulation of water in the cellular membrane, or great cavities of the body, takes place, and produces dropsies.

There is another set of vessels, which have been already mentioned, a part of the same system of absorbents, which from their office of absorbing a white fluid, the chyle, have been denominated lacteals; these arise from the inner surface of the intestines, in great numbers, and convey the chyle into the general mass of blood.—Whilst the minute beginnings of the lacteal vessels, from the internal surface of the intestines, is a matter of ocular demonstration, we have only presumptive proof of the origin of the lymphatics, which make the greatest part of the absorbent system. We have, however, good grounds for concluding, that they arise from every external and internal surface of the body. We find, for example, that certain remedies, as mercurial ointment, or turpentine, rubbed on the skin of any part of the body, produce effects on distant parts; the mercury by removing affections of various parts of the body, the turpentine increasing the flow of urine, and giving it a peculiar odor: these effects are explained by presuming the absorption of these substances, by the lymphatics, arising from the surface of the skin. We have further proof of this from the occasional absorption of watery fluids, under peculiar circumstances. Sailors at sea, in want of fresh water, have quenched their thirst by dipping their clothes in salt water, and applying them to the surface of the body, from which only the elementary part was absorbed by these vessels. A jockey, after reducing himself to a great degree has become in a short time too heavy to ride his match, merely by drinking a glass of wine, which had stimulated the absorbents of the skin to take up a large quantity of aqueous matter from the air. Or a person gibbeted alive, has been observed to make a considerable quantity of urine as long as he lived, without any liquid being taken by the mouth. These are all considered as evidences that the lymphatic absorbent vessels arise from every external surface of the skin, and are capable of taking up substances applied to them.

We find next that water accumulated in the large cavities of the chest or abdomen, or underneath the skin in the cellular membrane, of every part of the body, is occasionally removed from these situations, by remedies which have the power of increasing the action of the absorbent vessels. We hence conclude, that these vessels arise from every internal part, and are, in short, widely diffused over the whole body, though their beginnings are too minute to be detected by any mode of examination with which we are acquainted.

The absorbent vessels, from whatever part they arise, terminate in the blood-vessels, principally by one vessel or trunk, which is called the *thoracic duct*. This commences in the cavity of the abdomen, passes through the chest on the right side of the spine, and, at length, enters a large vein situated on the left side of the neck. Through this vessel, besides the fluids taken up in various parts of the body, the whole of the nourishment from digested aliment passes into the blood; it may therefore be said to be the most important vessel in the body,* and it is situated in one of the safest positions in the body, so that an injury done to it is a very rare occurrence.

Thus the absorbent system is formed of two sets of vessels, having the same structure, the same absorbing office, and the same termination, but differing in the fluids they convey, and the parts of the body they occupy. The one widely diffused over the whole body, and from their office of usually absorbing limpid fluids, called lymphatics; the other arising only from the intestines, and denominated lacteals, from the milky whiteness of the chyle they absorb.

Thus far the absorbent vessels have been described, as employed in taking up fluids only. The action of the absorbent system, however, is not considered as confined to the fluid parts of the body; there are a variety of instances, in which the most solid parts appear to be removed by the absorbents. Thus when a tooth is extracted, or drops out in old age, its bony socket is removed by the action of the absorbents. The pressure of a pulsating tumor, called aneurism, against the ribs, or thigh bone, has produced their removal in the same way. These are considered as instances of solid matter being removed by the absorbent vessels, from internal parts of the body, without any external opening. It is, however, a matter of doubt, which we cannot at present discuss, whether a bone is broken down by the absorbents themselves, so as to be removed in small particles; or whether, as is more probable, its presence or irritation (as an extraneous body) produces the secretion of a fluid, similar in its properties to the gastric juice, by

* A London Alderman, who had accidentally heard of the thoracic duct, was so struck with the importance and delicacy of the vessel, that he became very apprehensive lest it should be in the least obstructed; and, being one day caught in a crowd, from whence he could not extricate himself, he most earnestly entreated those who pressed on him, to take care of his thoracic duct.

which it is first reduced into minute particles, or entirely dissolved, so as thus to enter the absorbent vessels.

Another important part of the office of these vessels, is to model the shape of the body, and to concur with the action of the blood-vessels in regulating its growth. For the human body does not, like a marble statue, constantly contain the same identical particles in its composition. As the stream of a river is formed of a constant succession of aqueous particles, sometimes increasing, sometimes diminishing its natural bulk; so the human body is constantly undergoing an imperceptible change of parts. The absorbents, by their action, remove exhausted particles, whilst the arteries form from the blood an adequate supply of new parts. When these two powers are equal, the body continues of the same bulk; when from disease or contingent circumstances, the one or the other predominates, the body increases in growth, becomes corpulent, or emaciated.

Thus we have seen a variety of organs necessary to carry on the functions of perfect animals: these, however, are inert, and incapable of motion in themselves. Hence a *nervous system* becomes requisite, which may excite and influence the whole. We find in man, and quadrupeds generally, the nervous system placed principally in the brain and spinal marrow; from these sources, the nerves are distributed like white cords, and pass in various proportions to the different parts of the body, conveying the excitements of the brain.

One of the most important excitements conveyed from the brain, through the medium of the nerves, is volition; by this means the muscles become obedient to the will, and perform the voluntary actions of animals. If, for instance, I wish to take up a pen, I exert my volition towards the action, and the consequence of this is, that the muscles employed in the action, are stimulated to contract, from a peculiar excitement being conveyed to them from the brain, through the medium of the nerves. We are totally ignorant, however, of the state of the brain, whilst giving out the excitement, or the change which takes place in the nerves whilst conveying it. We know, however, that the brain may be rendered incapable of giving rise to the excitement, and it may be arrested in its progress down the nerves by artificial means. If a ligature be applied upon a nerve by tying a piece of thread round it, the nerve is rendered incapable of transmitting the excitement, so as to produce motion in muscles. The same state is frequently produced in the brain and nerves, by the disease called palsy, or by fractures of the scull. There are also various excitements passing from the brain to the vital organs of the body, whose actions are not regulated by the will, and are therefore called involuntary, or automatic actions, as circulation, parturition, &c. Thus if a person have ever so strong a desire, he cannot make his heart beat more frequently; nor can he prevent it from beating more frequently, if any one should put him in bodily fear; although the heart is formed of muscular flesh, similar to the muscles, which he can command in his arm. The reason of this is, that the nerves of the heart cannot convey the influence of volition; for the wisest reasons the heart acts without it.

It is also necessary for various influences to be communicated from external objects to the brain, to keep up a correspondence between animals, and the material world around them, and to communicate those impressions from which the brain is afterwards to carry on its functions. As the parts formed for this purpose differ from ordinary parts of the body, in having a larger share of nervous influence given to them, they have been called the *organs of sense*, which in an anatomical point of view, may be said to be five in number, the eye, the ear, the tongue, the nose, and the skin.

In the *eye*, we discover a most accurate optical instrument, adapted to converge the rays of light at its posterior part. It is composed of a spherical box, containing transparent media of different densities, by which the rays of light are conveyed to a point, so as to impress a minute image of the visible appearance of external objects upon the retina or expansion of the optic nerve, by which the impression is conveyed to the brain, so as to bring us acquainted with external objects.

The *ear* is formed to receive impressions from bodies in a state of vibration, which are conveyed to the brain by an apparatus composed of various substances, and eminently calculated to transmit the slightest tremors. The vibrations of the air, for instance, first strike the drum of the ear; are thence communicated to a delicate chain composed of four minute bones. By these the vibration is increased, and transmitted to a fluid, contained in several small winding canals, in which the delicate filaments of the nerves of hearing are arranged, so as to transmit the impressions they receive from the surrounding fluids, and produce in the brain the perception of sound; these two senses, by the infinitely varied modification of their impressions, convey a prodigious supply of materials for the action of the mind.

The organ of *touch* is next in point of importance; it has its seat in the extremities of the nerves distributed over the skin, and is the only sense which belongs to every class of animals. This organ gives rise to sensations, which have no natural alliance with each other. By this sense we compare different degrees of temperature with each other; from this we derive our idea of distance between bodies; of their tangible figure, of their roughness, smoothness, hardness, and other qualities, from the relative position with respect to ourselves, or the degree or kind of resistance they offer.

And, when man has been deprived of his communication with many external objects, by the loss of vision, we find the organ of touch gradually encroaching upon the function of the eye, and from attention to its finer impressions, becoming, through the education of necessity, a much more extensive source of information. As an instance of this, I may adduce Mr. Gough, who can accurately distinguish the color and character of flowers, by the nice sense of touch possessed by the tip of the tongue.

The other senses may be said to be of less importance. The *nose* affords a passage for the air to the lungs, and is impressed by the odorous particles of bodies diffused through it, and, whilst it thus occasionally administers to our gratification, it gives us notice of the presence of those aeriform fluids which are noxious to respiration. Like the organ of *taste*, which is impressed by sapid bodies, it has a peculiar sympathy with the stomach; thus the taste, or smell, of any disagreeable substance, very commonly excites sickness and vomiting.

Thus each of the organs of sense are formed in a peculiar manner, and are supplied with nerves of a peculiar structure, which are capable of being excited by certain impressions only, so as to give rise to sensation. The odorous particles of bodies, for instance, if applied to the nerves of the nose, excite an impression, which, when conveyed to the brain, gives rise to the perception of smell; but, every one knows that they produce no such effect when applied to the nerves of the skin. In the same way, the rays of light applied to the nerves of the eye produce vision; but, no such effect takes place when they impinge upon the tongue.—Each of the organs of sense then possess a peculiar modification of nerves, which are excited by appropriate impressions.

By these organs we become acquainted with what passes around us; but the nervous system gives us notice of many changes which take place within our bodies. Internal pains point out to us the presence and situation of diseases; and the disagreeable sensations of hunger, thirst, and fatigue, incline us to give refreshment and repose to the body. It is also by means of the nervous system, that we experience the passions and emotions of the mind.

There are some animals so simple in their structure, that neither brain, nor organs of sense have been detected; yet they are endowed with motion, and are capable of selecting and swallowing their food, and expelling their excrement; and as these acts appear to be voluntary, we must conclude, that they possess nervous matter, though it be so interwoven with the rest of their structure that we cannot exhibit or detect it.

All these different structures which have been described as entering into the formation of a perfect animal, are soft and flexible in themselves, and, in order to the right performance of their functions, require the support of a substance of considerable firmness, which may preserve them in their relative situations, and give a general shape to the body. For this purpose, *bones* are formed in the higher orders of animals. They consist of a certain portion of animal matter, on which their powers of life depend, mixed with a portion of earthy matter, which gives them a degree of solidity. The firmest substance in the body, composed entirely of animal matter, is cartilage, which possesses, however, too little solidity for the support of animals of considerable size, living in so rare a medium as air. Hence it happens that when the earthy part is, by disease, abstracted from the bones, they become bent and deformed by the weight of the body, or the action of its moving powers. In fishes, however, who inhabit a denser medium, cartilage becomes a convenient structure, being sufficiently firm for their support, and, from its lightness, better suited to their condition.

Had the osseous system been merely intended to give shape to animals, and preserve the relative position of their parts, it might, for any useful purpose, have been as well formed of one piece; and accordingly, when almost all the bones of the body have been anchylosed, or immoveably united to each other by disease, the functions of life have gone on uniformly to an advanced age. There is a remarkable skeleton of this kind preserved at Trinity College, Dublin; where all the large bones of the body are immoveably united together, except the lower jaw, and the joints of the fingers; every joint in the body was immoveable, and yet this person lived to an old age. In order, however, that animals may enjoy a power of changing their situation, the osseous system has been composed of a variety of pieces, and an apparatus added by which this may be easily effected. This is accomplished by adapting the ends of bones to each other so as to form joints, which vary in different parts of the body according to the motion of the part, some being formed for strength, others for extent and variety of motion; the two being incompatible, and never found in the same joint.

In the formation of a joint, however, it appears that two surfaces of bone would move with considerable attrition upon each other, not being capable of a sufficient degree of smoothness; it is therefore necessary, in order to diminish attrition, that a substance be interposed having a high degree of polish; this is supplied by cartilage, with which the ends of all bones, performing motion, are covered; and as animals, both from the common occurrences of life, and from accident, are liable to considerable shocks, in order to guard the system, as much as possible, against injury from these sources, cartilages are endowed with a considerable degree of elasticity, and thus by their reaction are capable of evading certain degrees of violence.

The smoothness of cartilage, however, only prevents attrition to a certain degree; that joints therefore may move with all possible ease and freedom, a fluid is interposed called *sinovia*. This is separated from the blood, by the vessels distributed to the inner surface of the joint, and is the most slippery of all fluids.

In order that bones may not be separated from each other, but preserve their relative situations, with a certain capacity of motion, it is requisite that they should be joined together; this is done by the ligaments surrounding a joint, which are of two kinds. The one adapted to the firm junction of the bones with each other, upon which the strength of the joint depends; the other loosely attached round the ends of contiguous bones, to secrete sinovia, and retain it in its proper situation; and hence called capsular or purse-like ligament.

This kind of structure, endowed with a power of secreting sinovia, is not confined to the joints alone; for in many parts of the body, where muscles during their action rub on bones, or tendon on tendon, small bags are formed for supplying sinovia, which are called bursæ mucosæ.

As all these parts subservient to motion are inert in themselves, that animals may enjoy the means of changing their situations and attitudes, a power must be applied to the bones for this purpose, which is supplied by muscular action. Thus we find the bones clothed with *muscles*, which give, in a great measure, the external shape to the body, and act in considerable numbers on the joints, particularly those which possess much motion.

All animals have a muscular structure entering into their composition, with some variety in its appearance. Muscles are generally fibrous to the eye, and in Man and Quadrupeds are of a red color; in some animals, however, these circumstances are not at all obvious. Thus in many fishes, the muscles are white, and put on a flaky appearance; whilst in the fresh water Polypus, which possesses a great degree of contractile power, no fibres can be seen. So that it is not necessary that these properties should be obvious in the muscles of all animals. Thus no person has ever seen the fibres in the muscles of a Flea, yet no animal can exert greater muscular power. In the same way, many parts of the body possess a contractile power, which have no apparent fibrous structure; the best example of this, is the skin of the scrotum. The redness of a muscle, in fact, depends in a great measure on the degree of exertion it undergoes; thus when a limb becomes motionless from palsy, the muscles uniformly become pale.—The function of a muscle consists in its contracting or shortening itself, in consequence of the application of certain stimuli or excitements; the effect of this contraction is, that the different bones to which the muscles are attached are moved in various directions. Thus (to give an example) a muscle affixed to two contiguous bones, by shortening itself, brings those points to which it is affixed nearer to each other; and, from this mechanism, arise all the motions of the body. The greatest part of the muscles which put the limbs in motion by their contractions, are said to act under the excitement of volition, or, in other words, are under the control and influence of the will, and are therefore called voluntary muscles. There are many muscles, however, which are not excited by volition, and are therefore called involuntary. As these are directed by influences, and perform the actions on which life immediately depends, they, for obvious reasons, are not only put beyond the powers of the will, but are enabled to carry on their contractions and motions without interruption or fatigue, entirely independent of its direction or our consciousness. In this manner the heart performs the circulation of the blood, and the stomach and intestines give the requisite motion to the food.—There are many other excitements which produce contraction in muscles, such as the passions and emotions of the mind, and various mechanical and chemical stimuli. Some of them occasionally excite the voluntary muscles of the body to a degree of action, over which volition has no control. Thus a person in an ordinary state of mind, can walk more or less quietly as suits his convenience; but it occasionally happens, we shall say in the field of battle, that the passion of fear is excited; this excitement frequently disregards the power of the will, and strongly excites the muscles employed in running away.*

In most animals, there is connected with the muscles another kind of structure called *tendon*, which consists in a white substance very different from muscles, but having a fibrous structure. Although tendons are not necessary to the action of muscles, yet there are several advantages derived from them; they occupy much less room than muscles, and can be placed in greater numbers around the joints, so as to preserve the beauty and uniformity of the limbs. They may be considered as living cords, joining the muscle to the bone on which it is to act, and, being more scantily supplied with blood than muscles, make a smaller quantity of blood necessary to the system, which is certainly a convenience. Although the different parts of the body vary very much in their functions and degree of motion; yet, it is convenient, that they should be all united together by a substance of considerable elasticity. This is done by the interposition of *cellular membrane*, which is the general connecting medium throughout the body, attaching each organ to its neighbor, but allowing sufficient play for the performance of its function.

It is in the cellular membrane of different parts of the body that fat is deposited; and from the seeming caprice of nature, in overloading some animals, and entirely denying it to others, its use has been thought inconsiderable in the system. When, however, we remark, that fat is taken up in some diseases where the appetite is impaired; and that torpid animals, before hibernation, have a large quantity of it accumulated, and come out of that state quite ema-

* This is a good example of muscles, which, under ordinary circumstances, are directed by the will, becoming involuntary from an altered excitement.

ciated: and that bees, who have no fat in their bodies, lay up a stock of food, having the same chemical properties, against their hibernating season; it appears very probable, that one use of fat is to form a reservoir of nutriment, which supplies the wants of an animal when food is not introduced by the stomach.

If we add the *skin* to the cellular membrane, we may say, without these the beauty and symmetry of the exterior would have been much diminished. We should have seen the raw muscles in all their actions, and the naked nerves exposed to the air and to injury. There would have existed deep fissures between the muscles, cavities in almost every part, and the body would have presented the sad appearance it now does in consumption.* But the cellular substance in some places only separates one part from another, or affords a slippery surface for one muscle to slide over the other: in others forming membranes or fascia to hide, to bind down and strengthen different organs; while in others admitting into its cells an oily substance, becomes fat, and fills up all the interstices, rounds off all prominences, softens acute lines, and gives a graceful softness and contour to the whole. And the skin enveloping in a close case, keeps all compact, and hides from the eye whatever might be offensive: while, at the same time the cutis or true skin serves for a surface for the nerves and exhalent vessels to terminate, the cuticle or scarf skin defends them from injury, and moderates their excessive sensibility.

As all animals are to live in media where the heat varies, it was necessary either to form them in such a way, that their functions should not be affected by varieties in temperature, or that they should be enabled to keep up the heat of their bodies at a regular point. Animals have been endowed with the latter power, and can accordingly maintain their heat, whether exposed to a high or low degree of temperature, with some exception as to the degree in the lower orders of animals, in some of which the temperature varies with that of the medium in which they are placed. This is the case with the Frog.—This animal, when placed in warm water, has the temperature of its body raised several degrees, and, on the other hand, may be reduced to the freezing point, without producing death. The heat of the human body, however, is little changed, whether it be exposed to intense cold, or much above the heat of boiling water. In the experiments made in heated rooms by Dr. Fordyce, and Sir Charles Blagden, these gentlemen remained several minutes in the heat of 260 degrees, nearly 50 degrees more than boiling water. At this heat a beefsteak and

Dr. A. Hunter remarks, "Were it possible for us to view through the skin and integuments, the mechanism of our bodies, after the manner of a watch-maker when he examines a watch, we should be struck with an awful astonishment! Were we to see the stomach and intestines busily employed in the concoction of our food by a certain undulatory motion; the heart working, day and night, like a forcing pump; the lungs blowing alternate blasts; the humors filtrating through innumerable strainers; together with an incomprehensible assemblage of tubes, valves, and currents, all actively and unceasingly employed in support of our existence, we could hardly be induced to stir from our places!"

eggs were cooked near the stove, and yet the heated air produced no bad effect upon their bodies: it raised the temperature of their bodies only a few degrees.—The lungs are the chief agents by which heat is introduced into animal bodies. By their means, the blood is exposed to the air, and consumes its oxygenous part, which contains the principle of heat in a combined state. This, during circulation, is evolved by the minute blood vessels, so as to become sensible on every part of the body: and it is an important fact, that the quantity of oxygen consumed is greater in cold than warm weather; by this wise provision, in proportion as the heat is more quickly carried off by the coldness of the surrounding medium, the animal receives an increased internal supply. Many experiments have been instituted to ascertain the quantity of oxygen consumed in a given time by ordinary respiration, and, according to the best calculations, it appears that the consumption amounts to about 33½ ounces troy weight, in 24 hours; and it has been computed by philosophers, that the quantity of heat, which the oxygen consumes and will supply to the body, is nearly equal to that given out by a common candle.* I have thus attempted to give a short view of the different structures and functions of the body, and have briefly pointed out some of their varieties in the different classes of animals.

This corporeal system, which by its uniform and harmonious action contributes so essentially and largely to our terrestrial enjoyment, exhibits an astonishing display of the infinite wisdom, almighty power, and boundless goodness of its glorious Creator. Galen, an ancient Pagan physician, on contemplating the different parts of the human body, and the disposition of them, fell on his knees in humble adoration of the wisdom with which the whole is contrived; and was excited to challenge any one, after a hundred years' study, to tell how the least fiber or particle could have been more commodiously placed, either for use or beauty. His seventeen books on the subject are like so many hymns of praise

* Mr. Cruikshank, late Professor of Chemistry at Woolwich, judiciously observes, says Dr. Olinthus Gregory, that the size of the body, the quantity of food taken in, the vigor with which the system is acting, the passions of the mind, and external heat or cold, are circumstances which will ever occasion considerable variety in the quantity of the insensible perspiration. This gentleman, assuming that the surface of the hand is to that of the rest of the body as one to sixty (an assumption which Mr. Abernethy thinks much too small for the body,) and that every part of that surface perspired equally with his hand, concluded that he lost during an hour, by insensible perspiration from the skin, 3 ounces, 6 drams; and in 24 hours, at that rate, would have lost 7 pounds, 6 ounces. Also, that he lost 124 grains of vapor by respiration, in an hour; or 6 ounces, 1 dram, and 36 grains, in 24 hours; which, added to the former cutaneous exhalation, would make the whole insensible perspiration, in 24 hours, equal to 8 pounds, 1 dram, and 36 grains: the evaporation from the lungs will be little more than one-fifteenth of the whole.

Mr. Cruikshank has not the smallest doubt, but that *electric fluid* is also perspired from the pores of the skin: it appearing to him impossible that an enraged Lion, or Cat, should erect the hairs of the tail on any other principle: indeed he strongly suspects that, as electric fire is now known to be the prime conductor of the variation in the atmosphere, so it is also the grand conductor of insensible perspiration. He likewise states it as a matter beyond doubt, that, independent of aqueous vapor (of fixed air and phlogiston,) emitted from the skin in insensible perspiration, there is an odorous effluvia, which, though generally insensible to ourselves and the by standers, is perceptible to other animals.—Hence it happens, that a Dog follows the footsteps of his master by the smell; and, in like manner, with regard to other animals: the Fox-Hound knows *afar* the smell of the Fox; the Pointer that of the Partridge, the Snipe, or the Pheasant; and every carnivorous animal that of its prey.—Haüy's Natural Philosophy, vol. i, p. 27.

to the almighty and all-wise God, the Creator. Lactantius calls his writings on the body of man, a marvellous comment on his creation, and Galen himself managed the subject as a full demonstration of a Deity which every man carries about with him.

But what is still more deserving of our attention is the *soul* of man: for if the external structure be so admirable a piece of mechanism, what shall we say of the immaterial and intellectual spirit resident in it? This noble, constituent, essential part of man, is yet a more astonishing production of infinite skill and power. Elihu says, "The Spirit of God hath made me, and the breath of the Almighty hath given me life. There is a spirit in man, and the inspiration of the Almighty giveth them understanding." God, by his creating energy, called all things out of nothing, but there was neither order, light, nor motion, till the Divine Spirit moved on the lifeless chaos; so the same all-wise and powerful Architect formed of clay the wonderful fabric of man's body, which remained without life and action, till the Holy Spirit infused a vital spirit into him, thereby enduing him with sense, motion, understanding, will, and active powers. This soul, therefore, became a living principle of intelligence, consciousness, and activity, in man.

The great Creator said, "Let us make man in *our image*, after *our likeness*." Now, as the Divine Being is infinite, he is neither limited by parts, nor definable by passions: therefore he can have no *corporeal image* after which he formed the body of man. The *image* and *likeness* in which he was created must necessarily be intellectual: his soul must have been formed after the nature and perfections of God. The Creator was now producing a spirit, formed after himself. He is the fountain whence it issued; hence the stream must resemble the spring which produced it.

The most perfect description of God, given to us in the Scripture, is that by our Saviour:—"God is a Spirit." It has been observed by expositors, that this assertion is no where else to be found in the sacred Writings. That passage, "Now the Lord is that Spirit," sounds something like it, but in meaning is different. The word *God* here is not to be understood personally, either for the Father, or the Son, or the Holy Ghost, alone, but essentially for the Divine Nature, which each of these glorious Persons possesses. The Divine Nature is *spirit*. This shows, that, according to the popular and common use of the word, he is a Being entirely separated from matter or body, in all its properties and affections; that he is a pure mind, and possessed of the most excellent powers and perfections, which belong to spiritual beings.

It is difficult, for persons of a low understanding, who are unaccustomed to abstract reflections, and who have imbibed their knowledge by means of the external senses, employed on material objects, to raise their minds to the contemplation of the existence of immaterial, invisible beings. But that there really are such, and particularly that God is such, admits of the clearest proof, and will not be called in question by any who on rational grounds acknowledge his existence. It is usually granted, that it is much more easy to say what a spirit is not, than to define what it is. It is not in the power of the wisest and most knowing of men, to declare its nature. Nay, who can explain what the consistence of any piece of matter is, which we every day see and touch!

But as, notwithstanding our ignorance of the essence of material objects, we are not only sure of their existence, but also know many of their properties; so in like manner, though we are ignorant of the nature of spirits, yet from their manifest operations and effects, we are both convinced that such beings exist, and have some notion of several of their faculties and powers.

The powers and capacities that we observe in all the operations and works of God, are utterly inconsistent with the properties we discern in matter. In the works of creation we perceive evident proofs of thought, intention, contrivance, and design; which powers, we are sure, having no affinity with solidity, figure, and a capacity of being moved by the impulse of another, cannot arise from the composition or mixture of any of the known properties of matter. Not only the existence, but many of the perfections of God, may be discerned in various parts of the universe.

In short, we can say nothing higher of God, than that he is a Spirit. This notion leads us to conceive of him as a most perfect Being, and to reject concerning him whatever would argue any imperfection. It leads us to believe him to be perfectly immaterial, free from all the imperfections of matter, and from all the infirmities of corporeal creatures. But though *spirit* signifies a being of higher rank than body or matter, yet the word is too low to express the essence of God, any otherwise than analogically, or metaphorically. He is infinitely more excellent than the highest created spirits, being eternal, and immutable. But some may inquire, if God be such a Spirit, how is it that in Scripture we read of his having bodily members, and natural affections, like men; such as head, eyes, ears, mouth, hands, and feet; and the affections, or passions, of anger, grief, love, joy, &c? these are ascribed to him, or rather assumed by him. I answer; this is done in condescension to our narrow capacities; for if God should speak to us of himself, as he is in himself, our understandings could not comprehend him. As the inconceivable glories of the world to come, are explained to us by the honors and pleasures of this life; so the nature of God, by a gracious condescension to our weakness, is signified to us by a likeness to our own. By human members being ascribed to God, are implied the moral excellencies of his spiritual nature, or rather his operations, which are more sensible to us than his invisible nature. His eyes are emblems of his knowledge, wisdom, omniscience, and providence. His face indicates his favor, and sometimes is expressive of his displeasure, because both these appear in the countenance of a man. His mouth is the symbol of the revelation of his will. His hand, or arm, is indicative of the less or greater exercises of his power.—Such a *Spirit* is the Creator of man, whom he made in his *image* or *likeness.*

Whoever reflects with attention on the human soul, may easily perceive it to be of a nature entirely different from the body. Being immaterial, it is not compounded of material principles, nor consists of innumerable parts which may be separated from each other; neither is it capable of solidity, figure, extension, and other properties of matter; but is a simple, uncompounded substance, though possessed of various and distinct powers; and therefore is neither visible nor divisible, nor has it any dimensions or shape.

The soul has a power of *thought*, with which mere matter can never be endued. If it pass through all the changes, and assume all the shapes of which it is capable, thought will never be the result. It may be differently modified, framed, and disposed, but cannot think. "I find in me something that *thinks*," says a celebrated author, "which neither earth, water, air, fire, nor any mixture of them, can possibly do. Something which sees, hears, smells, tastes, and feels, all which are so many modes of thinking." Thought is the privilege of immaterial beings.*

This inward principle is capable not only of thinking, but of love, desire, hope, joy; hatred, fear, sorrow, anger, and a whole train of inward emotions, which are commonly called *passions* or *affections.* A something apprehended to be good in itself, or calculated to be beneficial to us, is the object of love. If that good be absent, it excites desire: if there be a probability of obtaining it, that produces hope; and the possession of the desired object yields delight and joy. Evil, whether real, or imaginary only, is the object of dislike and aversion. If there be any probability of this evil coming in contact with us, it causes fear; and if it unavoidably come upon us, it produces sorrow or anger. These passions or affections seem to be the only spring of action in the soul.

The soul has received from God a principle of motion, whereby it governs at pleasure every part of the body, and directs its operations: only with this exception, that all the vital motions, which are absolutely necessary for the continuance of animal life, are involuntarily going on, whether we advert to them or not; which is a marvellous instance of the wisdom and goodness of God. With the exception of these, I direct the motion of my whole body.

* Dr. Priestley has positively asserted, that the doctrine of the soul has no foundation in reason or the Scriptures. But Dr. Jortin, in his sermon on John xi, 25, vol. vi, and Dean Sherlock, in his discourse on the immortality of the soul, completely refute the Doctor's arguments. In the fourth volume of the Memoirs of the Literary and Philosophical Society of Manchester, there is a very valuable paper, by Dr. Ferriar, proving, by evidence apparently complete, that every part of the brain has been injured without affecting the act of thought; the reasoning of which memoir, being built on matters of fact and experience, appears to have shaken the modern theory of the materialists from its very foundation.

By a single act of my will, I put my head, eyes, hands, or any part into motion: although the manner of doing this I do not comprehend. Every one feels that he has an inherent power to move this or that part of his body or not, and to give it a direction this way or the contrary, just as he pleases. I can, as I choose, open or shut my eyes, speak or be silent, rise up or sit down, stretch out my hand or draw it in, and use any of my limbs according to my pleasure, as well as my whole body. Matter may be moved, but it can never move itself.

The soul is free in its operations; it possesses this property, which is capable of being exerted with regard to all its faculties, as well as all the motions of the body. It is a power of self-determination, which, though not affecting all our thoughts and imaginations, yet extends to our words and actions in general, with but few exceptions. I am certain, that I am free to speak or not to speak, to act or not to act, to do this or to do the contrary, as I am of my own existence. I have not only what is termed a *liberty of contradiction*, but what is termed a *liberty of contrariety*, a power to act one way, or the contrary: to deny this would be to contradict the uniform experience of all human kind. The soul is not necessitated to judge or act by any bodily impulse. Let things appear as they may to the senses, the soul can suspend its judgment, till it has examined and considered them more thoroughly. Let the appetites and inclinations of the body strongly urge their own gratification, the soul can refuse their solicitations, and maturely weigh what the consequences would be. Let all the allurements of sensible objects, the assurance of sensual enjoyments, or the influence of custom and example, try to corrupt the integrity of the soul, and lead it astray from the paths of peace and purity; unless it consent, the attempts will prove ineffectual. We can reason, discourse, study, contrive, choose, and refuse with discretion; begin a work, and cease again at pleasure. We can reflect on what we have done, and either rejoice and delight in it, or be ashamed and grieved for it. We distinguish truth from error, moral good and evil; we fear punishment on having committed evil, and hope for reward on having done well. And, through the grace of God assisting us, we have a power to embrace and resolve to do good, as well as evil. We are free to choose whom we will serve, and, if we determine in favor of the better part, to continue therein.

*Conscience* is not a faculty of the soul distinct from the understanding, memory, will, and affections, but that power by which we are conscious of our own state, reflect on our actions, and pronounce them either good or evil, This supposes, that we are acquainted with the law of God, either natural or written, which is the rule of our duty. The name is derived from the Latin word *conscientia*, into which the Greek word συνειδησις is exactly translated. Both these words for conscience, signify, that the mind is possessed of a consciousness of the actions and thoughts of the man, and passes a judgment on them, according to some rule. The Jews have no proper word in their language for conscience, and therefore use the term *heart;* which is also used in the New Testament. Conscience is the journal or diary of the actions of man. Its office is, 1. To call, urge, and excite us to duty. 2. To testify and bear witness either for or against us, according as we perform or neglect our duty. 3. Either to excuse or acquit, or accuse and condemn us, on the evidence it gives of the moral nature and quality of our actions: if they be conformable to the Divine rule, as to matter and manner, it acquits us; if they be contrary to it, conscience accuses, condemns, and passes sentence upon us. 4. And if its sentence be true and just, conformable to rule, it is ratified by God the Supreme Judge, whose deputy and vicegerent it is in the breast of every man.

Though the soul is not under the imperious influence of the body, yet for many ages it has been allowed by sensible men, that "there is nothing in the understanding which is not first perceived by some of the senses." The imagination is the place where the images of things are first engendered, and from which they are transferred to the understanding. And therefore those who want any sense, cannot have the least knowledge or idea of the objects peculiar to that sense: as they who never had sight, have not the least conception of light or colors. But there is a great difference between our senses, considered as the avenues of knowledge. Some of them have a narrow sphere of action: others a more extensive one. By *feeling* we discern only those objects which touch some part of our body; and consequently this sense extends only to a small number of objects. Our senses of *taste* and *smell* extend to fewer still. But, on the other hand, our nobler sense of *hearing* has a wide sphere of action: especially in the case of loud sounds, as thunder, the roaring of the sea, or the discharge of cannon: the last of which sounds has been frequently heard at the distance of near a hundred miles. Yet the space to which the hearing itself extends is small, compared to that through which the *sight* extends. This sense takes in at one view, not only the most unbounded prospects on earth, but also the moon, and the other planets, the sun, yea, the fixed stars, though at such an immeasurable distance.

But still none of our senses can reach beyond the bounds of this visible world. They supply us with such knowledge of the material world, as answers all the purposes of life. But as this was the design for which they were given, beyond this they cannot go. They furnish us with no information at all, concerning the *invisible world.* But the wise and gracious Governor of the worlds, both visible and invisible, has prepared a remedy for this defect. He has favored us with a *revelation*, concerning himself, his existence, perfections, and will; and another world, its nature, certainty, and duration: and this revelation is contained in the Scriptures. And he has appointed *faith* to supply the defect of sense; to take us up where sense sets us down, and help us over the great gulf. Its office begins where that of sense ends. Sense is the evidence of things that are seen; of the visible, the material world, and the several parts of it. Faith, on the other hand, is the "evidence of things not seen," of the invisible world: of all these invisible things, which are revealed in the Oracles of God.* Though eternal things come not within the reach of sense, yet, by faith, they are as present to the mind, in their reality, excellence, and continuance, as if they were seen with the eye of the body. The testimony of the God of truth, is the foundation and reason of this faith; for what he says must be true, because he cannot lie: this is a principle concerning which all agree who own his existence.

The soul has a vast intellectual capacity; for the knowledge of God, nature, providence, the original and present state of man, the visible world, sublime speculations, and useful discoveries, come within its comprehension. It can reason, infer, reflect, and carry on a chain of thoughts, with perspicuity and close connection, concerning things. Its powers take in objects of all dimensions; yet they are not situated as bodies in a material place, where the greater occupy more space than the less: for the thought of a mile, or ten thousand miles, does no more fill or stretch the soul, than that of a foot, an inch, or a mathematical point. And whereas all matter has its parts, and those extended, one without another, into length, breadth, and thickness, and so is measurable by inches, yards, or solid measures; there is nothing of measurable extension in any thing belonging to the soul, neither length, breadth, nor thickness; nor is it possible to form an idea of a foot of thought, a yard of reason, a pound of wisdom, or a quart of virtue.† The soul is capable of abstract notions, mathematical and metaphysical conceptions. Its powers are so great, that we can explore nature, span the surface of the earth, dive into its capacious seas, and there discover the numerous inhabitants of the watery world. We can travel to the sun, continue our journey through our own spherical system, from planet to planet, tell their dimensions, measure their distances, and accompany them through their various revolutions. We can pass the boundaries of our own, and enter into other systems; and from thence, into eternity itself: ascending from region to region, from world to world, from the creature till we reach the abode of the great Creator, who is the first cause of all things; and then, with ravished eyes, gaze on that glorious Luminary of the moral world, till we are amazed, delighted, and overpowered, with the splendor of his infinite perfections.

* See Wesley's Sermon on Heb. xi, 1.
† Dr. Scott's Christian Life, vol. v, p. 14.

The soul is *immortal* in its duration: it once began to be, but will never cease to exist. When the whole of time is elapsed, it will live in the vigorous exercise of its active powers, and its existence run parallel with eternity. The death of the soul cannot be effected by the operation of second causes; and God, who is the first cause, will never annihilate it. The Sadducees denied the immateriality and immortality of the soul, saying, that, except God, there was no spirit: they were much like the Epicureans among the Gentile philosophers. In refutation of this Sadducean notion, our Saviour referred them to the five Books of Moses, which they acknowledged as of Divine authority, where God says, "I am the God of Abraham, and the God of Isaac, and the God of Jacob." Abraham had been dead upwards of 300 years when these words were spoken to Moses. Now, says our Saviour, "God is not the God of the dead, but of the living." Though the bodies of these renowned patriarchs had been long dead, and ceased to exist among mortals, their souls were still living, not only in a future state, but with God. He also warned his disciples of the opposition they would meet with, in the faithful discharge of their religious and ministerial duties, from the prejudice, rage, and fury of men; but urged them to take courage, and not suffer themselves to be intimidated, so as to neglect in any degree the execution of the important commission he had given them, saying, "Fear not them which kill the body, but are not able to kill the soul." Hence the soul is a principle distinct from the body, actually survives it, and can subsist without it, not only retaining its vital existence, but its consciousness, reflection, and activity. The following lines of Addison are strongly and beautifully descriptive of the immortality of the soul:

> "The soul, secure in her existence, smiles
> At dissolution, and defies its power.
> The stars shall fade away, the sun himself
> Grow dim with age, and nature sink in years;
> But thou shalt flourish in immortal youth—
> Unhurt, amidst the war of elements,
> The wreck of matter, and the crash of worlds."

In a word, since the soul is not material, it can have no parts; if it have no parts, then it cannot be separated; if it cannot be separated, then it cannot be dissolved; if it cannot be dissolved, then it is incorruptible; and if it be incorruptible, then it is immortal.

Thus it is evident, from all the perceptions of the soul, that it is not compounded like the body. Those powers and affections, such as thought and reason, judgment and liberty, love and hatred, joy and sorrow, can never be the properties or effects of matter, in any possible variation or modification of its parts. Nor can matter ever produce those noble and just sentiments, those sublime and generous affections, to which the soul sometimes rises in its contemplations of God, the phenomena of the universe, and the operation of Providence which sustains and governs all things. All this can never be produced by matter, which is altogether inactive of itself; and when motion is impressed on it, the only change produced is in the situation and contexture of its parts. Surely all attempts to account for these things, by any laws of nature known in the corporeal world, are absolutely ridiculous.

How strange is it then, that such a spiritual being should be united so closely to flesh and blood, imprisoned in a tenement of clay, and use the body as the instrument of active operations.—Several philosophers, among whom is Socrates, have called the body της ψυχης οικητηριον, *the habitation of the soul;* yea, φυλακη και ταφος, her moveable *prison*, and living *sepulchre.* These two essential parts of man, which God, at his creation, united so closely together, that both make but one person, is a great mystery; considering the different natures that adhere, soul and body, matter and spirit. All this is unintelligible to the human intellect, however improved and capacious. The disputers of this world will find themselves completely perplexed, in attempting to explain by what ties a spirit is united to a piece of clay; and what holds it confined to its habitation. The adhesion of the material particles in the human body, the flame of animal life kindled and burning clear and strong within us, and the union of spirit and matter, so that the one is the tenement of the other, and the instrument of its operations, are, as to their manner, mysterious, and attended with difficulties that would perplex and confound the most penetrating and sagacious mind.

Man then was created in the *natural* image of God, which consisted chiefly in the spiritual nature, amazing powers, and immortality of his soul; like God, it is a *spirit*, immaterial, invisible, active, intelligent, free, and immortal: and partly, in a lower sense, in the privilege of his body, which, in his state of innocence, was, by the promise of his Creator, entitled to a gratuitous immortality. Some make reason or understanding to be the image in which God created man: but, though this may be included, yet, it is not the principal thing intended by the Divine *image:* for if rationality were the image, it could never be lost. Sin, which defaces this beautiful image, does not deprive man of intellect: his nature will for ever continue rational; he can never, I presume, be deprived of his reason so as not to possess it any more. Thought and consciousness are inseparable from the nature of man, and therefore this *image* of God in which Adam was created, must be something distinct from reason. Indeed reasonable creatures only can be the subjects of it, but reason is not the thing itself. To suppose that mere reason is God's image in man, is an hypothesis unworthy of a reasonable nature; and with how much confidence soever some assert, the assertion is reproachful to our Maker.

The chief thing intended by the Divine *image*, is moral rectitude; man was created in the *moral image* of God; but that image in man was only a *likeness*, it did not equal, but resembled its high original—a disparity which necessarily exists between a creature and its Creator. According to any rational opinion we can form of God, we must believe that he is a spiritual Being; which includes the simplicity of his nature, his indivisibility, and his immortality; possessed not only of every natural perfection, but of all moral excellencies. He is not only an intelligent, omnipresent, omniscient, almighty Being, but wise, holy, righteous, and good. Without moral perfections, his character would not be very interesting to us. If he had no radical and constitutional principle in his nature that could move him to regard the temper of our minds, and the complexion of our actions, or cause him to be either pleased or displeased with our behavior, however conducted, we should have no reason to act either from motives of love or fear of him. His natural attributes alone, are very far from finishing his character; in conjunction with these, his moral excellencies complete his glory, exhibit him as the most perfect Agent, and render him in the most exalted sense our Governor. His holiness, justice, goodness, and truth, are called moral attributes, or communicable perfections; because we can trace some resemblance in angels and men; though there is an infinite disproportion between these perfections as they exist in God, and are faintly displayed in the creatures: in him they are infinite, in the creatures finite and limited.

These moral perfections constitute God a proper object of religious adoration, and without which no worship would be due or could be rendered to him. The Divine Nature is the foundation of that worship which we, as rational beings, are under obligations to perform; and the revelation of the will of God, with which he has graciously favored us in the Scripture, is the constant rule of his worship. On believing his existence, and cultivating the knowledge of his attributes, especially those which are so astonishingly displayed and harmonized in the redemption of mankind by Jesus Christ, it very naturally follows, to every reflecting mind, that we owe him ourselves, and are bound by the strongest ties to present to him the most spiritual worship of which our intelligent nature is capable.

The moral image of God, after which man was created, was his greatest excellence. His *understanding* possessed a large capacity for improvement, equal to an extensive and accurate acquaintance with things both natural and divine, the acquisition of which would facilitate his own happiness, by rendering him more competent to answer the benevolent design which his Creator projected in calling him into existence. This capacity was amply supplied by his Creator; for all divine knowledge is given by revelation; which he must either communicate to man, or he must remain ignorant of him. The capacity is one thing, and its improvement is another;

which, as it is not naturally inherent in man, so it must be acquired. The knowledge of the nature, perfections, and will of God, can, in the first instance, only be made known by himself; for there is not a correct notion of him in the whole intellectual and moral world, but what has been received from either Divine revelation, or his own immediate influence. Adam, then, as an intelligent creature, was endued with the knowledge of God, so far as was necessary to enable him to fear, love, and serve him. Without a perception of his existence and perfections, and the knowledge of his will, he could not perform any acts of adoration, reverence, reliance, regard, and delight, toward him. If therefore man, in his primitive state, was obliged to worship his Creator (of which certainly no one can doubt,) it must be granted that he possessed knowledge equal to the nature and extent of his obligations. In his state of innocence, he did not perform a blind devotion, or worship he knew not what. Such ignorance is the consequence of sin; therefore he could not be the unhappy subject of it before he transgressed.

Some persons have thought that Adam, in his primeval state, understood the doctrine of a Trinity of Persons or Subsistencies in the Godhead. Though the knowledge of this important doctrine cannot be attained by reasoning on the operations of Divine wisdom, power, and goodness, visibly and conspicuously displayed in the universe; yet, as Adam received by immediate revelation some truths, why may we not suppose that this mystery was not conveyed to him in the same way, that his acts of devotion might comport with the honors due to each of the Sacred Three? The Divine Nature is without multiplicity, it is one; but the Three Subsistencies in that Essence are essential to the Godhead: this arrangement is radical, constitutional, and eternal. Therefore why should not God be worshipped according to his own natural distinction of Persons in his undivided Essence, by man in his primitive state? A Trinity in Unity is the most correct view of God; and, consequently, the worship that accords with it, being the most accurate, must be acceptable to him. The Christian religion has not given existence to this doctrine of the Trinity; for independently of the mediatorial scheme of redemption and salvation by Christ, God was from eternity the same Triune Being, and cannot change. It is not improbable that man, while he retained his pristine state, worshipped the Father, the Son, and the Holy Spirit, in all his acts of religious worship. Lord Bacon, in his Confession of Faith, says,—"I believe that nothing is without beginning but God; no nature, no matter, no spirit, but one only, and the same God. That God, as he is eternally almighty, only wise, only good, in his nature; so he is eternally Father, Son, and Spirit, in Persons."

We cannot rationally suppose that Adam was a stranger to his *duty*, either in its nature, manner, or extent. If he had not known what duties his Creator required him to perform, it would have been impossible for him to act agreeably to his will. Obedience to any authority necessarily supposes a knowledge of what it enjoins: and, consequently, Adam must have known what he ought to practise, in what manner, and with what views; for, otherwise, he could not be obedient to the will of God in what he did. Hence we must conclude, that he was acquainted with the whole compass of his duty. As his understanding was not blinded by contracted prejudices, so it was free from any natural defect. His mind was furnished with correct views of God, his own dependence upon him, relations and obligations to him, and the way to please and enjoy him.

Adam, in his primitive state, knew wherein his *happiness* consisted. If he had been ignorant of that happiness to which he was entitled so long as he preserved his integrity, how could he have enjoyed it while in his possession; for a delight in any present good arises from a perception of its nature and value. Neither was he ignorant of the misery, into which an action committed against the will of his Creator would bring him. He certainly knew that sinning against God would inevitably be attended with fatal effects to himself. His unclouded reason could not but discern, that rebellion against the dignity and sovereignty of his Maker would unavoidably expose him to his righteous displeasure.

As the judgment of Adam could not but entirely approve of the supreme Good, in all the perfections of its nature, and revelation of the Divine Mind; so his *will*, with great freedom following its dictates, readily embraced what was right, and exactly harmonized with every requisition. He had a holy dispositon, such as comported with the infinite perfection of holiness, so resplendent in the Divine Nature. Some have asserted, that God formed man without any direction in his will either to good or evil. But this imagination is irrational, for it supposes that he was neither holy nor unholy. It is evident from Scripture, that he was created good in an ethical or moral sense, for he was made in the *image* of God, which chiefly consisted in a conformity to his moral perfections. He resembled these, particularly that of holiness; so that, though in an infinitely lower degree, he was holy as God is holy; without the least taint of sin in his nature, or any inclination to evil, all his powers and faculties being disposed to comply with his utmost requisition.

Adam's *affections* were subordinate and obedient to the higher faculties of his soul, and moved without the least tumult or disorder. Being pure and regular, there was no depravity or discord among them. No temptation arose from vanity seated in any of the inferior powers: neither was there a rebellious disposition among the passions directed against his reason. No unlawful love, delight, or aversion had any place in his innocent nature, and therefore the dictates of reason did not meet with any control from corruption in the affections; and, consequently, obedience to his Creator was not rendered difficult by unruliness in the passions. Being thus made after the *likeness* of God, he had the moral law written on his heart: that hereby he might have a perfect rule of obedience, and be easily apprised of his duty to him. And as he was indispensably obliged to yield obedience to this law, and the consequence of violating it would be endless ruin, God, as a just and gracious Sovereign, gave him ability to keep it. Herein he treated him as a rational creature, and a subject of moral government.

The inferior *appetites* of Adam were in a state of perfect subjection, and never indulged to the least excess. The animal structure requiring food for its support, there was a great variety provided. But while surrounded with plenty, he was strictly temperate; his appetite was regular, consistent with purity, and in harmony with his devotions. The *senses* also corresponded to the faculties of the soul, and were inlets to wisdom and enjoyment. Thus, as one observes, all his faculties both of body and mind were subservient to the glory of God, and contributed to his own felicity: a state which we are to regain by Christ.

"Enslav'd to sense, to pleasure prone,
Fond of created good;
Father, our helplessness we own,
And trembling taste our food.

Trembling we taste; for, ah! no more
To thee the creatures lead;
Chang'd, they exert a baneful power,
And poison, while they feed.

Curs'd for the sake of wretched man,
They now engross him whole;
With pleasing force on earth detain!
And sensualize his soul.

Groveling on earth we still must lie,
Till Christ the curse repeal:
Till Christ descending from on high
Infected nature heal.

Come then, our heavenly Adam, come,
Thy healing influence give;
Hallow our food, reverse our doom,
And bid us eat, and live.

Turn the full stream of nature's tide:
Let all our actions tend
To thee their source; thy love the guide,
Thy glory be the end.

Earth then a scale to heaven shall be,
Sense shall point out the road;
The creatures all shall lead to thee,
And all we taste be God."

Man was *happy* in his original state; he not only was free from pain and misery, but enjoyed delight. His pleasure was of a pure nature, not only such as God approved, but derived from a Divine source. If his mind had not been possessed of correct knowledge, his will disposed to obedience, his affections regular and holy, and his appetites and senses subject to a rational control, what pleasure could he have taken in the contemplation of infinite perfections, and in a compliance to the requisitions of the moral law? Happiness necessarily supposes delight, and delight as necessarily supposes a concordance between the disposition of the soul, and the objects from which its pleasure springs. Man was happy while innocent; he therefore enjoyed pleasure, which was pure, arising from positive holiness, and the presence and blessing of God. Surely it is reasonable to conclude, that Adam performed devotional acts with holy reverence and supreme delight. He could not but give the tribute of praise to his beneficent Creator, for his superabundant goodness toward him; being favored with every thing, not only necessary to his sustenance, in the excellent circumstances in which he was placed, but with whatever he could desire for the entertainment and delight of his innocent and heavenly mind. Above all, his grateful soul most certainly adored his Creator, for the glorious and beneficial displays of his wisdom, power, and goodness, and rejoiced in the interest he had in his approbation, protection, and kindness. While he retained his integrity, and enjoyed free access to his Maker, intimate communion with him, and was free from his displeasure, what serenity, satisfaction, and pleasure must fill his soul! He possessed that first and greatest of blessings, mentioned by Horace, *mens sana in corpore sano*, a sound mind in a healthy body.

Notwithstanding the excellent state in which Adam was created, and advantageous circumstances in which he was placed, yet he was liable to fall. By reason of the spiritual and intelligent principle in him, he became a moral agent, and a subject of moral government. He knew his duty, and had the power of determining his own choice and actions. He could choose good, and refuse evil, and be influenced by the hope of reward and the fear of punishment. He had no disposition to sin in his nature: for God could not create him in a sinful state, since that would render him the author of sin. He had full power to stand: but God could not interfere with the freedom of his will; and herein he acted toward him in a way agreeable to his condition of probation. The mutability of his will was essential to him as a rational creature, placed in a state of responsibility for his actions to the great Governor of the world. Dr. Paley says, "Free agency in its very essence contains liability to abuse. Yet, if you deprive man of his free agency, you subvert his nature." God answers for himself in Milton:—

—— "Man had of me
All he could have: I made him just and right,
Sufficient to have stood, though free to fall."

The sentiments of Faber are very appropriate. "When the Almighty ceased from the work of creation, he pronounced all that he had made to be very good. The new world was as yet free from the inroads of sin, and from the curse of sterility.

> —— 'Nature then
> Wanton'd as in her prime, and play'd at will
> Her virgin fancies.'

"The whole creation smiled upon man, and the golden age of the poets was realized. Blessed with perfect health, both mental and corporeal, our heaven-born progenitor was equally unconscious of the stings of guilt and the pangs of disease. His understanding was unclouded with the mists of vice, ignorance, and error; his will, though absolutely free, was yet entirely devoted to the service of God; and his affections warm, vigorous, and undivided, were ardently bent upon the great Fountain of existence. Though vested in an earthly body, his soul was as the soul of an angel, pure, just, and upright. He was uncontaminated with the smallest sin, and free from even the slightest taint of pollution. His passions perfectly under the guidance of his reason, yielded a ready and cheerful obedience to the dictates of his conscience; an obedience, not constrained and irksome, but full, unreserved, and attended with sensations of unmixed delight. Such was man when he came forth from the hand of his Creator, the image of God stamped upon his soul and influencing all his actions."*

We may add, the authority and *dominion* with which God invested Adam. This extended "over the fish of the sea, and over the fowl of the air, and over the cattle, and over the earth, and over every living thing that creepeth upon the earth." God constituted him the ruler, under him, of all the inferior creatures. He probably inducted him into this office when he caused the creatures to pass in review before him. "And the Lord God brought every beast of the field, and every fowl of the air, unto Adam to see what he would call them: and Adam gave names to all cattle, and to the fowl of the air, and to every beast of the field: and whatsoever Adam called every living creature, that was the name thereof." Man alone, says Smellie, enjoys the power of communicating and expressing his ideas by articulate and artificial language. This inestimable prerogative is a great source of improvement to the human intellect. Without artificial language, though the Author of nature has bestowed on every animal a mode of expressing its wants and desires, its pleasures and pains, what a humiliating figure would the human species exhibit?

Dr. Beattie, in defining the human voice, says, it is air sent out from the lungs, and so agitated, or modified, in its passage through the windpipe and larynx, as to become distinctly audible. The windpipe conveys air into the lungs for the purpose of respiration and speech; the top or upper part of which is called the larynx,

* Practical Treaties on the Holy Spirit, pp. 7, 8.

consisting of four or five cartilages, that may be expanded or brought together, by the agency of certain muscles which operate all at the same time. In the middle of the larynx there is a small aperture, called the *glottis*, through which the breath and voice are conveyed, but which, when we swallow any thing, is covered by a lid called the *epiglottis*. Authors have determined that the voice is produced by two semi-circular membranes in the middle of the larynx, which form by their separation the aperture that is termed the glottis. The space between them is not wider than one-tenth of an inch; through which the breath transmitted from the lungs must pass with considerable velocity. In its passage it is supposed to give a brisk vibratory motion to the membranous lips of the glottis, and so to form the sound which we call *voice:* in order to the production of which, it, however, seems necessary, that, by an energy of the will, a certain degree of tenseness should be communicated to the larynx, or at least to the two membranes in the middle of it. The voice, thus formed, is strengthened and mellowed by a reverberation from the palate, and other hollow places in the inside of the mouth and nostrils; and as these are better or worse shaped for this reverberation, it is said to be more or less agreeable. The glottis is found to be narrower in women and young persons than in men; hence the voices of the latter are deeper, or more grave, than those of the former. We can at pleasure dilate or contract this aperture, so as to form the tones of the voice to every variety of the musical scale. If we consider the many variations of sound, which the same human voice is capable of uttering, together with the small diameter of the glottis; and reflect that the same diameter must always produce the same tone, and, consequently, that to every change of tone a correspondent change of diameter is necessary: we must be astonished at the mechanism of these parts and the fineness of the fibers, producing effects so minute, various, and uniform. For it admits of proof, that the glottis is capable of at least sixty distinct degrees of contraction and enlargement, by each of which a different note is produced.*

Concerning the origin of language, numerous conjectures have been formed. As an instance how far the human mind, unassisted by a Divine revelation, can go, Diodorus Siculus and Vitruvius have asserted, "that men at first lived like beasts in woods and caves, forming only strange and uncouth noises, till their fears caused them to associate together; and that on growing acquainted with each other, they came to correspond about things, first by signs, then to make names for them, and in time, to frame and perfect a language; and that the languages of the world are different, because different companies of men happening thus to come together in different places, would, of course, form different sounds

* See Dr. Beattie's Theory of Language, chap. ii.

or names of things; hence would arise the variety observable even in ancient languages." Thus we perceive the necessity of the Scriptures relative even to this subject.

"The Mosaic History," observes Dr. A. Clarke, "represents man as being immediately capable of conversing with his Maker: of giving names to the various tribes and classes of animals; and of reasoning consecutively, and in perfectly appropriate terms, concerning his own situation, and the relation he stood in to the creatures. As in man's first attempt at speech, according to this account, there appear no crudeness of conception, no barrenness of ideas, and no inexpressive or unappropriate terms, it is most rational to conclude, that God who made and endued him with corporeal and mental powers, perfectly suited to his state and condition in life, endued him also, not only with the faculty of speech, but with speech or language itself; which latter was as necessary to his comfort, and, indeed, to the perfection and end of his being, as any other power or faculty which his Creator thought proper to bestow upon him."

Some assert that Adam *gave names*, from an intimate knowedge of the nature and properties of each creature: that this shows the perfection of his knowledge, for the names affixed to the different animals in Scripture always express some prominent feature and essential characteristic of the creatures to which they are applied; and that had he not possessed an intuitive knowledge of the grand and distinguishing properties of those animals, he never could have given them such names. Dr. Leland states, that man was immediately endued with the gift of language, which necessarily supposes that he was furnished with a stock of ideas, a specimen of which he gave in giving names to the inferior animals, which were brought to him for that purpose. Dr. Johnson affirms, that the origin of language must have come by inspiration. But Bishop Warburton conjectures, that God, in this transaction with Adam, taught him language. Here, says he, by a common figure of speech, the historian, instead of directly relating the fact, that God taught man language, represents it, by showing God in the *act* of doing it, in a particular *mode* of information; and that the most apposite we can conceive in elementary instruction; namely, the giving of names to substances; things with which Adam was to be conversant, and which therefore had need of being distinguished each by its proper name. And what a familiar image do these words give one of a learner of his rudiments? *And God brought every beast to Adam to* SEE *what he would call them.* But though it appears that God taught man language, yet we cannot reasonably suppose it any other than what served his present occasions, he being now of himself able to improve and enlarge it, as his future necessities should require. The celebrated Cowper, touching this subject says:—

"One man alone, the father of us all,
Drew not his life from woman; never gaz'd,
With mute unconsciousness of what he saw,
On all around him: learn'd not by degrees,
Nor aw'd articulation to his ear;
But, moulded by his Maker into man
At once, upstood intelligent, survey'd
All creatures, with precision understood
Their purport, uses, properties, assign'd
To each his name significant, and, fill'd
With love, and wisdom, render'd back to Heaven
In praise harmonious the first air he drew.
He was excus'd the penalties of dull
Minority. No tutor charg'd his hand
With the thought-tracing quill, or task'd his mind
With problems."

However, by the creatures passing before Adam, probably in pairs, and he giving them names as they passed according to the nature and properties of each, one thing evidently appears, namely, he was convinced that none of these animals could be a suitable companion for him; for, among all which he had named, "there was not a help-meet for him:" one suitable and proper as an intimate companion and friend.

"He views the vast creation o'er,
Marks his own structure more than e'er before;
Sees all the creatures with their co-mates blest,
Himself left pensive, far unlike the rest;
Without compeer with whom his hours to spend,
Or jointly at the sacred altar bend.
*Religion*—sacred to the first great Cause:
*Philosophy*—the voice of Nature's laws;
And *social dictates*, all at once combine
To teach their pupil, that the whole design
Is not completed, while his lonely life
Is left without a helper, friend, and wife.
Refulgent Sol, while traversing his way,
Has Luna shining with her lucid ray;
And though her glory is a borrow'd light,
She reigns sole empress of the sable night.
Soft purling streams to rivers speed their course,
And blend themselves with their capacious source.
The spreading branches of uxorious vines,
Clasp round each other with encircling twines.
The climbing Ivy does the Oak embrace,
And meets with verdant wreaths his bending face.
The feather'd tribes that wing the firmament,
By instinct led, to wedded love consent:
They range the neighb'ring meads in quest of food,
And guard and cherish their young callow brood.
And shall the creatures without just pretence,
Alone possess this high pre-eminence?
Though with abounding earthly comforts blest,
Shall man pre-eminent still want the best:—
A bosom friend, than virgin rose more sweet,
And whom he can with heart-felt rapture greet;
Of pleasing form, equal and tender mind,
To whom he can in closest ties be join'd?"

God did not approve of this state of solitude: he said, "It is not good that man should be alone," or only himself. The Creator had not yet finished his works. He saw it necessary to relieve man in his solitary situation; and his goodness and power were ready to concur with the dictates of his wisdom. He said, "I will make him a *help-meet* for him;" i. e. his counterpart, one like himself in shape, constitution, and disposition; exactly adapted to both his body and mind, the very image of himself, *a second self.*

"Must the fair creature promis'd to be giv'n,
Be sent to earth from the abode of heav'n?
Angelic nature could not well supply
The craving void, remote, and far too high.
Will God select amongst the brutal race,
One, and refine it for his fond embrace?
Nay, that would be too mean for his respect,
Beneath his nature, void of intellect.
The wise Creator, to complete his plan,
Resolves to make a *help-meet* from the Man,
Procure the stamina from him alone,
Thus constitute her "bone of his own bone."
From Man! but where? what part can he forego,
From head majestic to the servile toe?
The head imperial would be much too high,
Lest she, perchance, should for the mast'ry try.
The toilsome feet are base, of low renown,
Lest he should trample the fair creature down.
In Man's organic structure, mark! the part
Is that which lies contiguous to the heart;
Main spring of life, whence all the frame looks gay,
Centre, where all the lovely passions play;
Under the shield of the protecting arm,
Which can defend her from impending harm."

Accordingly, God proceeded in his work: not as before, when he made man, and formed his body of the dust of the earth; but he took of the substance of man, and of that formed an associate for him. The process is mentioned by Moses, "And the Lord God caused a deep sleep to fall upon Adam, and he slept: and he took one of his ribs, and closed up the flesh instead thereof; and the rib, which the Lord God had taken from man, made he a woman." The word תרדמה translated *a deep sleep*, signifies such a sleep as renders a man insensible of any thing done to him; which was not natural but an extraordinary sleep; not occasioned by any act of violence done to nature, but the immediate effect of the hand of God upon him. Sleep, says a German author, is one of the most remarkable effects of the Divine goodness. It is certainly a proof of the wisdom of our Creator, that we fall asleep imperceptibly. Sleep comes unsummoned: it is the only change in our manner of existence in which reflection bears no part; and is alike independent of the understanding and the will. Our situation, indeed, during the time of sleep, is wonderful. We live, but without knowing or perceiving it! The palpitations of the heart, the circulation of the blood, the process of digestion, and, in a word, all the animal functions continue to be performed without interruption. The mind appears, as it were, to suspend its activity, for a time: by degrees, it looses all sensation, every distinct idea. The senses are deadened, and stop their wonted operations. The muscles, by degrees, are moved more slowly, till all voluntary motion ceases. This change begins in the forehead: then the muscles of the eyelids, and of the neck, arms, and feet, are so much deprived of their activity, that the man seems to be metamorphosed into a plant. The situation of the brain becomes such, that it cannot transmit to the soul the same ideas as when we are awake. The soul perceives no object, though the nerve of vision is not altered; and it would see nothing, were the eyes to be even open. The ears are not shut, and yet they hear nothing. In a word, we find an unceasing source of admiration, in the wonderful preparations, and the tender care, which the Divine Being has employed, to procure us the blessings of sleep. The following epigram, translated from the Latin by Dr. Wolcott, is beautiful:—

"Come, gentle sleep, attend thy votary's prayer,
And, though death's image, to my couch repair!
How sweet, thus lifeless, yet with life to lie,
Thus without dying, oh how sweet to die!"

The word צלע *tsela*, and in the Septuagint πλευρα, rendered a *rib*, most probably means *bone*, and *flesh*, not a naked bone, but one with flesh adhering to it. "And the rib which the Lord God had taken from man, *made* he a woman," or, according to the Hebrew, *builded it up* to be a woman; signifying, that the human species was perfect when the woman was created, which before was like an imperfect building. This implies, an old author intimates, that as children are derived from their parents to build up the family, so the woman was derived from Adam to build up his great family, mankind, of his own nature and substance; and that his posterity might spring wholly from him, both in respect of himself, and of his wife, their common mother, who was taken out of him. What amazing wisdom is herein displayed; not only in producing a creature *like* man, but out of *a part of man himself!* God could have animated and organized the dust of the earth, and of it formed the woman; but had he done so, she would have appeared in the eyes of man as a distinct being, to whom he had no natural relation.*

"Her form completed, lo! she rises fair,
Possess'd of beauties far beyond compare!
This last production of the Artist's skill,
Best effort of his wisdom, might, and will,
Gains science' height: the high-wrought features shine,
Her form displays a symmetry divine.
Her pleasing gesture, as she walks along,
Exceeds the powers of harmony and song.
Her fine exterior, by her Maker drest,
Is but the mansion of a brighter guest,
To flesh superior far, howe'er refin'd;—
A pure, reflective, comprehensive mind!
Expression soft sits sparkling in her eyes,
While from her bosom heavenly raptures rise;
Intrinsic worth, comprising every grace,
Displays its radiance in her roseate face."

When the woman was formed, "God brought her unto the man," i. e. he presented her to him to be his wife. We are not to

* It is very singular, says Nicholas, in his very interesting history of New-Zealand, that the natives believe that the first woman was made of one of man's ribs; and, what adds still more to this strange coincidence, their general term for bone is *heree*, which, for ought we know, may be a corruption of the name of our first parent, communicated to them, perhaps, originally, by some means or other, and preserved, without being much disfigured, among the records of ignorance.

imagine, by *bringing her to the man*, is meant, that God merely placed her before his eyes, and thus exhibited her: but that he joined the man and the woman together in marriage.

> "Attending angels strike the choral lay,
> And hymn your anthems on this bridal day;
> While the first Pair unite their willing hands,
> Whose hearts are join'd in love's eternal bands."

On receiving the woman, Adam said, "This is now bone of my bones, and flesh of my flesh." Adam was the common stock and root of all mankind; not only all his posterity were wholly contained in him alone, but also the first woman, the mother of us all, had her vital life in him, and was part of his living flesh and bones: he saw that she was of the same nature, the same identical flesh and blood, the same constitution in all respects, having the same physical powers, mental faculties, and inalienable rights. He added, "She shall be called *Woman*, because she was taken out of man;" i. e. she shall partake of my name as she does of my nature. A literal version of the Hebrew would appear strange, says Dr. A. Clarke, and yet a literal version is the only proper one. איש *Ish*, signifies *man;* and the word used to express what we term *woman*, is the same with feminine termination, אשה *ishah*, and literally means *she-man*. Most of the ancient versions have felt the force of the term, and have endeavored to express it as literally as possible. The Vulgate Latin renders the Hebrew *virago*, which is a feminine form of *vir*, a man. Symmachus used ανδρις *andris*, a female form of ανηρ, *aner*, a man. Our own term is equally proper, when understood: it is a literal translation of the original; and we may thank the discernment of our Anglo-Saxon ancestors for giving it. Wombman, of which *woman* is a contraction, means the *man with the womb*. Verstegan, in his Restitution of Decayed Intelligence, justifies this sense of the word, on the ground of antiquity and propriety, and says it should be so written. The term *woman* was not peculiar to her, but common to the sex; she differing from man in sex only, not in nature. Afterward Adam called her חוה *chavah*, which answers exactly to ζωη of the Septuagint, both signifying *life*, because she was the mother of all *living*.

> "Oh blest existence! (now the man exclaims,
> And higher praises of his God proclaims.)
> My cup with blessings hast thou amply fill'd,
> Consummate joys for my great portion will'd:
> No wants are left, no good hast thou denied,
> Thy lib'ral hand has all I wish'd supplied.
> Thou Fount of being! source of pure delight!
> In thee my comforts center and unite:
> Thyself I love, thy vast perfections see,
> And all thy gifts receiv'd enjoy in Thee.
>
> He turns to Eve, whose charms are all in view,
> The perfect form which highest wisdom drew:
> Her sweet attractions touch his yielding mind,
> As three-fold cords his willing passions bind.
> Sensations soft with quick transition roll,
> And raise the transports of his grateful soul:
> While thrilling raptures through his bosom move,
> He feels his heart the seat of God—and *love*.

Their minds now glowing with celestial fire,
They jointly bend before their gracious SIRE;
Devotion's flame with greater ardor burns,
And both are vocal in his praise by turns.
While thus their pow'rs in pleasing acts employ,
The *social* worship much augments their joy:
Their warm addresses to the sacred throne,
Ascend as incense, and bring blessings down."

The relation between *husband* and *wife* is the strongest union that results from the highest obligations of nature. "Therefore," said Adam, "shall a man leave his father and mother, and shall cleave unto his wife: and they shall be one flesh." Here we perceive, as Dr. Delany intimates, that Adam had a perfect idea of father and mother, before any existed; that he had clear ideas of the affection arising from that relation, before any children were born into the world: and yet perceived that the endearment arising from marriage should be stronger than these ties, so as to attach a man with warmer affection to his wife, than to those very parents to whom he was indebted for life. Now if the received doctrines of philosophy be true, that the senses are the inlets of ideas, and that we can have no ideas without objects: then we must conclude, that as he had these ideas, and had them not from nature, he must have received them from express revelation. Hence our Saviour, in his answer to the Pharisees, informs us, that the words pronounced by Adam on this occasion, were the declaration of God himself. "Have ye not read that he which made them at the beginning, made them male and female, and said, For this cause shall a man leave father aud mother, and shall cleave to his wife: and they twain shall be one flesh." These two shall be considered as *one body*, having no separate or independent interests: or, these two shall be *for the production* of one flesh; from their union a posterity shall spring, as exactly resembling themselves as they do each other. The Greek word προσκολληθησεται, translated *one flesh*, signifies shall be *glued* to her.

How happy must such a state be, where the parties married come up to the design of this sacred institution! Dr. Hunter observes, "What an important era in the life of Adam! What a new display of the Creator's power, skill, and goodness! How must the spirit of devotion be heightened, now that man could join in *social* worship! What additional satisfaction in contemplating the frame, order, and course of nature, now that he possessed the most exalted of human joys, that of conveying knowledge to a beloved object! Now he could instruct Eve in the wonders of creation, and unfold to her their Maker's nature, perfections, and will!" Oh happy state! They are happy in the constitution of their nature,—being innocent, upright creatures; and in having their pure minds perfectly united in love and kindness to each other. They were happy in all their united acts of adoration and praise to their Creator,—exact harmony, unmixed delight, and untainted piety, residing in each breast! They lived in communion with

God, enjoyed a transporting sense of his favor, walked in the light of his countenance, and were raptured in their meditations on the Divine glory!

We have here the first institution of marriage, and we see in it several things worthy of peculiar attention and regard. 1. God pronounces the state of celibacy *not a good one:* and the Lord God said, "It is not good that man should be alone," לבדו *lebaddo* only himself. It was neither for his comfort, who was formed for society, nor for the accomplishment of God's purpose in the increase of mankind. Though he was created in the image of God, and enjoyed delightful intercourse with him, his solitary condition required a suitable companion. 2. God made the woman *for* the man; he was not made *for her*, but she was made *for him*, and derived, under God, her being from him. The apostle says, "Neither was the man created for the woman; but the woman for the man," to be a suitable helper and comfort to him. And thus God has shown us, that every son of Adam should be united to a daughter of Eve to the end of the world. 3. God made the woman *out* of the man: as Adam was immediately from God, so Eve was immediately from Adam; "the man is not of the woman, but the woman of the man:" made of a part of his body, taken out, not of his head, to show that she was not to exercise dominion over him; nor of his foot, to indicate that she must not be his slave; but of his side, to intimate that she needs his counsel and direction; from under his arm, to teach him that he must protect her; and near his heart, to tell him that he must love her as himself. The closest union, and the most affectionate attachment, should subsist in the matrimonial connection. The man should ever consider and treat the woman as a *part of himself;* and as no one ever hated his own flesh, but nourishes and supports it, so should a husband evince the greatest tenderness and affection for his wife: and on the other hand, considering that the woman derived her being from man, and was made *for* him, therefore the wife should "see that she reverence her husband." "For as man is the image and glory of God; so the woman is the glory of the man." 4. God himself instituted the marriage union, and being appointed and established by him, it must be an honorable state. "Marriage is honorable in all," being a Divine institution; and consequently suitable for persons of any rank, or employment, either civil or sacred. The corruption of manners has strangely perverted this original purpose and institution of God. However, he will never accommodate his morality to the times, nor to the inclinations of men. What was settled at the beginning, he judged most worthy of his glory, most profitable for man, and most suitable to his nature. 5. Marriage was instituted immediately on the creation of man and formation of the woman;

whence it is evident that God never designed that mankind should be preserved, and the earth peopled any other way. And as the marriage union took place while man was in a state of innocence, upright and pure, just such as his Creator made him, it is therefore suitable to the greatest purity both of heart and life. 6. The design of this institution was, that man and woman might be mutually helpful to each other, in all the necessities and uses of life partaking of the cares and labors of each other, reciprocally sharing in each other's delights and pleasures, and combining together to love, serve, and please God.

The *situation* of Adam and Eve is worthy of our attention. The sacred historian says, "And the Lord God planted a garden eastward in Eden; and there he put the man whom he had formed." The word עדן *Eden*, signifying *pleasure* or *delight*, is expressive of their excellent residence. The Septuagint render the passage thus: εφυτευσεν ο Θεος παραδεισου εν Εδεμ, *God planted a Paradise in Eden.* The Fathers of the Church; says Huet, both Latin and Greek, all the Interpreters of Scripture, ancient and modern, and all the Orientals, do agree, that Eden is a local name taken from the beauty of the place. The Garden or Paradise was situated in Eden, being two different places, as the whole from its part. "And a river went out of Eden to water the garden; and from thence it was parted, and became into four heads. And the name of the first is Pison: that is it which compasseth the whole land of Havilah, where there is gold; and the gold of that land is good; there is bdellium and the onyx stone. And the name of the second river is Gihon: the same is it that compasseth the whole land of Ethiopia. And the name of the third river is Hiddekel: that is it which goeth toward the east of Assyria. And the fourth river is Euphrates." The most probable account of the situation of the terrestrial Paradise, says Dr. A. Clarke, is that given by Hadrian Reland. He supposes it to have been in Armenia, near the sources of the great rivers, Euphrates, Tigris, Phasis, and Araxes. He thinks Pison was the Phasis, a river of Cholchis, emptying itself into the Euxine Sea, where there is a city called Chabala, the pronunciation of which is nearly the same with that of Havilah, or חוילה *Chavilah*, according to the Hebrew, the *vau* ו being changed in Greek to *beta* β. This country was famous for gold, whence the fable of the Golden Fleece, attempted to be carried away from that country by the heroes of Greece. The Gihon he thinks to be the Araxes, which runs into the Caspian Sea, both the words having the same signification, namely, a *rapid motion*. The land of Cush, washed by the river, he supposes to be the country of the Cussæi of the ancients; a nation of Asia, destroyed by Alexander to appease the manes of Hephæstion. The Hiddekel all agree to be the Tigris; and the other river, Phrat, or פרת *Perath*, to be the Euphrates. All these rivers rise in the same tract of mountainous country, though they do not proceed from one head.

Man, says Faber, was placed by the Deity in the garden of Paradise. The beauty of its scenery, the salubrity of its climate, the variety and excellence of its fruits, all contributed to the beatitude of the first pair, and tended to elevate their thoughts to that Being, who was the author and contriver of such numerous blessings. Trained, says Bishop Horne, in the school of Eden by the material elements of a visible world, to the knowledge of one that is immaterial and invisible, Adam found himself excited by the beauty of the picture, to aspire after the transcendent excellence of the Divine original.

From this, says Dr. A. Clarke, the ancient heathens borrowed their ideas of the gardens of Hesperides, where the trees bore golden fruit; the gardens of Adonis, a word which is evidently derived from the Hebrew עדן *Aden*; and hence the origin of sacred gardens, or inclosures, dedicated to purposes of devotion, some comparatively innocent, others impure. From the holiness of the garden of Eden, says Faber, the Pagans probably borrowed their ancient custom of consecrating groves to the worship of their various deities. The description given by Quintus Curtius of the sacred grove of Jupiter Hammon is singularly beautiful, and almost presents to the imagination the deep shades and the crystal streams of Eden. "At length," says he, "they arrived at the consecrated habitation of the deity, which, incredible as it may seem, was situated in the midst of a desert, and shaded from the sun by so luxuriant a vegetation, that its beams could scarcely penetrate through the thickness of the foliage. The groves are watered by the meandering streams of numerous fountains; and a wonderful temperature of climate, resembling most of all the delightful season of spring, prevails through the whole year with an equal degree of salubrity."

This golden age is described by Plato, in a manner which, independently of his confession (namely, that he gained his information from the Phœnicians, who received it from their ancestors,) proves him to have derived it, not from written records, but from traditional reports. His mansion of primeval bliss was not in this dark, diminished, and deformed, this corrupted globe, but in a pure, ethereal, and lucid orb of unlimited extent, where men breathed, not air, but light, drank nectar, and partook of fruits spontaneously produced. The inclement seasons were unknown, raiment was not yet invented, and nakedness produced no distress. When weary, the inhabitants reclined to sleep on soft herbage, which received the influence of one eternal spring. In these delightful regions no stormy winds interrupted their calm repose; no evil passion disturbed their serenity of soul; and reason, guided by benevolence, bore a universal sway. Whilst this state continued, man conversed freely with those animals, which, now wild, avoid his presence, and fly at his approach.

Virgil was no stranger to a golden age; and Seneca has well described the peaceful state whilst Saturn reigned. But of all the representations, that which we find in Ovid is the most beautiful, and, allowing for poetic imagery, is accurately just.

"The golden age was first; when man, yet new,
No rule but uncorrupted reason knew,
And with a native bent did good pursue.
Unforc'd by punishment, unaw'd by fear,
His words were simple, and his soul sincere.
Needless was written law where none opprest:
The law of man was written in his breast.
No suppliant crowds before the judge appear'd;
No court erected yet, nor cause was heard;
But all was safe, for conscience was their guard."

Such notions of the felicity enjoyed by man in a state of innocence, were not confined to Italy and Greece, but have been discovered equally among the Persians, Indians, and Chinese. The Brahmins say, that in the beginning of the world, plenty was every where diffused, and milk, with wine and honey, flowed from fountains. Similar images were used by the Persian magi to convey a notion of primeval happiness.*

Thus Adam and Eve were happy in their situation, being placed in Paradise, which was delightful for agreeable and pleasing accommodations of every kind to regale their senses; it was stored with the utmost profusion of Divine bounty!

"O Jesus! at thy feet we wait,
Till thou shalt bid us rise,
Restor'd to our unsinning state,
To love's sweet paradise."

* See Townsend's Character of Moses, pp. 66—68.

# CHAPTER VIII.

## SEVENTH DAY.

## On The Sabbath.

Sabbath Instituted—Blessed and Sanctified—Given to Adam as a General Precept for his Posterity—Renewed before and at the giving of the Law—A Sign between God and his People—Worldly Business prohibited—Works of Necessity and Mercy excepted—Advantages resulting from observing it—A Seventh Day regarded by the Heathens—The Sabbath of universal and perpetual obligation—The Lord's Day.

When God had made the world, and furnished it with a variety of creatures, suited to the different elements of which it is composed; had created man after his own image, far superior to all the other species of beings, endued with rational faculties, whom he therefore constituted lord over them, situated in a residence curiously and beautifully adorned, and plentifully stored with every thing adapted for sustenance and delight; he exacted a reasonable service, which consisted in the worship of himself, the one only true God, in celebrating the expressions of his almighty power, infinite wisdom, and boundless goodness, displayed in his works. And to perpetuate, as well as give a solemnity to this worship, he set apart a portion of time for the exercise of it; by the constant and regular observation of which, a just sense of his infinite perfections, the recollection of his wondrous works, and the true worship of him, might be retained among men.

Moses, the sacred historian, says, "Thus the heavens and the earth were finished, and all the host of them. And God rested the seventh day, and sanctified it: because that in it he had rested from all his work which God created and made." Here we have the origin of the Sabbath, *because that in it he rested,* says Moses; שבת *shebath,* from *shabath,* he rested; and hence *sabbath,* the name of the seventh day, signifying *a day of rest.* Not that he was weary with working, but he ceased to work, or rested from making any more creatures, or species of beings, all kinds being already either actually or virtually made. When he had finished the works of creation, in which he was employed six days, he rested on the seventh, and *blessed* and *sanctified* it; consecrated it for man to rest from all secular labors, and religiously employ this portion of time. This *blessing* and *sanctifying* the seventh day has the force of a law or command. God separated it from a common to a religious use, to be a standing memorial of his works of creation; and to be a sign to Adam and his posterity, who, by working six days and resting on the seventh, should show themselves to be the worshippers of that Being who made the world in six days, and rested on the seventh.

The method pursued in creating the world, presenting a regular succession of astonishing events, was doubtless intended to convey useful instruction to mankind. Considering the almighty power of the Creator, his *fiat* would have been sufficient instantly to produce the whole apparatus of nature, in beautiful and regular order. But he proceeded by degrees in this work, probably to teach us, that, after working six days, we also should rest on the seventh. What other reason can be assigned for his procedure, when a more expeditious plan would have been as easy to him, and more consonant to his omnipotence: but only, that all mankind from this measure should have a perpetual reason and obligation to consecrate a seventh day, after six days labor, to be a holy rest to the Lord; and it is reasonable to suppose that God expressly declared his will to our first parents as to this matter.

As the command for observing the seventh day was given to Adam, as a general precept for all his posterity, no doubt he and his sons regarded it. Afterwards, through the impiety of the antedeluvians, it might be obliterated in the earth, except in the solitary family of Noah; who, being a preacher of righteousness, cannot be supposed to have neglected the observation of this day, or to have omitted recommending such an important point of religion to the new world after the Flood. And though after this, when men were again multiplied on the earth, wickedness and idolatry were introduced, and the lapse of time had effaced from their minds this and other precepts of religion received from Noah; yet, we cannot but suppose that this important institution, with other things relating to the worship of God, was retained in the family of Abraham, and the succeeding Patriarchs, till their bondage in Egypt. But when, through the iniquity and idolatry of succeeding generations, the particular time, at first designed and allotted for this special service, became forgotten, and Divine worship was entirely neglected by the generality of mankind, God then revealed and instituted the Jewish religion, prescribed the mode of worship to be used, and by a special law appointed a certain season for the more solemn exercise of it; and to be a token of the sincere worshippers of the true God, who created all things: and the day thus appointed and consecrated to public worship, was called the *Sabbath*, on account of the rest required to be strictly observed on it, and a command given to all that they observe and sanctify it.

This command originally given to Adam, was renewed before the giving of either the moral, judicial, or ceremonial law. It is expressly taken notice of at the fall of the manna, which was granted to the children of Israel in the wilderness of Sin, before they came to Sinai, Exod. xvi, 23—27. It was afterwards inserted in the body of the moral law, Exod. xx, 8. It is annexed to the judicial laws, i. e. the laws determining right between man and man, and the punishment of transgressors, Exod. xxiii, 12. And it is added to the first part of the ceremonial law, or Levitical rites and ceremonies, Exod. xxxi, 13—18; in which passage it is repeated four times in the compass of four verses. In the fourth command God says, "Remember the Sabbath-day, to keep it holy." What day is meant, the following words determine, "Six days shalt thou labor, and do all thy work: but the seventh is the Sabbath of the Lord thy God: in it thou shalt not do any work." That is after six days of labor, the seventh shall be a day of holy rest, set apart for the public worship of God. The reason to enforce this is added, "Because in six days the Lord made heaven and earth, the sea, and all that in them is, and rested the seventh day." The Jews, in many of their feasts, were commanded to rest from servile labor, on which account these are sometimes called *sabbaths;* but we also read of one day, which, by way of eminence, is styled the Sabbath, or day of rest. Thus we see, that the precept which God gave the Jews for the observation of the Sabbath, appears to be only the repetition or renewal of the law given to mankind from the beginning of the world, and not the first publication of it. A new reason indeed is added for the observation of it, namely, their redemption from Egyptian bondage, which was effected on the seventh day of the week, when God overthrew Pharaoh and his host in the Red Sea, and thereby delivered them. "Remember that thou wast a servant in the land of Egypt, and that the Lord thy God brought thee out thence through a mighty hand, and by a stretched out arm: therefore the Lord thy God commanded thee to keep the Sabbath-day." And the Jews kept their Sabbath on the seventh day of the week, in remembrance of their redemption from slavery in Egypt.

It is worthy of remark, that the command for the religious observance of the Sabbath, was delivered by Moses at Mount Sinai, in a way different from all those ordinances which were only ceremonial. It was written by the supreme Being himself on tables of stone, on which every other thing written was confessedly moral, and of perpetual obligation: but no part of the ceremonial law was written by the finger of God. The fourth command was written on tables of stone, to signify that it was to continue, as well as the other; and also it was put into the Ark, with the rest of the moral precepts, and is referred to Deut. x, 4. as being one of the number.

The sanctification of the Sabbath is considered as a *sign* between God and his people. "Verily my sabbaths ye shall keep: for it is a sign between me and you, throughout your generations; that ye may know that I am the Lord that doth sanctify you:" or, as the original may be rendered, a sign to acknowledge that I Jehovah am your sanctifier. Again—"And hallow my Sabbaths; and they shall be a sign between me and you, that ye may know that I am the Lord your God." Thus God made the sanctification of the

Sabbath a sign by which it might be known who did belong to him. Working six days, and keeping a holy rest on the seventh, is a sign of being the worshippers of the one living and true God, who made heaven and earth in the space of six days, and rested the seventh: consequently, the neglecting and profaning the Sabbath is a tacit renouncing of him. Therefore the Jewish Rabbies have this saying among them, Whoever breaks the other commands is a wicked Israelite; but he who openly and avowedly profanes the Sabbath, is considered as an infidel and idolater. Hence we read, that such were to be cut off from the people, and put to death: as they would not comply with this institution, so God would not own them as his people, but reject them.

To those who religiously observe the Sabbath, there are many particular promises made. "If thou turn thy foot from the Sabbath, from doing thy pleasure on my holy day; and call the Sabbath a delight, the Holy of (or to) the Lord, honorable; and shalt honor him, not doing thine own ways, not finding thine own pleasure, nor speaking thine own words: then shalt thou delight thyself in the Lord; and I will cause thee to ride upon the high places of the earth, and feed thee with the heritage of Jacob thy father: for the mouth of the Lord hath spoken it." Here God secures to such persons the good of the land of Canaan, which he has promised as an heritage to Jacob and his seed. Plenty, honor, and security in the enjoyment of temporal blessings, are annexed to a religious performance of the duty; he will bless the honest labors of those who faithfully serve him, on the six days of the week, which he has appointed for secular employments. The more sincere and devout any person is in keeping the Sabbath, the more will his business prosper on other days. Promises of this nature have been accomplished in all ages, to those who have sanctified the Sabbath; and no doubt they will continue to be so in every subsequent period of time.

Attending to worldly business on the Sabbath, is a profanation of it, and strictly prohibited. God says, "Thou shalt not do any work, thou, nor thy son, nor thy daughter, thy man-servant, nor thy maid-servant, nor thy cattle, nor the stranger that is within thy gates." Again: "Six days shall work be done: but the seventh day is the Sabbath of rest; ye shall do no work therein: it is the Sabbath of the Lord in all your dwellings." The Sabbath was awfully profaned in the days of Nehemiah. He says, "In those days saw I in Judah some treading wine-presses on the Sabbath, and bringing in sheaves, and leading asses; as also wine, grapes, and figs, and all manner of burdens, which they brought into Jerusalem on the Sabbath day: and I testified against them in the day wherein they sold victuals. There dwelt men of Tyre also therein, which brought fish, and all manner of ware, and sold on the Sabbath unto the children of Judah and Jerusalem. Then I contended with the nobles of Judah, and said unto them, What evil thing is this that ye do, and profane the Sabbath-day? Did not your fathers thus, and did not our God bring all this evil upon us, and upon this city? yet ye bring more wrath upon Israel by profaning the Sabbath. And it came to pass, that when the gates of Jerusalem begun to be dark before the Sabbath, I commanded that the gates should be shut, and charged that they should not be opened till after the Sabbath: and some of my servants set I at the gates, that there should no burden be brought in on the Sabbath-day. So the merchants, and sellers of all sorts of ware, lodged without Jerusalem once or twice. Then I testified against them, and said unto them, Why lodge ye about the wall? if ye do so again I will lay hands on you. From that time forth came they no more on the Sabbath." This is a noble instance of well-directed zeal, and successful effort, in that great and good governor. His example ought to be followed by persons in authority, filling high official situations. The prophet Jeremiah speaks to the same purpose, "Thus saith the Lord, Take heed to yourselves, and bear no burden on the Sabbath-day, nor bring it in by the gates of Jerusalem: neither carry forth a burden out of your houses on the Sabbath-day, neither do ye any work, but hallow ye the Sabbath-day, as I commanded your fathers."

Works of necessity and mercy are here to be excepted: these may be done consistently with the sanctification of the Sabbath, though they are servile and laborious. But great care must be taken, not to plead necessity where there really is none. By such works are meant things of importance, which could not be done the day before, nor postponed till after the Sabbath. A necessity which is occasioned by negligence, or want of thought, or is only necessary to some worldly advantage, will not be a sufficient excuse in this case. In seasons when people have more than ordinary business in their hands, and therefore are apt to plead necessity for encroachments on the Sabbath; yet, even then, God has particularly commanded them to rest. "Six days shalt thou work; but on the seventh day thou shalt rest: in earing-time and harvest thou shalt rest."

The religious observance of the Sabbath is adapted to promote the spiritual advantage of God's people. Its exercises tend to wean them from this present world, and raise them above the attractions of sense. By this holy rest there is a pause made in their earthly pursuits, and they are called more solemnly to reflect on the invisible and important realities of a better world, in order to excite their devout affections. Had they no such intervals, their hearts would soon be overcharged with the labors and cares of this life, and they would be too regardless of a better state. God has made it even unlawful for them to follow any secular employments on this day, on purpose to preserve them from the undue influence of the objects of sense, and that they might with more intenseness pursue spiritual and eternal things. It is certain, as one judiciously observes, that much of the power of godliness consists in persons living above the present world, in being dead to it, in viewing it with a holy indifference, and in setting their affections on things above. But this would be very difficult, or next to impossible, if they were to be constantly employed in worldly affairs; and therefore he who best knows the composition and constitution of man, has wisely and graciously appointed one day in seven, as a rest from terrestrial pursuits, and as a season wherein he should set himself more intensely to prepare for the heavenly world. When thus withdrawn from earthly concerns, persons can more impartially examine, weigh, and consider how unsuitable a portion they are for an immaterial soul, immortal in its duration. They have leisure to meditate with greater freedom on the Author of their being, on his end or design in placing them on the earth, and on the results of their conduct awaiting them in a future state. They, therefore, who are duly informed of the worth of the soul, and suitably impressed with the awfulness of that world to which they are hastening; who desire the felicity of heaven, and dread the misery of hell; will rejoice at the return of the Sabbath, wherein they are called diligently to prepare for the one, and most cautiously to avoid the other. While thus abstracted from all sublunary things, and engaged in the exercise of devotion, they gain a more intimate communion with God. "Every one that keepeth the Sabbath from polluting it, and taketh hold of my covenant; even them will I bring to my holy mountain, and make them joyful in my house of prayer; their burnt-offerings and their sacrifices shall be accepted upon mine altar." When persons are employed on this sacred day, in meditating on the infinite perfections of God displayed in his works; when the desires of their souls are after him, and they are engaged in offering up prayers and praises to the glorious Author of their being and blessings; then he manifests himself to them in a manner he does not to other men, sheds abroad his love in their hearts, accepts their persons and services, and fills them with joy and peace. This communion is most effectually promoted, when they are disengaged from earthly things, and wholly employed in the duties of religion: according to that very encouraging promise, "In all places where I record my name, I will come unto thee, and I will bless thee."

The seventh day was observed by heathen nations, as well as the Jews. Josephus ventured to affirm, "There is no city, whether Grecian or Barbarian, there is no nation, which does not rest on the seventh day." Philo Judæus stated many years before, that the seventh day was a festival, not to one city or one country, but to all; and he, therefore, calls it the *universal festival.* The heathen writers speak of the Sabbath as a high day among them.

Clemens Alexandrinus gives quotations from Linus, Homer, Hesiod, and Callimachus, who speak of the seventh day as a day on which the work of the creation was finished, and call it *the holy day*, and *the birth day of the world*. Lucian informs us, in his Pseudologista, that children at school were exempted from study on the seventh day. This day Suetonius calls a *sabbath*. If any should say, that the Heathen, from the acquaintance they had with the Jews and the writings of Moses, knew that the seventh day was to be kept holy: I would answer; that is not probable, for some of the Heathen writers who speak of the seventh-day Sabbath, lived near the time of Moses. Beside, the Greeks were at that time wholly ignorant of his writings: the Jews thought it a profanation to communicate any part of them to the Heathen. Nor were the writings of Moses translated into the Greek language till several hundred years after Homer: the translation was made in the days of Ptolemy the second, king of Egypt, about three hundred years before the Christian era. And it is not of the Jews Saturday-sabbath that the Heathen writers speak, but of another day in the week. It was not the seventh day of the week to which the ancient heathens confined their rest, but *a* seventh day, *one* day in seven. Their Sabbath or high festival was that day of the week on which they worshipped the sun, their chief god. It remains then, that the notice of the seventh day among the Heathen came to them originally from the Patriarchs, whose descendants, in their several dispersions, carried along with them some impressions of the true religion, which partially continued with them afterward, though awfully corrupted with idolatry. To cure mankind of this idolatry, and secure the worship of him who made the sun, and the whole universe, Moses, by Divine direction, appointed the last day of the week to be the Jewish sabbath. We may also state, that the reason which God has assigned for sanctifying the seventh day to be the Jewish sabbath, namely, his creating the world in six days, and resting the seventh, not only concerns the Jews, but also the Heathens, who are equally bound to remember and adore their Creator. Hence the *Strangers*, or Gentiles, who sojourned among the Jews, and were not obliged to keep the ceremonial law, were bound to keep holy the Sabbath.

Thus we perceive, that this command is of a moral nature, and, therefore, of universal and perpetual obligation. The Sabbath was instituted from the beginning of the world, while all things were perfectly good, and our first parents were innocent and adorned with the beauty of holiness: even then the Creator appointed that the seventh day should be employed in his more immediate service. Some have thought, that there is no express command for the observance of the Sabbath, till after the children of Israel had come out of Egypt; and, therefore, that all the obligations to observe it must be derived from the law of Moses. But this command was given before sin had infected human nature, consequently previous to the ceremonial law, which, in all its parts, was contrived on account of sin, and intended to point to a Saviour: for in a state of innocence, there could be no propriety in the adoption of such shadows and ceremonies. Nay, as Archbishop Usher observes, the appointment of the Sabbath was not only before any part of the ceremonial law, but before any promise or prediction of Christ, to whom all the ceremonies of the law had respect. Therefore we may conclude, that a command which was to be observed though man had never sinned, and which stood in full force from the creation of the world, cannot be made a part of the ceremonial law, which was not given till after the expiration of 2,500 years. This is a duty incumbent on all mankind, as is evident from the reason and end of its first institution; all men being alike God's creatures, and as such equally concerned to worship him and commemorate his works. The Sabbath is as obligatory on all succeeding generations of men, as it was formerly on the Jews, or before the Mosaic economy, on the Patriarchs and their contemporaries. Every creature of God on earth, endued with reason, is obliged to separate this day from his common time, and to keep it holy to the Lord.

When the Jewish ceremonial law was abrogated by Christ, the fourth command continued in force, and was observed. Speaking of the moral law, our Saviour says, "Think not that I am come to destroy the law or the prophets. I am not come to destroy, but to fulfil. For verily I say unto you, Till heaven and earth pass, one jot or one tittle shall in no wise pass from the law, till all be fulfilled." Now if not one י *yod*, the smallest letter in the Hebrew alphabet, or *tittle*, or *point*, κεραια, either meaning those *points*, as a learned author remarks, which serve for vowels in this language, if they then existed; or the *apices*, or points of certain letters, such as ר *resh*, or ד *daleth*, ה *he*, or ח *cheth*, as the change of any of these into the other would make a most essential alteration in the sense; I say, if not one of these was to pass from the law, surely not the command which is the longest of all the ten, is the only one to which a memento is prefixed, and has more reasons to enforce it than any of the other nine! Yea, so far from abolishing this command, our Saviour explains it, in the case of his disciples plucking the ears of corn on the Sabbath; which is a manifest proof that he intended it to be continued for the use of the Christian Church. He also enjoined his disciples to pray, when Jerusalem should be destroyed, which did not occur till forty years after his death, and the consequent abolishing of all the Jewish rites and ceremonies, that their *flight* might not be on the *Sabbath-day*.

From the beginning of the world to the Christian dispensation, the seventh day of the week was the Sabbath: ever since the resurrection of Christ from the dead, the first day of the week is the Christian Sabbath. Our Saviour, who is "Lord of the Sabbath," changed it from the seventh to the first day of the week; which does not in the least derogate from the honor and glory of God. If one Sabbath had been abolished and not another instituted in the room of it, then he would lose the honor of public worship, which he has appointed to be performed on that day. However, if there be a greater work than that of creation to be remembered and celebrated, to appoint a day for that special purpose, tends much more to advance the glory of God, than if it should be wholly neglected. And if "all men should honor the Son, even as they honor the Father," then it is expedient that a day should be set apart for this worship, namely, the day on which Christ rested from the work of redemption, or, as the apostle expresses it, "ceased from his own works, as God did from his." In altering the Sabbath, from the seventh to the first day of the week, our Saviour displayed his sovereign authority; herein he enjoined what time he would have consecrated for his worship under the Gospel dispensation, as well as what worship he would have performed on that day. In observing the Christian sabbath, we express our faith in a public manner, that Christ is come in the flesh, and has completed the work of our redemption; and, consequently, that there is a way prepared for our justification, access to God, and hope of finding pardon, acceptance, sanctification, and eternal life. And as all the ordinances of Gospel-worship have a peculiar relation to Christ, it is proper that the time in which they are performed should likewise have respect to him; and, therefore, the first day of the week is set apart in commemoration of his finishing the work of our redemption.

That the Sabbath was actually changed from the seventh to the first day of the week, appears from the example of the apostles, who, after the resurrection of Christ, celebrated that day as a Sabbath. It was on the first day of the week that the Holy Ghost was poured down in a most miraculous manner on the apostles, to qualify them for the ministry, and render them fit instruments for propagating Christianity in the world. While St. Paul was at Troas, we read, that "upon the first day of the week, when the disciples came together to break bread," i. e. to receive the Holy Sacrament, "Paul preached unto them." This was not a private, but a public meeting of the Church; nor was it a day occasionally appointed by the apostle, but the stated time of their meeting; and it was usual for the Christians on their Sabbath to receive the Lord's Supper. The apostle had continued at Troas seven days; why did they not meet together, and he preach to them, on the seventh day of the week? because it was no longer the Sabbath, but changed to the first day. It was on the first day of the week that the primitive Christians made collections for the poor.—"Now concerning the collection for the saints, as I have given order to the churches of Galatia, even so do ye. Upon the first day of the week let every one of you lay by him in store as God hath prospered him, that there be no gatherings when I come." Every man at the conclusion of the week, was to cast up his weekly earnings, and see how much God had prospered him; and then to bring a right proportion, on the first day of the week, as is most likely, to the church or assembly, that it might be put in the common treasury. Thus it appears, as a learned commentator remarks, that the first day of the week, which is the Christian sabbath, was the day on which their principal religious meetings were held in Corinth, and the churches of Galatia; and, consequently, in all other places where Christianity had prevailed. The apostle John speaks of the Lord's day, "I was in the spirit on the Lord's day." He calls it the *Lord's day*, because on it Jesus Christ rose from the dead, and had appointed it to be the Christian sabbath: thus one Gospel ordinance is called the Lord's Supper, from its having been instituted by Christ.—If any should inquire when it was that Christ gave instruction to his apostles concerning the change of the Sabbath; we may reply, that it was in that interval of time, during which he "showed himself alive after his passion by many infallible proofs, being seen of them forty days, and speaking of the things pertaining to the kingdom of God;" of which we may reckon the change of the Sabbath to have been one. But if this should not be deemed sufficiently satisfactory, we have the highest reason to conclude, that information was given to the apostles by the inspiration of the Holy Spirit, whom Christ had promised to send them, and that should guide them into all truth. And surely there could not have been a more proper day fixed on for the Christian sabbath; and which the Christian church has ever since continued to observe, and of which God himself has signified his approbation. And as the reason of the change now stands, we can neither observe the Jewish seventh-day Sabbath, without disowning the redemption which Christ has accomplished for us; nor can we refuse to comply with this alteration, and keep holy the Lord's day, without a manifest contempt not only of our Creator, but of our gracious and merciful Redeemer, who, on this day of the week, rose from the dead, and thereby confirmed our redemption from sin, Satan, spiritual thraldom, and everlasting misery.

As the redemption of the Jews out of Egypt was typical of our redemption by Christ, and the Jews on their Sabbath were to keep their deliverance in remembrance; so surely Christians are under the greatest obligations on the first day of the week to remember their redemption by Christ. On this day our blessed Saviour rose from the dead, and his resurrection is a demonstrative evidence that the Supreme Judge is fully satisfied, and become the God of peace. There is no dispensing with the honor of the moral law, no receding from the sacred rights of justice. The obedience and death of Christ, as our surety, were such as the law and justice required; and by which the honor of God is secured, and of which he has most expressly declared his acceptance. When Christ had laid down his life, in an ignominous death, which was all that the law and justice could insist on, God himself unloosed the fetters of the grave, threw open the prison door, and in his resurrection from the dead, gave an evident and solemn testimony of his approval. This was the accomplishment of the words of the prophet, "He was taken from prison, and from judgment;" released and discharged, in full evidence that he had made satisfaction, and that God had accepted the payment at his hands. The apostle remarks on this important point, "Whom God hath raised up, having loosed the pains of death: because it was not possible that he should be holden of it." Not possible, as it is not just or righteous that a prisoner, who has satisfied every demand that the law has on him, should be kept longer in prison. The resurrection of Christ, therefore, was an open and authentic acknowledgment, that God, considered as the moral Governor and Supreme Judge of mankind, acquiesced in his death, as a proper, full, and perfect satisfaction to Divine justice for sin. Hence he is represented, in raising Christ from the dead, as acting under the peculiar character of the God of peace. "Now the God of peace, that brought again from the dead our Lord Jesus Christ, that great shepherd of the sheep, through the blood of the everlasting covenant." What a delightful view does this present of the resurrection of Christ—a risen Saviour, and a reconciled God! How safely may men trust in the one, and with what humble confidence may they apply to the other, for pardon, holiness, and heaven. With what holy joy should they on the Lord's day call to remembrance his resurrection, and meditate on the greatness of his love in shedding his blood for "the remission of sins," and to secure for them everlasting happiness.

The ardent desire he manifested for our welfare was not extinguished, or even abated, by the most discouraging considerations: not by the unworthiness of those who were the objects of his compassion; not by the thoughts of obscuring his Divine glory with frail humanity; not by the prospect of being exposed to the contempt of men and contradiction of sinners; not by the view of meeting with very ungrateful usage from his friends, and falling under the most bitter persecutions of his enemies; not by the necessity, arising from a covenant engagement, of suffering the punishment due to sin, and submitting to a most ignominious and painful death. In opposition to these formidable obstacles, our blessed Redeemer resolutely and immoveably persevered in his benevolent design of dying for us, and thereby effecting our salvation; and when suspended on the cross, he cried, "It is finished," and gave up the ghost. For calling this to remembrance, was the Christian sabbath instituted; and if the consideration of the love of Christ in being "delivered for our offences, and rising again for our justification," will not constrain us to sanctify the Lord's day, every other motive or reason will fail.

THE END.