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EXISTENCE AND DEITY

Illustrated and Explained;

BY

ROBERT SHAW, M.A.,
FOR MANY YEARS A DILIGENT AND UNBIASED STUDENT OF THE SUBJECT OF DEITY AND OF CREATED EXISTENCE.

In Two Parts.

PART FIRST.

Montreal;
PRINTED FOR THE AUTHOR.
1872.

INTRODUCTION.

THE principal object of this book,—although this is not the only purpose it answers, for it conveys to the reader a vast amount of information the most interesting and important,—is to simplify matters with respect to the subject of Deity. This being the chief end in view in its production this book is different from any that has preceded it, and, therefore, fills a place not supplied by any other. There is no substitute for this book in any language spoken on the earth. The subject of the Creator and that of Creation are intimately connected, and in this book the one is made to illustrate the other. The works already in print upon the subject of Deity or Theology are for the most part merely systems of ideas elaborated from the mind or imagination of the authors, and popularly called systems of Theology, or Bodies of Divinity, doubtless consisting of some truth, but mixed with much that is erroneous; considered in the light of works of fiction some of them speak well indeed for the inventive genius of their authors. This book deals with the subject of an omnipresent Deity, his character being illustrated by his works of creation and by the various objects and scenes of existence; but though omnipresent yet he is shown to be infinite as existence, and being infinite not conceivable by the mind of man, much less to be seen by his eye.

This is especially the case in Part First of the work, which treats of existence in its various conditions, phases, and aspects,—Physical, Spiritual and Moral,—and illustrates variously the subject of creation and the character of the omnipresent and infinite Deity.

In using the sciences for illustration of existence in Part First of the work, more especially the science of Astronomy, we found it both necessary and most to the purpose to set forth the science itself with its deductions and discoveries hitherto, which will be much more beneficial, and satisfactory to the readers than the statement of isolated facts and ideas derived from that science, its deductions and discoveries. Besides, we have treated of the Scenery of the heavens as viewed from the Planets and their Satellites which makes the subject of Astronomy, as here presented, far more interesting than as set forth in the common treatises on that science; and exhibits the power, wisdom, and glory of the Deity, as set forth in the scenes of existence, in a peculiarly interesting light.

The especial object kept in view in Part Second of the work is to remove erroneous opinions which have hitherto prevailed with respect to Creation, Redemption, and the subject of Deity generally, as derived from a partial misunderstanding of the Old and the New Testaments of our Bible, or from other sources; to remove error superstition and idolatry from the universal Christian Church; to disenthral the minds of mankind from the bondage of superstition and ignorance, to liberalise and enlighten them; and to teach human beings, as they are also taught in Part First, that they are really free and responsible agents, who may, if they will, be and do good rather than evil; and that their duty is, with respect to adoration, to worship the invisible and omnipresent Deity alone, with the peech and with the understanding, in spirit and in truth.

The subject of Deity, infinite existence and of Creation, is variously illustrated in Part First; Mystery, the prolific mother of superstition, is removed in Part Second; the true light now shines, and men to whom this book may come shall no longer have any excuse for their errors of superstition and idolatry and for their evil practices, all which we trust they will for the honor of their righteous and holy God henceforth discard and eschew.

We have observed throughout in its preparation the strictest impartiality in regard to religions, especially when treating of the Christian religion as to its origin, and in the application of the civil and religious history of the Christian nations to the fulfilment of the Scriptural prophecies in Part Second of the work. Our whole aim was to set forth the truth in plain and moderate language with respect to the Christian establishments and their history, or the establishments of Church and State of the Christian nations, there being no deviation from the line of truth on any consideration of sect. When, therefore, the Catholic of the Greek or Roman Church reads concerning the fulfilment of the prophecy in the history of the Church and State establishments of Constantinople and Rome, or of the East and West, let him remember that he has before him only a fair and impartial representation of the subject, — a subject which, it is very plain, we could have no object to misrepresent,—and let such read on carefully and patiently, and before he has got through reading the history of the Protestant branch of the Catholic Christian Church, as applied to the fulfilment of prophecy, he may perhaps conclude that the scale is pretty equally balanced and that there has been no impartiality used, and no misrepresentation made by the author. On the other hand, when the Protestant reads the history of the Greek and Roman Churches as applied to the fulfilment of prophecy, let him not be disposed to be captious or to glory in the failings of men, but bethink himself that he is reading the history of his own ancestors in common with those of his brethren of the Greek and Roman Churches, and keep in mind that in reading the history of his own branch of the Church he will observe that like failings characterised its founders of the Reformation and onwards, as he has seen to have characterised the old heads and leaders of the Greek and Roman branches of the Catholic Church, though in the main not to so great an extent. He will observe that this varied display of human character in every age and nation is simply the outworking of the principles inherent in human nature; that each human being in any or in every age or nation may, if he will, be and do good rather than evil, that when one thinketh he standeth he should take heed lest he fall, and should always be a living, active power for godliness in the world, which is the only safeguard against being and doing evil.

To such as might be disposed to look upon this work with an eye of criticism, as only the learned and competent could be supposed to do, we may remark that the work, consisting of Two Parts, is one of design, neither part being complete without the other, and that the whole needs to be read through carefully in order for the idea and design to be completely understood. It is better, however, for all to read it with a sober and a prayerful spirit than with an eye of criticism and captiousness, and thus to profit by the information and experience which it affords.

The authors we have consulted and from whom we have quoted in the the preparation of this work, both in its First and Second Parts, are, in their several departments, regarded by the learned as the highest standards for veracity and style.

We have also added to the Second Part of the work several brief discourses explanatory of the prominent doctrines of Christianity, which will not only be useful and interesting to Christian ministers in the future prosecution of their work, but also to the general readers. And, thus, we submit our work to a public, which we trust will appreciate it (as we believe they will,) in firm and humble reliance on God who has suggested and assisted its production, that it may result in the enlightenment and happiness of all, and so answer the purpose for which it is designed.

THE AUTHOR.

ERRATA.

On page 35, in line 15th from the top, for *system* read *systems*.

On page 69, in line 11th from the bottom, for *Mardonus* read *Mardonius*.

On page 73, in line 16th from the bottom, for *Yermark* read *Yermuk*.

On page 97, in line 17th from the bottom, for *become* read *became*.

The work from which that quotation is, which begins at the bottom of page 102 and ends on page 104, is entitled "China and the United States," by Dr. Wm. Speer, a missionary of the American Presbyterian Board.

On page 128, in the 17th line from the bottom, the semicolon (;) properly comes after the word "name."

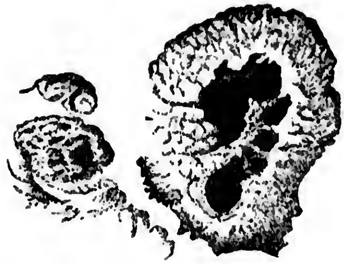
On page 132, in line 14th from the top, for *rousing* read *roaring*.

On page 226, in line 14th from the top, the proper order of the colors is *red*, *orange*, *yellow*, *&c.*, as seen in the figure on the same page.

On page 246, in line 10th from the top, for *their* read *thin*.

On page 267, in line 8th from the top, for *inconceivable* read *inconsiderable*.

The annexed figure represents a large spot on the Sun to which No. 103 on page 284 refers.



On page 286, in line 19th from the top, for *faculta* read *faculæ*.

On page 287, in line 16th from the bottom, for *revolved* read *resolved*.

On page 300, in line 15th from the bottom, for "66° 3′" read "66°,32′"; and in line 11th from the bottom, for "66°" read "66° 32′."

On page 331, in the bottom line, for "$\frac{1}{30}$th" read "$\frac{1}{60}$th"

On page 335, in line 22nd from the bottom, for *plan* read *plane*.

On page 349, in line 11th from the bottom, for "$\frac{1}{32}$th" read "$\frac{1}{5}$th."

On page 362, in line 7th from the top, for "1774" read "1744."

On page 400, in line 3rd from the top, after the word *phases* supply the words *as the moon*; and in line 10th from the top, for *Copernicus* read *Copernican*.

On page 425, in line 2nd from the bottom, for "Foo" read "Foë."

On page 437, in line 10th from the bottom, for *receptable* read *receptacle*.

On page 438, in line 13th from the bottom, for *superstitions* read *superstitious*.

On page 498, the phrase *Remarks on the preceding* placed nearest the bottom is merely a repetition and means nothing.

On page 510, in line 8th from the top, after the word *accomplishment* supply *of the purposes*.

On page 537, in the 11th line from the bottom, for *Remarks on the Preceding* substitute *On the Transfiguration*.

On page 641, in the bottom line, for *Jesus* read *Jews*.

On page 649, at the bottom, for γιγώνσκω read γιγνώσκω.

On page 731, in the 9th line from the top, for *rules* read *rulers*.

On page 764, in the 2nd line from the bottom, for *erę* read *were*.

On page 796, for *Doxént* read *Docent*, and for *Anabaptists* read *Anabaptistas*.

On page 801, in the 7th line from the bottom, for *instituing* read *justifying*.

On page 809 at the bottom, for *Eccles. Researches* read *Hist. of Chs. V.*

On page 825, in the 12th line from the top, for *ascent* read *assent*.

On page 833, in the 6th line from the bottom, for *smoe* read *some*.

On page 836, in the 17th line from the bottom, for *adopted* read *developed*.

On page 875, in the 7th line from the bottom, for *them* read *their*.

On page 880, in the 12th line from the bottom, for *glorifying* read *glorying*.

CONTENTS

PART FIRST.

EXISTENCE AND DEITY.

PART I.

EXISTENCE, PHYSICAL, SPIRITUAL AND MORAL, ILLUSTRATED.

WHEN we speak of the CREATOR we mean that Being whose presence is everywhere, who has created all things that have been created in the physical universe, and in whom we live and move. When we speak of the Creator being everywhere present, which means in every conceivable or inconceivable place in the universe, we do not mean to say that He is visible to the eye or can be conceived* by the mind of man. The Creator is infinite, and an Infinite Being cannot be conceived by the mind, much less seen by the eye of sense. True, we see creation around us, but we are to remember that creation stands in the same relation to the Creator as the effect does to the cause which produces it. And we shall show further on how that we could not distinguish one object from another were it not for the intervention of the colors of light; and, we are aware, we could not see anything at all were it not for light itself. Also, when we speak of the Creator being infinite, and everywhere present, we mean that there exists but one such Being, for more than one Omnipresent Being there cannot be. But, though the Creator cannot be seen by the eye nor conceived by the mind, yet, since His agency produces all the effects that are produced in the natural world, His character may be understood and appreciated from a consideration of His works, just as the character of an artificer can be judged of from a consideration of the work he executes, or the strength of an animal from the power it exerts.

By the word CREATION † we mean change of what already exists into other forms. The changes which we shall have principally to illustrate in

* In our conceptions concerning the Creator we cannot conceive of Him as anything, although He is present everywhere, in the earth and in ourselves, creating in us to will and to do of His good pleasure. Being infinite He is not conceivable as any object or thing, but we can conceive of the ideas which have eternally existed in the Creator's mind, from the endless diversity of created objects which present themselves to our view.

† This general idea of creation refers to all the objects created on and in the earth, on and in each of the heavenly bodies, or in any part of space, as well as to the earth and each of the heavenly bodies themselves, inasmuch as they, analogously to the human body while living, are continually and wholly subject to change, and are in this sense objects of creation.

this part of our work are of two kinds: *first*, that unceasing change which we see ordinarily take place in nature by growth and decay, and which we may also term transformation of matter; and, *secondly*, change of place by motion, as that effected by the earth in its journey round the sun. The first kind of change or transformation of matter, according to the ordinary operations of nature, is that only which we denominate creation, being effected by the Creator; the second kind of change, or change of place by motion, although effected by the Creator, yet is not creation, since it effects no transformation of matter, but only a presentation of the same thing in a different place, or after a certain period in the same place again. Change of place by motion will be fully illustrated when we come to speak on astronomy. There are yet other kinds of change which pertain especially to man as a free, intelligent actor, and which we shall also illustrate in their proper place, when speaking of the moral world, or that world which exists with special reference to man as an intelligent and free actor.

CHANGE by transformation of matter may be illustrated from numberless sources by ordinary observation. Thus, a flower which begins to grow in the spring, and blooms in the summer, since it did not exist before, is a creation. The species of vegetable to which the flower belongs had before existed; the seed from which the flower sprung had previously existed; the flower is the effect of change of matter; it had not existed before as a flower; it is created. And it may be here observed that no change or combination of matter could produce that flower, or any other particular plant, except the seed of that flower or plant existed before to give it birth. Take, for illustration of the property of seeds, the grain of wheat; it puts forth the blade in the Fall or Spring, which gradually grows till it comes to maturity as a full ear in the Autumn. This ear of corn did not exist before; the species of vegetable to which it belongs existed before; the kernel in which it was germinated and which gave it birth previously existed; (and we may remark in passing that the young plant exists in embryo in the seed, and that the process of sprouting takes place in the seed itself, independently of the aid of the earth, as may be observed in the case of barley or other grain sprouting when moistened and subjected to heat for some time in the process of malting) this ear of wheat, we say, since itself did not exist before, is a creation. The seed, therefore, must exist before the plant, and every seed brings forth after its own kind. If a seed of wheat is sown an ear of wheat will result from it, if anything do result, and not an ear of rye or of any other species of grain; and an oak tree is sure to result, if any thing do grow, from the acorn.

This property of seeds is true of all animals as well as plants. When a child is born, or the young of any animal is brought forth, it is a creation. This organized being has not before existed, though its substance and life have never not existed. When the trunk of a fallen tree or the body of a dead animal becomes mineralized or petrified, this mineral or petrifaction is a creation, the component parts of the original form combining with certain other elementary substances, a new form or species of matter is produced.

Also, if it be understood that the earth assumed or was given its present form from the matter composing it having previously existed in another form, say in an æriform or nebular state, then that change of the matter into the form of the earth would be properly termed a creation, although of such a creation we may say there is no satisfactory evidence.

It is seen that on the surface of the earth, and for a short distance below it, all things are continually changing; one form of matter is continually taking the place of another in existences animate and inanimate. Animal and vegetable remains are changed into clay, and rocks and water; and these again enter into the production and support, and compose the solid framework of the organic structures of vegetables and animals. When the living or animate body dies it does not cease to exist, for there is no such thing as non-existence. True, if it be a human being that dies, that human being ceases to exist as an organised conscious agent, but the body retains the principle of life, which descends in it to the tomb. Death is only a sleep or state of unconsciousness of the body previous to its change into other organic or organised existences. Thus, the chrysalis state of the caterpillar, in which that creature remains to all appearance dead, has been often and aptly compared to the state of the dead of the human race. But what happens to the caterpillar? At the end of a month he comes forth from his tomb having gorgeously tinted wings, and soars on high, a beautiful butterfly. We have yet to learn whether in his new and exalted state of existence he remembers his former humble condition of a caterpillar. We may, however, presume that he does not.

The animate body dies because some one or some of its organs or faculties cease to perform their ordinary functions, just as a mill ceases to operate when a wheel or a cog is broken, or any of the internal machinery is deranged or out of gear. And, as the mill ceases to operate when deprived of sufficient motive power, as wind, water or steam, so does a human being die when he has not a sufficiency of air to breathe, of water to drink, or of food to eat. A man will also die if he have only a limited quantity of air to breathe, and this impregnated with noxious gases, as was the case with that great number that perished from suffocation in the "Black Hole of Calcutta" in 1756, and is the case with hundreds who are suffocated in coal mines, in our own time.

The wind-mill, when in working order, depends upon the same agencies to enable it to operate as a man does who has a sound constitution; they both depend upon the atmosphere; and reason, assisted by the atmospheric agent, directs the operations of the mill in both cases. In like manner a water-mill depends upon the same agency to enable it to operate as a man does, both, as before being supposed sound in their internal machinery, depend upon a sufficiency of water being furnished them; if this be not in sufficient quantity to turn the large water-wheel, the mill ceases to grind; and if there be not a sufficient quantity of water for the requirements of the animal system, or if, as in the case of noxious air, the quantity that is in supply be deleterious, the man's body consumes and he dies. Here we may remark that water enters largely not only into the support, but into the constitution of the human body, seventy-five per cent. of all the fleshy parts being water.

Also the steam mill is analogous to the human body, both, being sound in their internal parts, depending upon a sufficient quantity of steam being generated to enable them to perform their functions. The body, as the mill, has a furnace, the stomach, to which a sufficient amount of fuel, food, needs to be supplied, in order to keep up a sufficient degree of heat to sustain the combustion and decomposition which are continually going on in it; for by combustion and decomposition in the body there is a continual decay and waste of animal tissue, which decay and waste must be as constantly supplied by the generation of new chemical compounds in it. The human body, therefore, is truly a kind of laboratory in which a chemical process is continually taking place, of decomposition or decay, of recomposition for the supply of animal tissue; and, as it is said that no two persons see the same rainbow, so it may, with equal truth, be said that no human being has exactly the same body two days in succession.

And the human body is further, as is plainly perceived, analogous to the steam-mill, having its furnace, boilers, and complex machinery for generating heat and steam; for heat has to be generated in the body, and consequently steam in order that its functions may continue to be performed. In breathing out of doors on a cold frosty morning, one can see from the condensation of his breath as compared with the surrounding air at every exhalation what an amount of steam one generates.

If the human body therefore, as has been shown, is in every part continually undergoing change during life, is it any wonder or any ground of apprehension that there shall be a more radical and permanent change effected in it by death; a change from which a new and nobler creation may arise? Death, as we have before intimated, is only a loss of consciousness, and a cessation of action in the intellectual and sentient being. It is not a loss of life, for the body retains in every part the principle of life; it is not a loss of existence, for not a particle of the human system ceases to exist, but it is a change which the body must needs undergo previous to its being created anew into other forms of existence.

THERE IS NO DEATH.

There is no death! The stars go down
  To rise upon some fairer shore,
And bright in heaven's jewelled crown
  They shine for evermore.

There is no death! The dust we tread
  Shall change beneath the summer showers,
The golden grain or mellow fruit,
  Or rainbow-tinted flowers.

The granite rocks disorganize,
  And feed the hungry moss they bear;
The forest leaves drink daily life
  From out the viewless air.

There is no death! The leaves may fall,
  And flowers may fade and pass away—
They only wait through wintry hours
  The coming of May day.

There is no death! An angel form
  Walks o'er the earth with silent tread,
And bears our best loved things away,
  And then we call them "dead!"

He leaves our hearts all desolate;
  He plucks our fairest, sweetest flowers;
Transplanted into bliss they now
  Adorn immortal bowers.

The birdlike voice, whose joyous tones
  Made glad these scenes of sin and strife,
Sings now an everlasting song
  Around the tree of life.

Where'er he sees a smile too bright,
  Or heart too pure for taint and vice,
He bears it to the world of light
  To dwell in paradise.

Born to that undying life,
  They leave us but to come again;
With joy we welcomed them the same,
  Except their sin and pain.

And ever near us, though unseen,
  The dear, immortal spirits tread;
For all the boundless universe
  Is life—there is no death!

LORD LYTTON.

The principle of life is inherent in all matter and in every particle of it; and at this juncture of our discourse it may be well for us to state that there is nothing but matter in the universe. The life seems latent in rocks, earths, minerals, and such like, but a microscopic inspection of them will show that it is not entirely so. Every part of matter, even the solid rocks, the earth, the waters and the air, when examined with the microscope, is found to teem with living and sensitive existences. This instrument discovers to view myriads of little animals in a drop of stagnant water, some of them so minute that when viewed with a glass which magnifies one hundred thousand times, they severally do not appear larger than a visible point. And yet each one of these is a distinct being. If a microscope of high magnifying power be directed to the atmosphere on a calm, clear day in summer, shoals of animalcules may be seen in its undulations. But according to our statement above, the existence of life in matter does not depend upon its containing organised, sensitive beings, and the fact of its existence there may be illustrated by many and potent considerations.

All vegetables derive their nourishment from the earth assisted by the atmosphere and the sun. From these, animals derive their nourishment. It is true that the earth cannot bring forth vegetables or animals spontaneously; if it did, then we might say that they derived their existence *immediately* from the earth; these must spring from their peculiar seeds; but having been originated in that way, the earth and its accompaniments, the atmosphere and the sun, afford them increase of life and nourishment, which if matter did not contain it could not impart. All vegetables and their seeds return to the earth whence they sprung, bringing their principles of life and vegetation with them, and become earthy matter. Also the bodies of all animals return to the earth, bringing their principles of life and generation with them, and become part of the earth. These very principles of vegetation, generation, and life, again enter into the production and support of other living beings, animate and inanimate. It is, therefore, seen that the same principle of life which exists in all living beings, animate and inanimate, exists in the earth, the atmosphere and the sun.

And not only is the principle of life inherent in all matter but also that of intelligence. This principle is perceived, as it were, in its germ in the lowest orders of animals, and is brought to a fair degree of perfection in highly civilized and cultivated man. Between these two extremes there exist different grades and degrees of intelligence, but the fact of the existence of this principle in all animate beings is certain, and it needs only to be educed in order that it become apparent. But how is it to be educed in the case of the lowest orders of animals, microscopic animalcules? It need not necessarily be educed in their case, for they naturally exhibit it unmistakeably to observation. The following extract from Mr. Baker, a celebrated naturalist, in his description of the hair-like animalcules will help to illustrate this. "A small quantity of the matter containing these animalcules having been put into a jar of water, it so happened that one part went down immediately to the bottom while the other continued floating on the top. When things had remained for some time in this condition each of these swarms of animalcules began to grow weary of its situation and had a mind to change its quarters. Both armies, therefore, set out at the same time, the one proceeding upward, the other downward, so that after some time they met in the middle. A desire of knowing how they would behave on this occasion engaged the observer to watch them carefully, and, to his great surprise, he saw the army that was marching upward open to the right and left to make room for those that were descending. Thus, without confusion or intermixture, each held on its way; the army that was ascending marching in two columns to the top, and the other proceeding in one column to the bottom, as if each had been under the direction of wise leaders." Here we have unmistakeable evidence of voluntary motion and of a considerable degree of intelligence in these exceedingly minute animals.

The ancient Romans appear to have been aware of the inherent existence of the principle of intelligence from their use of the word *educare*, to educate, which means to draw out or develop that which already exists in principle within. Many of the inferior animals, when taught, display a remarkable degree of sagacity, and, although we need not necessarily believe what Cicero says as to Orpheus taming the wild beasts of the forest by playing to them on his lyre, yet we now-a-days have abundant experience of what the domesticated animals, such as horses and dogs, and many of the wild animals, such as lions and tigers, can be taught to do. As the rough, unshapen block of granite or marble from the quarry may be formed into the stately and beautiful sculpture, so resembling the living and animate being as to deceive us if not assisted by the sense of touch; as the rough block of iron ore may, by being put through a certain process of fusing, hardening, malling, etc., be reduced to the form of the sharp-edged instrument, the sword, the knife or the razor; as the telescope which so wonderfully opens up to us the distant regions of the universe, and enables us to contemplate far distant worlds, as if they were nigh; and the microscope which enables us to investigate the races of animated beings, invisible to the naked eye, which exist in the earth, in the air, and in all matter, are made chiefly of such earthy substance—as sand and ashes; even so may the intelligence of all the inferior animals which are capable of being taught be brought to a much higher degree of development than that which it has yet attained;—even so may the intelligence of uncivilized human beings be brought to that state of development to which civilized man has already attained; and that of civilized man be brought to a degree indefinitely higher than that which we know of man to have yet attained. It is an old saying, and generally a true one, that what is in will come out; but it is more positively true that what is not in cannot come out; therefore, if the principles of life and intelligence were not inherent in matter there could be no life or intelligence developed from matter; but, since life and intelligence do exist and are developed amid such complex and multiplex changes of matter, it is plain that the principles of life and intelligence do exist, though in different degrees, in all matter, and that in proper circumstances they become apparent, and by proper development they become more apparent; but that the fact of their non-apparency in certain states and conditions of matter to an intelligent being does not alter the fact of their existence there in a latent state.

Uneducated persons are apt to suppose that the air they breathe is the principle of life; some, that it is the soul. This seems to have been the conception of it entertained by the ancient Hebrews; for the Nephesh Hayya of the book of Genesis is translated into our language the "breath of life" or the "soul of life," but the truth is, the air only helps to sustain the animate being in life; it performs its part in supporting life, as food, the production of the earth, and water,—which two elements are quite as necessary for animal supports,—perform theirs. Air is the element which terrestrial animals breathe by means of lungs, just as water is the element which aquatic animals breathe by means of gills; alter the conditions of these two great classes of animate beings and they could not exist as animals; submerge a land animal in water and it will very soon be suffocated; elevate a marine animal to the land, and he will as soon die. All these animals are produced by their kind, but, having been introduced to the world they are supported by the elements to which they are naturally adapted. Not less than all these elements are necessary for their sustenance. The various tribes of aquatic animals are supported by different kinds of food which they find in the waters and on the bottom of the ocean, lakes, and rivers, on rocks, etc. Many of these tribes, which correspond to the carnivorous species of the land, subsist by preying on other tribes; but water is the element in which they all live, which they breathe, and from which mainly they derive their support,—for sea animals do not depend for support upon the land, their own realm supplying all their wants. We may remark here that a very small quantity of air pervades all water, and a small quantity of water in the shape of vapor pervades the atmosphere; and both these elements seem mutually to assist each other in the support of living beings, and to be adapted to each other's co-existence.

A man or any land animal may be in the enjoyment of an abundance of pure air and wholesome food, but, if he have not a sufficient supply of water for his animal wants, he will die. Also, he may have an abundance of pure air and water, and, if he have not a sufficient supply of wholesome food, he will die. And, further, he may be furnished with a plenary abundance of both wholesome food and water, and, if he have not a copious supply of pure atmospheric air, he will languish and die. All these are indispensably necessary for his animal existence; but, with all these, his life would still be a peculiarly wretched one, if he could at all be supposed to exist, without the light of the sun. If the sun never shone upon our terrestrial sphere, the earth would be a dark, desolate wilderness; no vegetables could grow on it, and no animals now existing on its surface could live on it. Solar light and heat are necessary to the existence and growth of vegetables, and the vegetable kingdom, together with air and water, are necessary to the support of animal life. And can any one now say to which he is most indebted for the necessaries and comforts of life,—whether to the products of the earth, to the air, the water, or the solar light and heat? Can any one now tell to which of these he owes most, or whether he is a debtor to any one or all of them? They all, it is seen, are mutually necessary for the support and existence of man. The answer will doubtless be that they are all necessary and good; that this world is admirably constituted for the maintenance and accommodation of animate and intellectual beings; that, in short, if the means and privileges which this world affords were rightly distributed among mankind, and used without abuse, our earth would be a terrestrial paradise, worthy the name of heaven below; all would be happiness and peace among men; no one would covet or wrongfully seek what did not belong to him; all would be equally interested for the good of others as for their own; but, since no one is responsible for having been born into the world, one does not consider himself peculiarly indebted to it for the gifts and privileges it affords him, provided he has obtained and uses them aright.

It will be seen that the principles of life and intelligence are inherent in all matter not only from the preceding illustrations but from those that follow. In the processes of change earth becomes rocks and minerals, and rocks and minerals become again crumbled into earth. The earth produces the vegetables, vegetables become incorporated in animals from being their food, and animal and vegetable substances become incorporated in man from being his food. The vegetable and animal substances are earthy matter, including common clay, mineral, and metal, now temporarily in different states from that in which they exist in the solid earthy substances. But these animal and vegetable substances are continually undergoing change, and destined soon to return to the earth again, where they will still be undergoing change; and one animal or vegetable body, say for example the body of any animal whatever, or a tree, when deposited in the earth, may give birth to thousands, yea, tens of millions of living beings; and these countless beings ceasing to exist in their turn, their substances become earthy, which may give birth to other living beings or go to the production and support of plants and animals.

But vegetables and animals do not consist altogether of earthy matter, properly so called; the largest part of their substances is made up of water, another species of matter; and also the atmosphere, light and heat, enter into their production and substance. But water, as we have intimated, is a material substance, and so is the atmosphere ; and light as well as heat is an everywhere present element, even in the dark and in the cold, only requiring the action of certain material agencies, or rather that matter be in certain conditions, in order that we become sensible of their presence. Light and heat are merely phenomena or effects attendant upon certain states or conditions of matter. All existence, therefore, is material, and nothing exists but what is of matter. Others may substitute another name for it instead of matter, if they conceive of a more suitable one, as the names of all objects are arbitrarily given. The animal body is precisely of the same material as are the mediæ in which it exists. The intelligent, rational being is conscious that his system is made up of such like materials as earth, rocks, minerals, metals, water, air, light and heat; and it may perhaps be said, all circumstances being considered, that man is an epitome (here we will say) of material existence.

To illustrate that the air is a material substance such things as the following might be considered : when a person runs against the wind he feels a force pressing him backwards, and the faster he runs the more is he sensible of its resistance. Though he is unable to see anything around him, yet he is sensible that something exists to press him back, for he experiences its effects. But a better illustration of its materiality is the following: that it excludes all other bodies from the space it occupies. Thus, if over a cork, floating on a vessel full of water, we invert a glass jar having a wide mouth, it will be seen that but a very small quantity of water can get into the jar, because the air of which the jar is full keeps the water out; otherwise if it were emptied of every material substance the water would rush in and completely fill the jar. The cork, still floating on the surface, will show how far the water rises in the jar. On this principle the diver's bell has been constructed, an instrument in the shape of a bell, the use of which enables men to walk about on the bottom of the the sea with as much safety as upon the land. The head of the diver being within this bell-shaped instrument, which comes down in ordinary cases nearly to his shoulders, is separated from the water, for the water cannot enter the bell except for a very short distance while the bell is filled with air. Fresh air is constantly supplied to the diver by means of an air-pump, situated on the land or on the deck of a vessel, and a tube which connects it with the diver's bell. In most cases there is a large diver's bell in which the divers descend, which connects directly with the air-pump by a tube, and in which a supply of air is kept for the divers, who have during their submarine explorations the small bells which they use connected by a tube with the reservoir of air in the large bell. Such an arrangement is necessary, for if air were not supplied the diver in sufficient quantity he could not remain below for any length of time, as the air contained in the bell which he uses becoming very dense by the pressure of the water and vitiated by his own breathing would become poisonous, and he would die.

And again, if we take a pair of common bellows, and, after having opened them, if we shut up the nozzle and valve-hole, and try to bring the boards together again we shall find it impossible. There is something included which prevents the bellows from coming together in the same manner as if it were filled with flax or wool; but on opening the nozzle we can easily shut them by expelling this something from within, which will issue with considerable force, and impel anything that lies in its way. This something is atmospheric air.

Also, air is not only material but wonderfully expansive and elastic. Thus, if a bottle, being put under the receiver of an air-pump, is entirely emptied of its air, and in this condition being tightly corked is again introduced to the receiver, when the air is admitted to the receiver the bottle will be broken to pieces by the pressure of the air upon its outside, since there is nothing within the bottle to resist its pressure. Also, if a bottle full of air, and hermetically sealed, be put in the exhausted receiver of an air-pump, the air within the bottle expands, and, there being nothing on the outside of the bottle to resist its outward pressure, breaks the bottle to pieces. All which shows that air is a material substance and capable of expansion when in a vacuum or rarer medium. And that it is susceptible of compression when acted upon by a denser body is proved by the fact of the water having ascended a short distance in the jar and the diver's bell, although they were full of air; for no water could have entered them if the air they contained were as dense as the water. Air is so elastic that a quantity of it, as it exists at the earth's surface, can be expanded into nearly fourteen thousand times its original bulk; and the fact that it is elastic shows it also to be compressible, for whatever is elastic is capable of being compressed into a smaller space. Air is capable of being compressed into a small space compared with that which it naturally possesses.

There can be no difficulty, we think, in any one conceiving how that water is a material substance. Like air it is capable of great expansion. A cubic inch of water, when reduced to steam, occupies a cubic foot or over seventeen hundred times its original bulk. But it is with difficulty that water can be compressed into a space less than that which it naturally occupies. It is one of the first principles of natural science, that no two bodies can be made to occupy the same space at the same time; therefore, air is a body and so is water, just as much material bodies as stone or iron is. Fill a vessel full of water, and immerse in it any convenient solid and a quantity of water will flow out of the vessel, exactly in proportion to the bulk of the body immersed. When a vacuum or empty space is made by the removal of any body, solid or fluid, the air rushes in from all sides instantaneously to fill up the vacuum, just as water rushes in from all sides to fill up the vacuum which is made by the taking of a pail of water from a reservoir, and as the vacuum which is made by the rolling of a wave on the surface of the ocean is instantly filled up by another wave rolling into its place, which undulatory activity is continued until the air becomes calm and the water level. The partial vacuum which is made at any place on the earth's surface by the expansion of the air by heat is instantly filled by the denser air from all sides rushing in to effect equilibrium. Such is the way in which winds are caused; the air at certain parts of the earth becoming rarified by heat, the denser air from other parts comes in rapid motion to fill up the partial vacuum thus made. Thus, we have, during a good part of the year, strong north-east and south-west winds, which are caused by the colder and denser air of the north and south polar regions coming in rapid motion to fill up the partial vacua which have been caused by the rarefaction of the air by heat in the equatorial regions. A vacuum is a place from which all the air has been withdrawn; a partial vacuum a place from which part of the air has been taken. A vacuum cannot exist in the universe except it be an artificial one, such as that in the upper end of a barometer, called the Toricellian vacuum, from Toricelli, the inventor of that instrument, which is considered the most perfect vacuum, and that in the exhausted receiver of an air pump.

All the spaces intervening between the heavenly bodies are occupied with air of a greater or less density. In some places it is dense as at the surface of the earth, where, as we have said before, a quantity of it can be expanded into fourteen thousand times its original bulk; and in some places it is rare, as on the tops of high mountains and in the upper regions of our atmosphere. In the spaces intermediate of the heavenly bodies it is reduced to an exceedingly thin fluid called ether; but in no place is it wanting in sufficient weight and density to counterbalance its surrounding elements, for all existing things are naturally in equilibrium, and when there is any disturbance, as by a vacuum, they tend to equilibrium.

Thus, the atmosphere within the sphere of the earth's attraction is attracted to the earth's surface, and revolves with it round the sun, just as all the other bodies on the earth's surface are drawn towards its centre, and revolve with it in its diurnal and annual journey. The atmosphere, which is beyond the sphere of the earth's attraction, is either attracted by others of the heavenly bodies within whose spheres of attraction it lies, or it exists in the intermediate spaces in the form of ether, where it is not subject to any sensible attraction from any of the heavenly spheres.

The atmosphere which surrounds the earth is analogous to the ocean of water which covers three-fourths of its surface; which atmospheric ocean, as the ocean of water, revolves with the earth, and in the bottom of which, we, with the beasts and birds, exist, as do the aquatic animals in their own element.

The expansibility of the air and water by heat is exceedingly great; and not only these fluids but the densest and solidest substances, such as rocks, and iron, gold, platina, and iridium, the densest and heaviest metals with which man is acquainted, can be reduced to a gaseous or aeriform state by the application of sufficient heat. Heat has the power of penetrating all bodies, and the greater the amount of heat enters any body the more the body will be expanded. Thus, a certain degree of heat will reduce ice to water, and a certain additional amount will reduce the water to steam, which is an invisible gas. Fill a bladder about half full with air and bring it close to the fire, and the heat entering the bladder will expand the air until it bursts the bladder. Fill the bladder about quarter full or put a still less amount of air in it, and leave it for a sufficient length of time before the fire, and the air will expand as before and burst the blad 'er. A like result also would happen to aeronauts if they should be carried so far from the surface of the earth as that the air in their bodies would be much denser than that by which they were surrounded; the air inside their bodies would expand, seeking equilibrium, and burst their bodies. Yet this will scarcely ever happen, we think, for the hydrogen gas with which balloons are filled, though lighter than the air at the earth's surface and for some miles above it, will not ever suffer the balloon to ascend into a very rare medium. The air contained in an apple can be expanded by heat to such a degree as that it will fill a space more than forty-eight times the dimensions of the apple. Take an iron bar whose end when cold fits exactly into a hole, and when you have heated it red hot you will find it too large to enter the hole. Heat it more intensely and you will reduce it to the state of a fluid, and apply a sufficient additional heat and you will reduce the iron to the state of a gas. You may take a similar process with gold or platina, iridium or any other solid substance in the earth, and attain the same result. This process of the reduction of solids to gases applies to all bodies in the earth; they are all ultimately reducible to a gaseous or aeriform state by the application of sufficient heat. It is therefore theoretically though not practically true that the whole earth is of a substance reducible to the form of gas or air. If it were practically true, which does not appear to be the case, we might not be sorry if there should be a residuum after the reduction of our sphere to an aeriform state, which we, had we the good fortune of being removed to other scenes of existence, might use as material for making telescopes and microscopes to open up to our view the still distant regions of the universe. But gas means air, and air means spirit, and spirit means breath or that which we breathe; the whole earth, therefore, on which we dwell, with all that is connected with it, is spirit in a condensed form. In fact all the heavenly spheres, as we shall make plain hereafter, are of the same character, namely, condensed spirit, and the greater the amount of spirit condensed in a given sphere the greater is its power of attraction, just as the greater and stronger the mind of a man is, provided he uses it aright, the greater is his power to govern the minds of others.

There is a natural constitution and order of things in general, a state in which they tend to remain if not acted on by forces external to nature, none of which exist, or by the art of man. Thus, the atmosphere will remain in its natural or normal state, and so will the sea and the solid land, if not operated on artificially by man. The extent of his operations on these elements is, however, very limited. He may reduce water and some solid substances to air, and he may reduce air, as carbonic acid gas, to a solid form ; but all these will ultimately return to their natural condition, and the general condition of the atmosphere, the waters and the earth, will remain the same notwithstanding all the change which man can effect in them. When therefore things are altered from their natural state by man's art, the process may be explained upon the principle of excess and deficiency of spirit. For example, water in its natural state occupies a given space, but being reduced to the form of a gas, or steam, it occupies a much greater space. But how has this great expansion been effected ? By the penetration into the substance of the water of an additional substance called heat, which expands it or assimilates it to itself; for although heat, as light and electricity, is an everywhere present substance, yet in its objective action it has to proceed from certain centres. The water in its natural state had its proper amount of heat, but in the steam or gaseous form it has heat in excess. Also, a piece of iron, or any other metal or solid, when in its natural state has its proper amount of heat, but when reduced to an aeriform state it has heat in excess. And, conversely, when iron or any other solid is subjected to intense cold it contracts, because of the abstraction of some of its normal heat by the surrounding elements ; in this state it possesses heat in deficiency of its natural amount. All substances are expanded by heat, and all substances except water are contracted by cold. Water expands by freezing about one-seventh of its natural bulk, because the particles of the water crystallize, and the polyhedral crystals, we know, take up more room than the globular particles of the water in its natural state. Every one knows how his body and limbs swell, how his veins puff out, when he is much heated by severe exercise. One may also observe how his body and limbs contract, how the veins disappear, and how lank and meagre he is in comparison, when he is subjected to severe cold. In the one case he has heat in excess of his natural amount, in the other he has it in deficiency.

But things as naturally constituted may also be explained on the same principle of excess and deficiency of spirit, only by way of comparison. The air, the waters, and the earth tend, as we have before said, to remain in their natural state. The more solid or dense a body is the more matter or spirit, which here mean the same thing, does it contain. The solid earth then, with its internal contents, minerals and metals, is evidently denser than water, and water is evidently denser than the atmosphere, and the atmosphere which surrounds the earth is denser than the ether which lies in the spaces intermediate of the heavenly bodies. The globe of the earth therefore, land and water, in the given space which it occupies, comprises much more matter than the atmosphere does in the space which it occupies as compared with that occupied by the earth ; and the earth's atmosphere may be said to comprise more matter than does the ether in any part of the universe, taking space for space. Thus, the solid parts of the earth may be said by comparison to have matter in excess of the fluid parts, taking equal spaces, and the waters to have matter in excess of the atmosphere, taking equal spaces ; and the atmosphere to have matter in excess of the ether, taking equal spaces. And, conversely, the ether may be said, in like manner, to have matter in deficiency of the atmosphere, the atmosphere in deficiency of the waters, and the waters in deficiency of the solid parts of the earth. The earth, therefore, is the great concentration of spirit to which all things else tend that are within the range of its attraction. It is denser towards and at its centre than near or on its surface, and all things on its surface and its atmosphere are attracted towards its centre. And it contains in itself that power by which it moves, but it is confined to a certain course by the attraction of a weightier body, the sun, and by other heavenly bodies.

The same power of penetration belongs to electricity and light as to heat. Light, heat, and electricity are all the same substance, under different modes of action and manifestation, or, rather, we may call electricity the element of which light and heat are peculiar phenomena or modes of action. They are always found together when means are employed sufficiently sensitive or delicate to detect them, and all three are capable of producing a number of effects of precisely the same character in every respect. They are all three capable of penetrating all other bodies with which man is acquainted ; they are all three capable of dispersion by means of conduction or radiation ; and they may all be accumulated and concentrated or intensified in their action. Thus electricity is capable of being diffused by means of light, and also by means of heat ; that is, if electricity be accumulated or intensified in its action at any point, and light and heat only be given off from that point, it is found that the electricity is dispersed, although no current of electricity proper has flowed from the point. And, again, if light or heat, either or both, be applied to any point, a current of electricity can be educed from it ; all of which goes to show that light, heat, and electricity are one and the same substance under different modes of action and manifestation.

Science has hitherto discovered 62 or 63 natural elements, which enter into the composition of our earth and atmosphere, which it denominates simple or uncompounded, and which it thus classifies. Three permanent gases, oxygen, hydrogen and nitrogen ; four elements having many similar characteristics, chlorine, bromine, iodine, and fluorine ; five solids not possessing the usual metallic properties, such as metallic opacity and lustre, carbon, boron, selenium, sulphur and phosphorus; fifty metals, only one of which is a liquid, namely, mercury or quicksilver, all the other metals being solid. Of these it is generally considered that all known things are constituted, and the names given to these simple substances,on account perhaps of their peculiar properties,distinguish them from one another. But it may not be necessary to understand any more than two elements in nature which we may call by the old names, electricity and carbon, the latter substance representing the solid parts of existence, the former the fluid or gaseous ; and the time will come, and perhaps is not far distant, when scientific men will conclude that there is no necessity of understanding any more than one substance to be in existence, which we shall call spirit, or leave unnamed, and of which all the varieties and diversities met with in nature are but modifications and phe-nomena. Nor may they think it necessary to limit the number of these modifications to sixty-three, or to put any limit whatever to their number; for the number of modifications in nature, as existence itself, is infinite.

But let it be remembered that, though all these so-called simple substances are but modifications of the same general substance, yet the knowledge and classification of them, after such a manner as has been in vogue by scientific men, may not be without its use. If it may be employed in the arts for the abridgement of human labor, for the prevention of human suffering, or for the supply of human wants and necessities, conveniences or comforts, then it is useful ; but, if it be employed in the arts which minister to the detriment of human beings, so far it would be better not known nor practised. There are no men who should be more candid, more interested in the welfare of mankind, or more active and industrious for the amelioration of the condition of human beings, than learned and scientific men. They are in the possession of that of which the great mass of mankind are destitute, which, if they use aright, will doubtless prove a blessing to their race, but, if they abuse or neglect, will prove a detriment and injustice. Such men should remember that they have a trust committed to them, for the proper use of which they are responsible to their Creator, but for the abuse of which they will suffer the consequences in their own experience. Men feel all the happier for being good and doing good, yea, all the good they possibly can. Let each one of our readers remember this.

But the great mass of mankind, although unacquainted with chemical science or natural philosophy, have yet enough of common sense and sound judgment to guide them in their use of natural objects. Nature is a good guide, if they will but give sufficient attention to it, observe its laws, and live according to its dictates. Surely most men know that matter is continually changing, undergoing new modifications, and entering into new combinations; and that a material substance which in one state would be healthful in another state would be a rank poison. No man in the use of his senses and reason would choose to live in a place surrounded by unwholesome air and noxious gases in preference to a healthy place where there is an abundance of pure air, yet we find thousands in the rural districts, and even in large towns and cities, who erect their houses on the edge of marshes, and in the bottom of valleys, environed by hills, where they are surrounded with pestilential effluvia, carbonic acid gas and other gases, instead of on the brow or summit of a hill, where they will have the advantage of wholesome air. Neither would he choose to drink unwholesome pool water in preference to the limpid water of the running brook or the springing well; nor, in preference to this last would he consent to use such productions of art as champagne or claret, whiskey or rum, gin, ale, beer, porter, and such like intoxicating drinks, although a great many who, in other respects, seem to use right reason are weak and silly enough to make use of such beverages. If a man who sleeps in an ill-ventilated room does not know scientifically the cause that is producing the weakness of his system, it may interest him to be told that, in breathing the confined air during the night his system has absorbed its nutritive properties, and has left only that part of it which is not fit to be breathed, which is technically called carbonic acid gas, and which, if it continues to be breathed, will cause suffocation and will ultimately cause death,—he,then,will be likely to conclude, whether scientifically or not, that he needs a constant supply of fresh air in his sleeping apartment. But there are few men so stupid as not to know, even though they may not be acquainted with one of the first principles of chemical science, that they stand in need,day and night, of a constant supply of fresh air. Without any knowledge of chemistry, the coal miner knows that he needs a constant supply of fresh air in the mine or that he cannot work there (and here it is proper for us to remark, since the vital interests of a large class of human beings are at stake, that it is the duty of the proprietors of coal mines, and of other mineral mines, to provide that the mines be supplied with a copious supply of fresh air, and otherwise kept as safe as possible, and that there ought to be superintendents of mines appointed by government whose care it should be that these things be done). Coal mines are usually supposed to have two shafts reaching from the surface of the earth to the bottom of the mine, into one of which air is impelled by means of an air-pump, which air traverses the whole length and breadth of the mine, penetrating all its departments and recesses, and enabling the men and animals there to prosecute their employments. At the bottom of the other shaft a fire is kept burning, which rarifies the air now vitiated and impregnated with noxious gases after traversing the mine, and causes it continually to ascend through this shaft. It will be remembered that air rarified by heat always ascends. In some of the coal mines of Pennsylvania, in which such appalling accidents have happened of late, we have learned, whether it be true or not, there are some that know, that there was only one shaft used for the access and escape of air to and from the mine.

Experience will teach men, if they will but observe, that the air in deep wells, in cellars, in close rooms, in caverns, in marshes and low places, as well as in the upper regions of our atmosphere, is unfit to breathe and detrimental to health; and how bracing and wholesome is the air upon the elevated surface of the earth, and in all places to which it has free access, or which are kept well ventilated; how the air inside a building which has become vitiated by the breathing for a long time of a large assembly of people is not by any means as wholesome to breathe as the pure out-of-door air; how that the water contained in marshes and stagnant pools is not fit to drink, and how that contained in the running brook or springing well is wholesome and refreshing; how that the piece of flesh or other article of food which when fresh would be wholesome and nutritious, when undergoing decay would be a rank poison.

The hungry man does not stop to enquire whether the loaf of bread he receives is a compound of a number of simple substances, or whether it is but one substance. He takes it for granted that it is wholesome, and does not suspect that it contains any noxious properties. The use of a similar substance before has given him experience to know that it is just what he wants to satisfy his appetite. He knows, very probably, that it is made up of flour, water, yeast and salt; and it may not interest him to learn that the component salt is itself a compound of chlorine and hydrogen; that the yeast is composed of carbon, oxygen, hydrogen and nitrogen; that the water is composed of oxyen and hydrogen; and that the flour is the product of the albumen of the wheat or other grain, which is itself made up of carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, &c., and that the whole loaf, if he can spare it, may be reduced to the state of a gas or air by the application to it of sufficient heat. He, probably, in his hungry state is not interested to know whether the egg he receives is but one simple substance, or that science has determined it to be made up of 55 parts carbon, 16 parts nitrogen, 7 parts hydrogen, and the remaining 22 parts, out of a hundred into which the egg is supposed to be divided chemically, are made up of oxygen, phosphorus, sulphur, &c., and that it, as the loaf, can be reduced to the form of an invisible gas by heat.

But if he received that loaf or egg in a mouldy or decayed state, his reason or common sense would at once suggest to him that it would be injurious to his system if he ate it. He probably does not know, nor is interested to learn, whether the piece of flesh he receives is one simple substance, or whether it may be compounded of many simple substances, as carbon, hydrogen, nitrogen, oxygen, sulphur, phosphorus, &c., which chemical science determines it to be. He takes and uses these without hesitation, knowing from past experience and daily observation, that they are just such food as he needs. But if he receives these in a decayed state he would not use them, experience also telling him that in such a state they would do him hurt. Good common sense, therefore, accurate observation of the operations of nature, and the experience which is derived from the varied scenes and associations of life, seem most of the knowledge that is necessary for men to be possessed of, provided they use them rationally, in order to their well-being. It is, however, desirable that men should become possessed of all the knowledge they can, whether in relation to science, or art, or the affairs of life or any other branch of knowledge which may administer to their happiness and well-being. But even here common sense and reason should guide them in the selection of the branches of knowledge which they should pursue; those should be selected which are most necessary, and undertaken and pursued with a good and useful end and object in view. Time, for example, spent in the study of some of the dead languages and of some other branches which are never reduced to practical use, if these studies be not pursued merely as a discipline for the mind whereby some good may be derived from them in that sense, is time lost. That time might be well and usefully spent in a practical way, or in the study of those branches which could be reduced to a practical use for the benefit and well-being of the person's self and of mankind. And not only the person's own benefit but that of mankind also should be kept in view, in the selection and pursuit of any branch of study. The knowledge of chemistry, we allow, may be made of great use to mankind, if employed by those who become possessed of it for the benefit and highest good of mankind, and not, as in many cases it is, for their detriment. What shall we say of all these poisonous luxuries that adorn the tables of the rich, and which owe their existence to chemistry? Or of gunpowder, which chemistry informs us is made up of nitrate of potassa, carbon and sulphur, in specific quantities?

That that which we denominate matter has always existed is certain, and is not doubted by any of the learned that we are aware of. That change has always taken place in matter, that the earth and the heavenly bodies have always been as to their substance and motion the same as they are now, that mankind has always existed as to general form and appearance much as he in general exists now, that the universe has always presented to the eye of man, in general, the same phenomena as it does now, that it has always been to him a present thing,—a thing, we say, so far as it came within his view or could be conceived by his mind; but as to its being wholly conceived by his mind, nothing; of all this, although we do not necessarily assert the positive, preferring to leave people to judge for themselves concerning these matters from the arguments which we shall afterwards adduce, we may assert that there is no valid evidence to the contrary. (*)

The only conceptions which the mind of man can form are of objects or things. Objects or things are limited or bounded, they all have a beginning and an end, a limit in every direction. But the universe being infinite, that is, without beginning or end, or any conceivable possible limit in any direction whatever, is no thing, no object; it is *nothing*. This may be better understood from an illustration. Take a line, (which is necessarily an imaginary one,) and beginning at any given point, say the centre of the table before you, conceive of it as extended upward toward the zenith, or straight above your head; or right downwards toward the Nadir, straight beneath your feet; or towards the East, West, North or South, or in any other direction whatever, toward any point of the celestial sphere; conceive of this line as extended for any length of time, say for a thousand millions of centuries, and at any rate of rapidity of extension, say ten thousand millions of miles per second; let it be conceived of as extended for any length of time, and at any rate of rapidity whatever, and it can never be conceived of as coming to a termination in any one direction, so that it cannot be conceived of as being capable of being extended further. It is as near such a termination in any direction where it ceases to be extended, as it is at the central point of the table from whence it began to be extended. And that central point, too, of the table, which we have used for convenience of illustration, we do not conceive of as having either beginning or end; it is infinite and nothing. Here then is the idea or the no idea; the universe infinite and nothing; a point infinite and nothing.

The human mind, as we have stated, can conceive only of objects or things. A man is an object, a tree is an object, the earth is an object, the moon is an object, the sun is an object, the planets and stars are objects; and everything that has or can be conceived of as having a beginning and an end, a bound in every direction in space, and everything that has or can be conceived of as having a beginning and an end in time, is an object or thing. In fact the universe, so far as it can be conceived by the mind, is an object or thing; but considered as infinite it is nothing.

(*) See examination and comparison of the accounts of the Creation in the book of Genesis in the beginning of Part Second of this book.

This illustration of infinitude and finitude will throw some light upon the statements we have made in the opening page of this book, as to the Creator and Creation. Is it not very plain that our omnipotent and glorious Creator, that is infinite, cannot be conceived by the mind, much less seen by the eye ? And yet men are so unreasonable, so presumptuous as to set up material objects as representations of Him, and worship them ; and invent systems of ideas which they call systems, or "bodies" of divinity, and set them up and worship them instead of Him. For how is it possible to conceive of an Infinite Being ? The mind can form no idea of Him, and how absurd and blasphemous that men should worship objects and things such as the sun, moon and stars, idols of wood and of stone, and men living and dead of their own race ! It appears so absurd and blasphemous as scarcely to be tolerable. And yet we are sensible of the presence of our great Creator, and can see His character reflected in every natural object. How important it is that men should be good and do good, and maintain an humble and devout spirit in His presence ?

It is plain that the distinction between objects and things and nothing or, in other words, between the finite and the infinite, arises from the different states and conditions of matter as to density and rarity,—an idea which, perhaps, will be understood from the explanation we have already given of it, and may be more clearly understood from what follows: If all the matter in our globe and in all the other bodies in space were reduced to a gaseous or aeriform state, all of the same density, which reduction we have shown to be theoretically possible, there could be no object or thing in the universe; nothing but space which we can now conceive of would exist. We might conceive of space to no end, but there would be no proper object to be conceived by the mind. Matter considered in the form of our earth or of any other globe, or even of Saturn's ring or of any other form, is an object or thing, and the condition of its being a definite object depends upon its existing in that condensed form to distinguish it from other forms of matter. Hence partly arises the numberless objects which are in and on the earth, —partly we say, for some objects are distinguishable from others by their difference of density, some by their difference in form, and some by their difference of color, etc.; for there is such a diversity in all these, and in other respects, that scarcely any two objects in all nature are exactly alike in every respect. This will be better understood from illustrations which we design to give further on. Hence it may truly be said that the earth exists out of nothing, also the sun, moon and stars, and each of the other heavenly bodies which do exist in the universe; each of these bodies, however large, is a definite object or thing, and each of them may be said to exist out of nothing; and, if all were reduced to an aeriform state of the same density throughout, they would cease to be definite objects or things, and would vanish into nothing. Hence, too, may have arisen the notion entertained by the ancients, of the earth and the heavens having been created or caused to exist out of nothing in six days—a notion which has descended to our time, which has been stoutly and confidently declared from the pulpits, but which, of late, since the researches of geologists have shed a glimmer of light upon the Hebrew writings, has begun to be understood differently by many, understood in such a way that the six days are made to represent six long periods of time. And what do we guess the next step will be which theologians will take in respect to this subject? Why they will fully understand, and be happy to confess, that the earth in its essence and present general form has never not existed. And, if the earth, so the heavenly bodies in their present general form and aspect in relation to the earth; even thus they generally believe now. There are some men who require considerable time to come to a full knowledge of any particular truth, but the truth once arrived at mankind is not benefited by having it concealed from them. The doctrine of the creation of the earth out of nothing, as it has been taught and believed, has been the cause of a great deal of superstition, and indeed a particular inconvenience, and impediment to progress in the right direction. Not the old creation of Genesis, but the new creation of John, should be held forth as of any importance for men to believe in; not a creed of miracles which were never performed, or of tradition, which to every candid reader are self-contradictory, should be held forth as of importance for men to accept by the teachers of mankind. They should teach men to be good and to do good individually; to live lives of self-denial, of holiness and righteousness, of charity and of honest industry; they should teach men to depend for happiness and peace upon their own godly living, and not to depend for immunity for their own misspent lives, their lives of impurity, of vice and of wickedness, upon the virtues of any other which will not avail them. They should practise this doctrine of the regeneration themselves, and let their lives of humility, of industry and of godliness be conspicuous examples for those they teach to imitate. They should not teach men to expect the millenium, except men themselves, by their godly living, bring it in; and they should do all in their power in the state, in their own narrower sphere, and in the improvement of individual life, to introduce and perpetuate that glorious era.

That the earth has always existed as to matter and motion much as it now exists, there is, as we have stated, no valid evidence to the contrary. There are abundant illustrations that *tend* to prove that it did so exist, and, if our readers have patience, we shall present to their view some of these illustrations in this place and, further on, some more. One of the simplest and most striking of these is its uniform daily and annual orbitual motion, a motion which it has performed with such regularity and precision during the last three thousand years, or within the records of Astronomy, as not to deviate in time or space a single second or inch. Although Astronomy was cultivated by the ancient Eastern nations, especially the Babylonians and Egyptians, for thousands of years before the Christian era, yet Thales, a Milesian, whose date is 610 B.C. was the first we know of to have recorded an eclipse ; and astronomers of the present day, tracing backward the eclipses to his time, have determined his record to be correct. And, if the earth has been so regular and precise in the performance of its motions for such a long period of time, it is fair to conclude that it performed them with the same regularity and precision during the three thousand years preceding these, and then during the three thousand years preceding them, and so, backwards, until there can be no time found for the beginning of its existence and motion, for it has moved as long as it has existed. And, not only the earth, but the moon and planets, and all the heavenly bodies with which the telescope has made us acquainted, have performed their motions with a like undeviating regularity and precision, during the period of which we have astronomical records. Therefore, tracing backwards in the same manner, we may fairly infer that they have always performed their motions with the same regularity and exactness as they now do. The compound ring of the planet Saturn is a body of such immense dimensions that it is computed to contain an area of more than one hundred times that of our globe, and to revolve around that planet at an exceedingly rapid rate of motion, namely, 900 miles a minute. It is found to be not exactly concentric with the body of Saturn, and, therefore, must subsist about that planet in a state of unstable equilibrium. "The observed oscillation," says Sir J. Herschell, an eminent astronomer, lately deceased, "of the centres of the rings about that of the planet is, in itself, the evidence of a perpetual contest between conservative and destructive powers, both extremely feeble, but so antagonistic to one another as to prevent the latter from ever acquiring an uncontrollable ascendancy and rushing to a catastrophe. The smallest difference of velocity between the body of the planet and the rings must infallibly precipitate the latter on the former, never more to separate ; consequently their motion in their common orbit round the sun must have been adjusted to each other by an external power with the minutest precision, or the rings must have been formed about the planet, while subject to their common orbitual motion, and under the full free influence of all the acting powers." Such is the complexity of the system of Saturn : the immense globe of the planet, itself a thousand times larger than the earth, in rapid motion, and surrounded with a compound ring of such immense dimensions, as we have mentioned above, and with eight moons, all in rapid motion around the body of the planet, and with the planet in space around the sun, as well as the doctrine of gravitation,—as all forbid the idea of these bodies having been formed at all or their motions adjusted to each other when in rapid motion in space, and subject to all the acting forces.

But the main question which will suggest itself in the case before us doubtless is: If the earth as to its substance and motion has not always existed as it does now, how has it come to exist thus? One of the first ideas that strike the mind when investigating this subject is that of the gradual condensation of matter from all sides towards a common centre. This probably led some to suppose that the earth and all the celestial bodies are the results of a gradual condensation or closing in of the matter of which they are composed towards their several common centres. But such a thought, or theory, is inconsistent with the regularity and precision of the motions of these spheres, as well as with the character and constitution of the earth as to solid, liquid and gaseous. All things on the earth's surface, and for a certain distance in a perpendicular direction from its surface, tend or are attracted toward its centre. If an earthly body, solid or liquid, is rarified sufficiently by heat, it ascends from its surface, but, becoming condensed again in the atmosphere it returns to the earth's surface again. You can reduce water to the form of a gas as steam, but it becomes vapor in the atmosphere, accumulates into clouds and descends to the earth again in the form of water or rain. Also, if any earthly substance, or mineral or metal be reduced to a gas, every particle of it will soon find its way to the earth again in some form or in different forms, for the atmosphere is so constituted as to be sufficient in itself to answer the purpose which it is adapted to fulfil. Water is also so constituted as to be a stable element, sufficient in itself to fulfil the purpose for which it is adapted; there is always exactly the same quantity of it in the earth, and belonging to the earth, in the atmosphere, in the form of vapor. The solid parts of the earth also are so constituted as to be a stable element, sufficient in itself to fulfil the purpose for which it is adapted; for, as we have stated, if an earthy substance or mineral be reduced to an aeriform state, every particle of it will find its way to the earth again: the atmosphere does not want it, having enough of its own, and whilst it remains there it is a foreign in the midst of a native element. Also, if any part of the dry land by earthquakes, the action of the waves on coasts, or any occurrence in nature, be submerged, an equal extent will be freed from the dominion of the waters in some other place; and men bringing their land plants and animals with them, they will all be propagated upon this new land to supply the place of those vegetables and animals which were lost by submergence. There is no sufficient reason to believe that more than small portions of land are lost at any time by the water, or that more than small portions are set free when compared with the whole extent of the dry land.

The solids of the earth, the waters, and the atmosphere always retain their natural or nominal bulk, if not expanded by the admission to them of an excess of heat, or contracted by the abstraction of some of the heat that naturally belongs to them. A certain quantity of heat, as we have before said, belongs to all bodies, and so long as they possess just that amount and no more, or no less, they are said to be in their natural or normal state. And the doctrines of natural science prove as clearly as anything can be proved, the stability of fluids if allowed to remain in their natural state. It is proved by hydrostatics and pneumatics that fluids press equally in all directions. For example: fill a square measure full of water, and put on the lid air-tight, the pressure upwards against the lid of the vessel will be the same as that downwards against its bottom, and the pressure against either of its sides will be equal to the upward or downward pressure; there is, in short, an equal pressure upon each of the six sides of the vessel outwards. Let the same square vessel be filled with atmospheric air, and exactly the same results will follow, the upward, downward, and lateral pressure upon the inside of the vessel will be equal. This is seen more clearly in the case of a globe-shaped vessel filled with water or air; the pressure outwards upon every point of the inside of the sphere will be equal; and the fluid is said to be in stable equilibrium. Let it be remembered that the fluid in both of these cases needs to be in its natural state; for if either water or atmospheric air be possessed of more than its natural amount of heat its tendency is to ascend, and, therefore, the pressure upwards against the lid of the vessel would be greater than that downward or in any other direction. Heated water is seen to ascend in the shape of steam, and the air heated in the fire place makes its way up the chimney, carrying with it the unconsumed particles of charcoal, in which condition it is called smoke.

The fact of air and water or any other body, expanded by heat, ascending perpendicularly rather than going in any other direction from the earth's surface, needs explanation. Thus it will be remembered that the earth is round like a ball, and is continually revolving round an imaginary line, passing from its north to its south poles or points, and called the earth's axis. It revolves round its circumference in the space of about twenty-four hours, producing in that length of time the succession of day and night. When it is noonday with us in the northern hemisphere, it is midnight with those residing in the southern hemisphere, and during the interval of twelve hours, between twelve o'clock night and twelve o'clock noon, the earth has travelled round half her circumference, or over 12,000 miles; and during the interval of twelve hours more, between twelve o'clock noon and twelve o'clock night, the earth has travelled over 12,000 miles more, or the other half of her circumference; for the whole circumference of the earth is nearly 25,000 miles. It will be readily understood, therefore, that the inhabitants of the southern hemisphere have the soles of their feet directly opposite to those of ours, and their heads pointing in contrary directions to our heads. Hence in the day-time, when we consider ourselves looking up into the heavens and contemplating the sun, they must necessarily be looking downwards, or in the contrary direction, when viewing the stars; and in the night-time, when we consider ourselves looking up into the heavens and contemplating the moon, the stars and the milky way, it being their day-time, they must be looking downwards, or in the contrary direction, when viewing the sun. And, conversely, during their day-time, which is our night, when they imagine themselves looking up toward the sun and the shining heavens, we must necessarily be looking downwards, or in the contrary direction, while gazing on the moon, the stars and the milky way; and during their night-time, which is our day, when they imagine themselves looking up toward the heavens at the stars, the moon and the milky way, we must necessarily be looking downwards, or in the contrary direction, while contemplating the sun in his brightness passing the meridian. Hence, as in natural science it is proved that equal and opposite forces acting on the same plane produce a negative result, so it is here as evidently proved that there is *neither up nor down* as regards the universe, or, speaking otherwise, as regards infinite, spiritual or material existence. This subject may be more clearly illustrated by the use of an artificial globe, such as are used in schools. Thus, the earth being round like a ball, when a body is expanded by heat into a gas at any point of its surface it will take a direction perpendicular to the place where it begins to be expanded in separating itself from the earth's surface. Hence, if the whole earth underwent a gradual expansion at the same time, the expanding matter going in directions perpendicular to every point of the earth's surface, we may conceive that the earth, provided it became reduced into fluid all of the same density, would be expanded into an immense gaseous globe, perhaps fifty or one hundred thousand times its present dimensions, though still retaining its globular form. This we have shown before to be theoretically probable,* though it is not practically so, for as long as the material elements, solid, liquid, and gaseous, of which our earth and atmosphere are composed have neither more nor less heat than what naturally belongs to them, they will remain in their natural state.

Also, the uniform globular figure of the earth and of all other heavenly bodies is proof of their eternity. To this spherical form of the heavenly bodies there is no exception but one, namely, Saturn's compound ring, among the tens of thousands of those bodies which the telescope has enabled us to explore. And if all these bodies were formed by the gradual settling in of their matter toward their centres, how does it happen that none of them except Saturn's ring is of any other than a globular form? why are not some of them in the form of squares, or pentagons, or hexagons, or in some other polyhedral form? or why did Saturn's compound ring

* See page 21.

assume the form it has? The evidences that the earth is a globe are complete and irresistible; and every one who has the use of his eyes knows by observation that the sun and moon are round. The telescope enables us to contemplate the planets of the solar system from a nearer standpoint than that at which we survey the moon without its aid. All these planets are of globular shape, each performing its motions in space as the earth is. Telescopes of high magnifying power, such as that of Herschell and Earl Rosse, also virtually transport us to the regions of the fixed stars, regions so immensely distant that any conceivable agent, travelling at the rate of twelve millions of miles a minute, would take scores, yea hundreds, and from some of them thousands of years, to reach our earth. Although the distances of those stars are so immensely great that none of them have yet been closely contemplated, still there is evidence, judging from the *cones* of light which they send forth, to show them to be of globular figure.

The great nebular system, so many of which have been brought into view by the telescope, are found when closely scrutinized by telescopes of great space-penetrating power to consist of systems of stars, each star of which it is reasonably conjectured is the centre sun of a planetary system, and each star and planet of which is most probably of the globular form. Over 3600 of these systems of nebulæ have been discovered in the northern and southern hemispheres. The nebulæ which were known to astronomers before the great telescopes were invented had given rise to various theories, and, among them, this, to which the assent of many minds was given, that the formation of the celestial spheres took place from the gradual condensation of celestial vapor, such as these nebulæ appeared to them then to be. Sir Wm. Herschell's great telescope first dispelled this idea by showing that many of the nebulæ, so regarded as vapor, were really clusters of stars; but at the same time by its space-penetrating power it revealed new nebulæ before unknown and beyond its resolving power. The construction of Earl Rosse's great telescope next contributed a new and vastly increased resolving power, and again showed that nebulæ unresolved before consisted of star-clusters only still more remote, but at the same time it added to our knowledge the existence of other nebulæ before unknown, and, in turn, beyond its power of resolution. "Thus," says Humboldt, "by increasing optical power, resolution of old and discovery of new would follow each other in endless succession; so that it may be fairly asked whether we can with probability assume both such a state of the universe and such a degree of improvement in optical instruments that in the whole firmament there shall not remain one unresolved nebula." When the phenomena which gave rise to the theory of gradual condensation had vanished one would think that the false impression to which the theory gave rise should vanish also. It is not, however, necessary for any one to conclude that all the bodies existing in space, as our earth is, are of globular form, for, although all those we can see with our eyes and all the telescope has brought within our view are of that form, yet, the universe being infinite, there may still remain bodies existing in it of great diversity of form.

Also, the laws of gravitation, by which all things on or near the earth's surface are drawn towards its centre with a force proportional to their weight, are further proof of the earth's eternal existence. Although the laws of gravitation act universally, yet that which we have to speak of concerning them here relates to the earth and its neighbor globes of the solar system. We have before endeavoured to illustrate that the earth is round like a ball; and as we know by observation and experience that all things on the side of the earth on which we are tend towards its centre, even so all things on the side of the earth opposite to us are attracted toward the the same centre, but in a contrary direction. Every point on the earth's surface has a point situated directly opposite to it in another hemisphere of the earth: thus, we and all around us are attracted toward the earth's centre, while those in Australia, directly opposite to us, are attracted toward the same centre in a contrary direction. Those also in Central Asia are attracted toward the earth's centre in a direction contrary to that in which the people of Brazil are attracted toward the same centre; and those living in Northern Africa and Europe are attracted in a direction contrary to that in which the New Zealanders are attracted. Thus we see all bodies, wherever they are situated on the earth's surface, are attracted towards its centre. The force of this attraction is found to be the same at all points on the earth's surface, with the exception of an exceedingly slight variation at the North and South Poles. This being so there are equal and opposite forces in operation at all points on the earth's surface, which produces a negation; for equal and opposite forces acting on the same plane, produce a negative result. Now, as every point on the earth's surface has a corresponding point directly opposite to it on the other side of the earth, and as there are two forces connecting these two points respectively with the earth's centre which are equal and acting directly opposite to each other, these forces may be conceived to meet on opposite sides of a plane, situated at right angles to their direction, and to produce a negative result, that is, no result. These two forces represent any two equal and opposite forces, or any number of equal and opposite forces acting toward the earth's centre. It may, therefore, truly be said that there are no forces of attraction connecting the surface of the earth with its centre except that by which lighter bodies have to yield to heavier ones. This, however, is a definite force, well-known, and acting uniformly and universally. The earth's elements, and consequently itself, are so constituted as to be in equilibrium; and the reason why bodies in its atmosphere tend toward its surface, and those on its surface toward its centre is because their specific gravity is greater than the medium in which they are; and because the interior and centre of the earth are made up of weightier materials than its exterior parts. Put a piece of iron into water, an dit sinks to the bottom; put a piece of wood in, and it floats on the top; because the weight, that is, the specific gravity of the iron, is greater than its own bulk of water, and that of the wood lighter. Elevate a solid body of any kind in the air, and having nothing to support it, it falls to the earth, because its weight is greater than that of its own bulk of air. In one sense, therefore, gravity means the same as weight, and the word *gravity* is the Latin for the English word *weight*. It may seem strange to some that the earth, being round like a ball, should have the faculty of drawing bodies towards itself at every point of its surface; for, if a solid body be elevated in the air at a point of the earth directly opposite to that which we occupy, the body falls to its surface, as with us; and if iron or wood be there thrown into water the one will sink and the other float, as with us. Now it is known beyond all doubt, that all bodies possess the power of attraction in proportion to the quantity of matter they contain. Some bodies, as the loadstone, possess it in even a greater degree. It is plain, therefore, that the earth, being so much larger than any body on or near its surface, possesses the power of attracting them to itself at every point on its surface. This power, however, is not limited in its action by the earth's surface, but extends into the atmosphere and far into space. It is the earth's attraction which retains the moon in its orbit round the earth; and it is the sun's attraction which retains the earth and moon in their orbit round the sun; and, conversely, it is the attraction of the earth and moon and all the planets which retains the sun in his position and orbit in space. The attraction, therefore, is mutual between all bodies in space, and acts in proportion to their several weights. Bodies, however small, at or near the earth's surface, attract the earth in proportion to their weight; but the earth being so much weightier than any of these, their attraction is as nothing compared with the earth's, and, therefore, all these small forces yield to the attraction of the earth. The earth, also, being nearly fifty times larger than the moon, exerts on the latter a proportional attraction, and thus retains it in its orbit round the earth, and prevents it from flying off into space in a tangential direction, which that body, as all other globes in space, has a tendency to do if not counteracted by the superior weight of other bodies. And the sun being over 1,300,000 times larger than the earth, and considerably larger than all the known planets of his system taken together, exerts a balancing power over all these bodies. It is plain, therefore, that all these bodies are in equilibrium, and that the principle of attraction may be resolved into that of the maintenance of equilibrium, and of the stability of order. The universe, though it may be considered as one great whole, is constituted of different parts, and these parts of different elements, all of the same general substance, but in different degrees of density and rarity. The earth, though composed of three elements, solid, liquid and aeriform, each of which fills its own place and performs its own functions in the earth's economy, may be called a unit; and each of these constituent parts may be called a unit in relation to the constitution of the earth; but yet the earth is only a member of universal existence, filling its own place, and performing its own functions, as the other members are.

We have mentioned before with what regularity the earth and the heavenly bodies move. This regularity and precision is not greater than that which governs bodies falling towards the earth's surface. Small bodies will not fall to the earth unless they be within the sphere of the earth's attraction. By this we mean that there are parts of space in which the earth's attraction is nothing. The sun, moon, and each of the planets has a sphere of attraction of its own. But then, there are the spaces intermediate of these bodies, which do not come within their spheres of attraction in any sensible degree. There, as we have before remarked, the ether is in equilibrium. Not that the attraction of each of these bodies is not exerted on each of the others, but that their contrary attractions, counteracting each other, produce equilibrium in certain parts of space intermediate of these bodies.

The attraction of gravity, and the dispersion of light, are analogous in their operation. The intensity of both decreases as the squares of their distances from their centres of action increase. Here we remark that the principle of gravitation acts in a manner analogous to the principle of light and heat. The force of all these decreases with the square of the distance from the centre of action. Suppose you are reading at a certain distance from a candle, and that you receive a certain quantity of light on your book, if you remove to double that distance from the candle you will enjoy four times less light than you had before: here, then, though you have but doubled your distance, you have diminished your light four-fold, because four is the square of two. If, instead of doubling your distance from the candle, you remove to three, four, five, or six times the distance from it, you will then receive at these different distances, nine, sixteen, twenty-five, or thirty-six times less light than you did at first, for these, respectively, are the squares of the numbers three, four, five, six. The same is applicable to the heat imparted by a fire, at a distance of two yards from which a person will enjoy four times less heat than one who sits at one yard from it, and at three yards distance nine times less heat, and so on decreasing with the square of the distance from the fire. And if a body is removed to double the distance from the centre of gravity, the attraction exerted on it is one-fourth; if to three times the distance, it is one-ninth; if to four times, the distance is one-sixteenth, and so on decreasing as the squares of the distances increase.

All bodies have their centres of gravity or points about which all their parts are balanced. The earth's centre of gravity is its centre. The *differences of the power* of the earth's attraction are not discernible at short distances from its surface, owing to the distance of the latter from the centre of gravity. But it is determined that, could we ascend 4,000 miles from its surface, or double the distance of the surface from the centre, we should there find the attractive force to be one-fourth of what it is here; or, for example, that a body, which at the earth's surface weighs one pound, would, at 4,000 miles above the earth, weigh but a quarter of a pound. By the most accurate observations the moon is found to be obedient to the same laws of attraction as other heavy bodies are. Its mean distance is clearly ascertained to be about 240,000 miles, or equal to about sixty semi-diameters of the earth, and, of course, the earth's attraction on the moon ought to diminish in the proportion of the square of this distance, that is, it ought to be sixty times sixty, or 3,600 times less at the moon than it is at the earth's surface. This is found to be the case by the *measure of the deviation* of its course from a right line. Bodies near the earth's surface, when left free to descend, fall at the rate of sixteen feet in the first second of time; but, as the attraction of gravitation is continually acting, so the body continues to fall with an increasing, or, as it is usually called, an accelerating velocity. It has been determined by the most accurate experiments that a body falling from a considerable height, by the force of gravity falls sixteen feet in the first second; three times sixteen feet in the next; five times sixteen feet in the third; seven times sixteen feet in the fourth, and so on, constantly increasing according to the odd numbers, one, three, five, seven, nine, etc. The true distance fallen in our latitude in the first second is $16\frac{1}{12}$ feet, but by reason of the centrifugal force, that is, the force which impels the earth in its orbit, the distance varies a little in different latitudes.

The following rule holds in all cases as to falling bodies: that the spaces they describe when falling freely from a state of rest increase as the squares of the times increase. Or, the following formulæ with respect to falling bodies will convey a clearer idea of the uniformity with which this law acts:

Seconds.	Space passed over in a second.	Velocity at end of second.	Total space passed over to end of second.
1	1	2	$1 = 1^2$
2	3	4	$4 = 2^2$
3	5	6	$9 = 3^2$
4	7	8	$16 = 4^2$
5	9	10	$25 = 5^2$
6	11	12	$36 = 6^2$
7	13	14	$49 = 7^2$

If, after the demonstration of the uniformity of the action of gravity, any one should be puzzled to understand how it is that, while the earth is continually rolling round like a ball, it retains all things in connection with it to its surface, they should remember that we constantly meet with illustrations of this force. A can, filled with water, may be swung round the head without a drop being spilt. When the can is at its highest point, and therefore has its mouth downwards, the water is attracted towards the earth; but this attraction is more than overcome by the centrifugal force, or the force of the hand by which the can is swung, and hence it remains in the can as if it were solid. It does not lose a particle of its water. Some persons are worried because they say they cannot understand this with regard to the earth, but the same persons hardly ever consider how it is that flies and other insects walk upon a perpendicular pane of glass, or upon the ceiling over their heads. Does not this seem as inexplicable as the others?

But something, at least, has been adduced to prove that the earth has always existed, constituted in general as to its elements and motions as it is now. No valid proof that it has not so existed can be brought forward; and if any one attempted to prove such a position, he would have to prove how it came into existence, how it attained its present form and constitution, how it was given its motion and maintained in it; where, in short, it came from, and, as we may suppose such a one would hold the doctrine of its final destruction, where it is going to.

We have shown heretofore that matter and spirit are the same thing * in different states as to density and rarity; that the most solid substances can be reduced to an aeriform state, and it is of the same essence in the gaseous form as it is in the solid. In the one case it is condensed, in the other expanded; in the one case it is the solid, tangible substance, in the other the intangible, invisible gas. Spirit, from the Latin word *spirare*, to breathe, from which our words inspire, expire, etc., are derived, means that which we breathe, or breath. The Greek word for the same thing is πνευμα, wind, or breath, from which our technical word pneumatics is derived, meaning the science which treats of wind or air. Also, the Hebrew word translated into our language spirit means air or wind; as for instance in the second verse of the first chapter of Genesis, it says the spirit of God moved upon the face of the waters, which equals, the wind of God moved upon the face of the waters. The difference between spirit and matter, then, is only one of degree of density and rarity of substance; it is the same substance in two different states; in the one state in a form

(*) Mind as it relates to man is properly called a development from matter or from spirit; but mind is really infinite and universal as is deity. The soul as applied to man means the living, conscious, rational human being, and in a wider sense the principle of life in man.

to be breathed, in the other in a form too dense to be breathed. We do not mean to say that air derived from the reduction of any and every solid substance to a gaseous form would be fit to be breathed by human beings and all the animal creation ; we mean only that it would be air or wind (for wind is air in a state of motion) just as much air as is the atmosphere which surrounds us. We do not mean to say that the solid parts of the earth, or even water, are intended to be reduced to air and breathed ; indeed their very constitution, and the purposes they fulfil in the production and support of animals and vegetables, indicate different. The atmosphere is that one constituent element of our terrestrial system, which is intended to be breathed. Each of the three constituent elements of our system has its own purpose to fulfil, and yet they are all three mutually helpful to each other. The atmosphere and water may be called the servants of the solid earth. The earth needs air and water as well as the solar light in order to the production and support of vegetables and animals. The earth also supplies oxygen to the atmosphere, and absorbs the impurities with which that element becomes impregnated. This operation is performed by the leaves or lungs of vegetables, which absorb the carbonic acid, (*) from the air, retain its carbon to increase the solid tissue of their plants, and expire or reject its oxygen, which is the vital principle of the air we breathe. The atmosphere, as a sponge, sucks up the water from the surface of the ocean of lakes and rivers and lets it down upon the thirsty earth again in the form of rain. This process of imbibing water by the atmosphere is called evaporation. These three elements are, as we have before remarked, modifications of the same general substance, each so constituted that nothing can be added to or taken from it; but they are all three mutually dependent on each other, as the parts of the human or other animal body are dependent on each other. When water is evaporated from the surface of the ocean, of lakes, and of rivers, it is not lost,—not a particle of it goes beyond the sphere of the earth's attraction ; but, having descended to the earth again as rain, snow, etc., it in due time finds its way into the rivers again, and thence to the ocean. When a tree decays part of it becomes water, part carbonic acid, and part humus or clay. When any vegetable or animal body goes to decay its component parts return eventually to their original elements, earth, water, and air. These three elements in the constitution of the terrestrial system form an individual or unit, just as the parts and members of the human body form an individual or unit.

Matter is defined in general terms to be everything which is an object of our senses, and includes the ideas of extension, solidity, inactivity, and mobility. The theory with respect to the constitution of matter hitherto

(*) Carbonic acid is composed of Carbon and Oxygen.

is: that all matter is made up of infinitely small particles, called atoms, that is, parts so minute as to be incapable of further division; and that these atoms or ultimate particles are unchangeable and indestructible, unless the power which gave them existence so effects it. The most minute particles, which even the microscope can only just discern, may contain millions of these atoms, so that they must be infinitely beyond the reach of the recognition of our senses. A molecule (a little mass), which may be called the secondary atom, is the smallest particle capable of existing by itself. This, though it may contain millions of atoms, and be undiscernible by the naked eye, is considered the ultimate particle of a compound body. For a long time the theory supposed these molecules to be round solid particles, but the expansion and contraction of bodies under the influence of light, heat and electricity had never been satisfactorily accounted for on this hypothesis, nor how solid bodies become liquid, and solid and liquid bodies become gasiform. The theory, therefore, has for some time supposed that the molecules of matter are not solid, but are filled with electricity, as the soap bubble is with air, and are, like it, capable of great elastic expansion and contraction, and that they are only round like the soap bubble when taken singly, but are polyhedral or manysided over all their surfaces of contact, when like the soap bubbles in connection with each other, or in clusters. This theory shows how electricity, which undoubtedly pervades all bodies, may be contained within the molecules; and also how electricity, which is undoubtedly capable of expanding all bodies, can expand them; and, further, how molecules, which, from extreme contraction are hard, and solid, and opaque, may, by extreme expansion and rarefaction, become fluid, gaseous, diaphanous, and transparent. It also satisfies the chemical requirement of definite atoms for proportional admixtures of different elements and their concurrent expansion and contraction within definite limits in the compounds they form.

But let us see from the following illustrations what these molecules are which are conceived to be filled with electricity, by this also seeing the extent to which matter is capable of being subdivided.

One hundred cubic inches of a solution of common salt will be rendered milky, by adding to it a cube of silver, each side of which measures the $\frac{1}{1000}$ of an inch, dissolved in nitric acid. The atoms of silver have found their way into every particle of water, and there with the salt formed the white chloride of silver, which rendered the solution milky; that is, the small cube of silver has divided itself into at least one hundred millions of parts, a number which the seconds pendulum of a clock would beat in 31,688 years; and even yet we are not sure that we have approached the measure of an atom of silver, we have only reached the limits of our power of subdivision. A single grain of gold can be spread into a leaf containing 50 square inches, and this leaf may be readily divided into 500,000 parts, each of which is visible to the naked eye; and, by the help of a microscope which magnifies the area of a surface 100 times, the 100th part of each of these becomes visible; that is the 50 millionth part of a grain of gold will be visible, or a single grain of that metal may be divided into fifty millions of visible parts. But the gold which covers the silver wire used in making gold lace is spread over a much larger surface, yet it preserves, if examined by a microscope, a uniform appearance. It has been calculated that a single grain of gold under these circumstances would cover a surface of nearly thirty square yards.

If a bar of silver be gilded and then drawn out into a wire, the thread may be so fine that the gold covering one foot weighs less than the $\frac{1}{6000}$ of a grain; an inch of this wire will contain the $\frac{1}{72000}$th of a grain; this may be divided into 100 parts, each visible to the eye, and being covered by the $\frac{1}{7200000}$ or the one 7 million 2 hundred thousandth part of a grain of gold. Under a microscope magnifying 500 times each of these pieces may be subdivided by the eye into 500 parts, the gold retaining its original appearance, and showing no signs of dividing into its separate atoms; and yet the particle visible to the eye, that which covers the upper part of the wire, is $\frac{1}{7200000000}$ or the one seven thousand two hundred millionth of a grain.

If a pound of silver wire, which contains 5,760 grains, and a single grain of gold be melted together, the gold will be equally diffused through the whole silver, insomuch that if one grain of the mass be dissolved in aquafortis, the gold will fall to the bottom. By this experiment it is evident that a grain of gold may be divided into 5,761 visible parts, for only the 5,761st part of the gold is contained in a single grain of the mass.

The diffusibility of parts of natural bodies is still more surprising. Odoriferous bodies, such as camphor, musk, and asafœtida are perceived to have a wonderful subtilty of parts; for though they are perpetually filling a considerable space with odoriferous particles, yet these bodies are found not to lose any sensible part of their weight in a great length of time.

Again, it is said by those who have examined the subject with the best glasses, and whose accuracy of observation is not questioned, that there are more animals in the milt of a single codfish, than there are men on the whole earth, and that a single grain of sand is larger than four millions of those animals. Now if it be admitted that these little animals are possessed of organised parts, such as a heart, stomach, muscles, veins, arteries, etc., and that they are possessed of a complete system of circulating fluids, similar to what is found in larger animals, we evidently approach the idea of the infinite reducibility of matter. It has indeed been calculated that a particle of the blood of one of these animalculæ is as much smaller than a globe one tenth of an inch in diameter as that globe is smaller than the whole earth.

Captain Scoresby, in his account of the Greenland Seas, states that, in July, 1818, his vessel sailed for several leagues in water of a very uncommon appearance. The surface was variegated with large patches of a yellowish-green color. It was found to be produced by animalculæ, and microscopes were applied to examine them. In a single drop of the water examined by a power of 28,224 (magnified superficies) there were fifty in number on an average in each square of the micrometer glass of $\frac{1}{840}$th of an inch in diameter; and as the drop occupied a circle on a plate of glass containing 529 of these squares there must have been in this single drop of water taken at random out of the sea, and in a place not the most discolored, about 26,450 animalculæ. How inconceivably minute must the vessels, organs, and fluids of these animals be! A whale requires a sea to sport in; a hundred and fifty millions of these would have ample scope for their evolutions in a cup of water! We might adduce many more instances of a like kind, but these we doubt not will be sufficient to illustrate into what exceedingly minute parts matter is capable of being subdivided; parts so infinitely minute that they are evidently a rare fluid or gas, reducible doubtless to as rare a gas as the air we breathe.

And since that all existing things are of a substance reducible to a fluid of the same density throughout, it remains to give a name to that existence. We have begun this illustration with the proposition that there is nothing existing in the universe but spirit, in different states of density and rarity. This, according to the literal meaning of the word spirit, and the consideration that all existing things are of a substance reducible to a state of air, seems an appropriate term. Others, however, may conceive of a more appropriate term to be applied to universal existence, and the more appropriate the term the more worthy of being applied and universally adopted. Nor do we think it proper or just to deprive scientific men of their atomic theory, provided it holds these ultimate particles to have never not existed, since they regard it as expedient for their purposes.

Affinity, in the language of chemistry, is that force in virtue of which two or more substances combine to form a compound body. This body exhibits properties different from those of the combining elements, and is called a chemical compound. Some substances display a greater affinity for each other than others do. For example, if we take a piece of chalk, and put it in a glass of water, in due time it will become softened, and if the water be stirred, the chalk will render it milky, but no change has taken place, for if it be let stand the chalk will sink to the bottom, or, if the water be evaporated, the chalk may be recovered unaltered. But had a little nitric acid been added to the water, bubbles of gas would have arisen to the surface, and the water would have become clear. The chalk was composed of lime and carbonic acid. The nitric acid having been added a combination of it takes place with the chalk, by which carbonic acid gas is set free, and escapes in bubbles from the surface of the water. If now the water be evaporated, chalk will no longer be found, but a transparent crystallised substance, called the nitrate of lime, very different from the lime or the nitric acid of which it is composed. Here then is an illustration of chemical affinity, and of chemical combination. Chemical action always evolves heat. The action which took place when the nitric acid came into contact with the chalk was analogous to that which takes place when a stick of wood is thrown on the fire, in which case heat and flame result, and the component parts of the wood enter into new combinations. This phenomenon of chemical affinity very plainly depends upon the principle of electrical attraction. We have before explained that electricity, light, and heat, are the same substance under different modes of action and manifestation; or rather that electricity might be regarded as the element of which light and heat are peculiar manifestations. This element pervades all bodies, which only require to be properly acted upon in order that it be made apparent in heat, or light, or both. Before the invention of lucifer matches the blacksmith,in order to kindle his fire,battered a nail on his anvil until it became red hot. Also, the savage who has no access to the means employed by civilized people for making a fire, educes that element by rubbing together two sticks of wood. Even water is pervaded by the active principle of combustion, and if thrown on a blazing fire in insufficient quantity tends not to quench but to strengthen the flame. All bodies in their natural condition are supposed to contain a certain amount of this electric fluid, and if they possess no more and no less than this natural amount they tend to remain in the same electric state. But if a body contains more than its natural amount it is said to be positively electrified, if less it is said to be negatively electrified. When a positively electrified body is brought near or in contact with a negatively electrified one, attraction takes place between them, and the former discharges its surplus fluid into the latter to make up for its deficiency. Thus thunder is caused by a positively electrified cloud coming near a negatively electrified one, which it attracts, and discharging into it its surplus electricity; and the lightning is merely a manifestation of the electric fluid itself. But what causes the noise, it will be asked, which scares the children? The noise is caused by the electric discharge rushing through the air, and in its course displacing its own volume of the latter, thus causing a vacuum which the air from all sides rushes in to fill up. This combination of causes produces the thunder, but principally the air in rushing in to fill up the vacuum. When two bodies having more than their natural share of electricity come near or in contact with each other they tend to repel each other. This principle of electrical attraction and repulsion satisfactorily explains why some substances have a strong inclination to combine with each other chemically, while others exhibit little or no desire to do so. Now, in the example before us, the nitric acid and the chalk attract each other, one of the two containing a less amount of electricity than the other; and thus combining with each other heat is evolved, and consequently gas is set free, and a chemical compound results. But the whole process of chemical combination is explainable on the principles of equilibrial diffusion of electricity, and the change and recombination of matter.

We have already endeavoured to illustrate how that not only life but intelligence* is inherent in all matter. Now that we have resolved all matter into spirit it will not be difficult to understand that proposition. The mind readily conceives of the principle of life as existing in all spirit, though it may not conceive of it so readily as existing in all matter. This, we think, arises in the main from the mind being habituated to think in a certain way concerning matter and spirit, and from a certain meaning which has been given to the word spirit in the ancient world, and especially in the Christian world, a meaning not original or literal, but collateral; not essential, but only attributive. For instance the word spirit is commonly used to express the disposition, inclinations, state of heart or temper of a human being, although it is not often thought that the air the individual breathes is the literal spirit, or that the human being himself is a real, though not in his present state a literal, spirit. Also, the Deity is especially spoken of as a spirit invisible and everywhere existing, which is very true, for an infinite being cannot be conceived by the mind, much less seen; and if a being be infinite he must be everywhere present; confessed as a being he cannot be nowhere. But as we know that we exist and as we see the works of the Creator in nature all round us we know that He exists and exists everywhere. But the Deity, as everywhere existing, speaking both from a physical and moral point of view, must include bad as well as good, false as well as true God. What we have said hitherto with respect to the Creator we mean also of the Deity, for the Creator and the Deity we understand as synonymous terms for the same Being. The Deity, then, though unseen, must comprehend in Himself all that is seen to exist, and to be perpetuated in existence, in the two opposite aspects of evil and good in which it is seen by us, for the physical as well as the moral world presents existence in these two contrary aspects.

In the physical world we have the frigidly cold climates of the north and south polar regions,—the regions of eternal snow and ice, in which animal life cannot exist, and where if human beings try to live for a short season they must suffer the effects of intense, biting cold, and be every moment in danger of being frozen to death. We have also the parching torrid zone for twenty degrees immediately North and South of the equator, where men and animals suffer almost as much from the effects of the burn-

* See pages 14, 15, etc.

ing heat of a vertical sun, as in the polar regions from the effects of the intolerable cold. In contrast with these we have the mild climates of the temperate zones, where men enjoy the most delightful and refreshing breezes; the most beautiful scenery, and magnificent and sublime prospects of creation, the most lavish abundance of the good and useful productions of the earth, both animal and vegetable; where nature with benignant smile and outstretched hand seems to anticipate the various wants of man, and offer him in luxuriant abundance even more than his heart desires.

Certain parts of the earth are subject periodically to violent storms and tempests, hurricanes and tornadoes, which often render men lifeless or homeless, and cause a great deal of terror, inconvenience, and damage to the inhabitants of the districts where they prevail. The hurricane and tornado are destructive winds that prevail upon the American Continent, and in the West India Islands, causing terror and often death both to men and the inferior animals. Then there are the poisonous winds, the terrible harmattan, and sirocco, and samiel, and simoom, which prevail upon the Continent of Africa, and in the south-western countries of Asia, causing the inhabitants of these countries to quake and hide their heads, as well as often causing much destruction to life and property. In contrast with these we have the mild and gentle breezes of our temperate climates, which are favorable to vegetation and to animal health; and, also, the trade-winds and monsoons which enable our seafaring men to navigate every sea and ocean, and to waft the products of the earth and of the arts from land to land.

In the animal kingdom we can contemplate the character and disposition displayed by the wild carnivorous animals of the land, the lion, the tiger, the hyena, the wolf, the bear, the jackal, the wild-cat, etc.; and the monstrous carnivora of the ocean, as the shark, the whale, the porpoise, and others innumerable about which we know nothing. And among the reptile tribes we can contemplate the boa constrictor, the rattle-snake, the adder, the alligator, the crocodile, the anaconda, etc.; and also among ravenous birds, the eagle, the ostrich, the vulture, the hawk, the raven, etc. And on the other hand we can contemplate the character and disposition of the gentle and useful domesticated animals, the sheep, the cow, the horse, the goat, the deer, the camel, the dromedary, the tamed elephant, the ass, the dog, the cat, the pig; also, among birds, the pigeon, the hen, the goose, the duck, the guinea-hen, etc.

In the vegetable kingdom we are presented with two varieties, noxious and innoxious plants. Poisonous plants are numerous indeed, they are to be found in most of the species, but some species contain many more than others. The order *Ranunculaceæ*, for example, of flowering plants, are almost all poisonous, and in some cases the poison is so virulent, that death speedily results from swallowing a very minute portion of the fruit. More than one poisonous principle abounds in this tribe; but of these the alkali termed by chemists *aconitum* is the most violent. It is a white substance something like flour to look at, and so frightfully poisonous that the twentieth part of a grain or even less is a fatal dose. Of all the various species of aconitum, that termed *aconitum ferox* is the most dangerous. This plant grows in the Himalaya mountains, and was on one occasion made use of by the natives to rid themselves of their subjugators, the English. A few leaves of this plant having been thrown into a well so poisoned the water, that men or beasts drinking it were almost infallibly killed. Also, the Poppy tribe, especially cultivated in India, is that which supplies the opium which is doing so much to poison the Chinese and the Hindoos. Plants belonging to the order Ranunculaceæ are supplied with a watery, acrid, poisonous juice; but in plants of the Poppy tribe the juice is milky, from which milky juice the luxury, opium, is expressed. Also, the great natural order *Umbellifera*, or umbrella-bearing plants, are of a dangerously doubtful character. Their chemical characteristics may be said to depend on the presence either of an odorous, volatile oil, or of a poisonous matter. Everybody knows how agreeably odorous is caraway seed, and most people are aware of the poisonous nature of the hemlock, and of the noxious character of the fools' parsley. The advantage when one is in an unknown country of being a practical botanist, so as to be able to refer a plant to a harmless or noxious kind, is considerable. It is related that when, during Anson's voyage, his crews disembarked in unknown places, the surgeon, fearful of poison, would not allow them to partake of any vegetables, except grasses, notwithstanding the scurvy was making great ravages among them.

The greater number, if not all the members of the order *Cucurbitaceæ*, or cucumber-tribe, contain a bitter poisonous principle, presenting many degrees of intensity. In the colocynth it attains its maximum. In the ordinary cucumber the poisonous bitter principle is usually but little developed, never to the extent of being dangerous, although frequently enough to be disagreeable. In the melon sugar is the principal secretion, nevertheless, the bitter principle so prevalent in the family is present in a small degree; it exists in the outside rind of the fruit, and to a still greater degree in the roots, which are violently emetic. Bryonia, another species, is still more violent in its poisonous action than the colocynth. Also, nearly all, if not all the members of the order *Solanaceæ*, or Night-shade tribe, contain a poison of a narcotic kind. To this order belong the common night-shade, henbane, tobacco, stramonium, and the mandrake plant. It is a highly dangerous family of plants, although one that ministers to our sustenance in the potatoe. Even this is not entirely free from poison; the fruits are notoriously poisonous, and even the juice of raw potatoes is highly injurious. The nutritive properties of the potatoe arise from the starch and gluten which it contains being mingled with so little of the poisonous principle, that the latter is destroyed by the cooking process to which the potatoes are subjected before eaten. The egg-plant and tomato belong to this family; the former is occasionally eaten, the latter frequently and almost universally by the Spaniards, and now by the Americans. We may here remark that the vegetable substance, starch, is largely diffused throughout many poisonous plants, yet when separated from them it is invariably harmless. Of this we have a remarkable example in tapioca, which is nothing else than the baked starch extracted from the trunk of a tree, the jatropha manihot. The juice of this tree is so poisonous that they poison arrows with it; nevertheless tapioca is a delicate article of food. The common deadly Nightshade, atropa belladonna, grows in shady places, and is an elegant though dangerous-looking plant. We may here remark that, as a general rule, most plants having dark-green foliage and dark-coloured flowers are poisonous. The belladonna bears a cherry-like fruit, which is sometimes incautiously eaten by children, and too often with a fatal result. In 1793 some orphans brought up in the *Hospice de la Piété* at Paris were employed in weeding a botanical garden. They happened to be attracted by the tempting-looking fruit of a belladonna plant, of which they ate a considerable quantity. Fourteen of these unfortunate children died in consequence only a few hours afterwards. This lamentable catastrophe justifies the generic name atropa, from atropos, one of the fates who was supposed to cut the thread of life. The specific name belladonna signifies beautiful lady, and is dependent on the circumstance that the Italian ladies used the distilled water of this plant as a cosmetic. They foolishly imagine that it improves their complexions. The mandrake is a species very nearly allied to the belladonna. It grows in the South of Europe, and in dark places. This plant, known and celebrated from times of great antiquity, was employed by the sorcerers of ancient days to produce narcotism, and disordered vision. Its roots are large, often two-pronged, whence its fancied resemblance to the limbs of a man. This plant has from very early periods of history been regarded with much superstitious dread, which has probably arisen partly from its poisonous properties, and partly from its large and irregularly shaped roots, which at times approximate to the uncouth form of a man. Shakespeare writes: "And shrieks the mandrakes torn out of the earth, that living mortals hearing them run mad." The notion that prevailed in days gone by regarding the sounds of complaint uttered by the mandrake when being rooted up appears to have been widely entertained by the ignorant. Misfortune of the direst kind was believed to be the portion of any one bold or rash enough to engage in disturbing the mandrake in his earthbed. An old English proverb says: "He who gathereth the mandrake shall die ; blood for blood is his destinie." It is supposed that the mandrakes mentioned in some parts of the Old Testament were not the same as the plant known to us by this name, but that under this term reference is had to the fragrant but insipid fruit of the *Cucumis Dudaim*, a plant which is cultivated in the gardens of the East for the odor it exhales. The mandrake is also confounded with the sleep-apple, a mossy excrescence on the wild rose, which when laid under the pillow was supposed not to allow any one to awake until it was taken away. This property of stupefying doubtless arose from its narcotic properties.

Henbane is a European plant belonging to this genus under consideration. It is a biennial plant, and grows amidst the ruins of buildings, in the neighborhood of habitations. Its stem is studded with a cotton-like substance, and it constantly exhales a repulsive odor. Its corolla is palish yellow, veined with purple. It owes its peculiar properties to the presence of a peculiar alkali. Its action is far less powerful than that of belladonna; nevertheless it may cause death if eaten. A German physician relates that, on a certain occasion, the Benedictine monks of the convent of Rhinon were presented with a salad in which the root of chicory, as was thought, had been placed. Instead, however, being of chicory the root was of henbane. After the repast the monks went to bed. Symptoms of poisoning soon commenced ; the monks were all stupefied. The time for matins or morning prayers arrived, and one monk was so fast asleep that his fellows supposed him to be dying, and under this impression administered to him extreme-unction. The other monks went to chapel, but they had much better have stayed away ; some of them could not even open their eyes, much less read. The vision of others was so disordered that they thought insects were crawling on their books, and employed themselves in blowing and brushing the intruders off. Others instead of praying uttered nonsense. In the end all the monks got well, even the one supposed to be dead ; but one poor individual, a tailor, could not thread his needle for a long time afterwards, so disordered was the state of his vision. Instead of one needle the tailor saw three, and as he could not tell the real needle from its ghostlike duplicates, there was slight chance of his threading it. This anecdote illustrates better than any mere description the physiological action of henbane.

The stramonium is another plant of the Night-shade order. It was unknown to the ancient Greeks and Romans, but is now common in Europe, having been brought from Central Asia in the middle ages by the wandering gipsies. Its active principle is called *daturine*, which exists in the leaves and in the seeds. This principle is a potent narcotic alkaloid, resembling in its quality and the effects it produces the alkaloids yielded by the henbane and belladonna. It is a deadly poison, and among the most striking of its properties may be named the effect it produces on the pupil of the eye, namely, that of causing it to dilate strongly. Nevertheless the stramonium, or the thorn-apple as it is sometimes called, like many other poisonous plants, has its beneficial uses. In Cochin China a decoction made of its leaves is considered an effectual remedy for hydrophobia, the terrible malady resulting from the bite of a mad dog; but this by some is considered very doubtful. In small quantities *daturine* is very useful as a pain-soother or anodyne, and as an antispasmodic. Persons suffering from asthma have found relief from smoking the dried leaves of the plant, or inhaling an infusion made by pouring boiling water on the seeds or leaves. Great care, however, should be used less the patient take an overdose. Tobacco is another plant belonging to this natural order, and the use or abuse of which is too well known to require comment here.

The order *Euphorbiaceæ*, to which the castor oil plant belongs, is mainly made up of very dangerous plants. The greater number of its species contain a milky, acrid, and poisonous juice, which often holds dissolved, in addition to other principles, a peculiar elastic substance, and occasionally a coloring matter. The species *Euphorbiæ*, the type of this natural order, present an aspect of great variety. The manchineel is a large tree of intertropical America, celebrated for its peculiarly poisonous qualities. If accounts are to be trusted it is certain death for an individual to sleep under the shade of one of this species; and even rain which touches the skin after having fallen upon the leaves of this tree raises a blister. The manchineel tree also bears tempting-looking fruit, from which an agreeable odor is exhaled, but even a small portion if eaten produces certain death.

The order called *Loganiaceæ* is also largely represented by poisonous plants. The sub-family strychnos contains the most remarkable species of this natural order. The greater number possess in their bark and seeds two alkaline principles, termed respectively strychnine and brucine. The action of these on the animal organism is extremely violent. The *Strychnos-tiente* is a climbing plant of the Javanese forests, with the juice of which the natives poison their arrows. It is the famous upas and is often confounded with another Javanese vegetable poison, obtained from the *Antiaris Toxicaria*, a tree belonging to the natural family Artocarpeæ. The ourari, or wourali, is also a poison furnished by another member of the same natural family, the strychnos toxifera, a native of Guiana. The Indians who dwell on the banks of the Orinoco, the Ipura and the Rio Negro, employ this substance as a poison for their arrows. The nux-vomica tree, or koochla tree of India, is perhaps the most valuable of this tribe, furnishing an alkaloid, strychnine, very poisonous, but of great use in medicine.

The natural order Apocynaceæ, which name Greek scholars will recognise, and is significant of the dog-killing power of certain of its species, is also a dangerous tribe. The plants belonging to this order are usually trees or shrubs, seldom herbs, and for the most part containing a milky juice. This natural order is rather frequent in tropical climates, but the number of species is very inconsiderable in our latitudes. The milky, acrid and bitter juice which flows from many of these plants imparts to the family an emetic and purgative tendency which in some species is deleterious. The bark of many of the dog-banes contains a bitter astringent principle; in other species a tinctorial matter predominates. The seeds of many genera are poisonous. Many species of the genus cerbera, as well Asiatic as American, possess narcotic acrid seeds, sometimes poisonous, but useful as a remedy for the bites of serpents. The cerbera ahouai secretes an exceedingly poisonous juice, which is employed in Brazil for the purpose of stupefying fish. The poisonous tanghin is a native of Madagascar, about thirty feet in height, yielding a dropaceous fruit which contains an oily seed, and is employed by the natives judicially in the trials by poison. The accuser makes his complaint to the judge, who refers it to an official denominated the ampananghin, and whose office is the double one of priest and executioner. If sufficient presumptive evidence of crime is forthcoming, the tanghin is administered and the guilt or innocence of the accused is judged by the result. If he recover from the effects of the poison he is declared innocent. If he die he is considered guilty and his goods are forfeited. Even the natural order of endogenous plants to which the grasses and cereals belong is not without its poisonous species. The darnel grass is strongly poisonous owing to the presence of the chemical principle loline. Festuca quadredentata, a species which grows abundantly in Peru, is mortal to cattle which graze upon it. Another species, balmogrostis, is juiceless, and, when swallowed by animals, injures their throats, rather on account of the flinty matter with which it is profusely coated than because of any poisonous principle it contains. The orders here mentioned contain each many genera, species, and varieties, and what we have adduced as to poisonous vegetables gives only a very general idea of their number and varieties, in the vegetable kingdom.

Having taken a glance at the noxious portion of the vegetable world, it will be proper, for the purpose of contrast, to give a passing notice to the innoxious portion of it. With this part of the vegetable kingdom people are better acquainted than they are with the other. In this part are contained the plants which furnish the food for the human race and for the inferior orders of animals. It will not be necessary, therefore, to give any extended description of it; for what every body knows to some extent, or may know extensively by a little observation, they need not be told about in detail in such a treatise as this.

All seed-bearing plants are classed by botanists under the two general natural divisions of *exogenous* plants, or those which grow or increase by external depositions of their substance; and *endogenous* plants, or those which grow or increase by internal depositions of their substance. Of the former class the oak, the elm, and most large trees are specimens; of the latter the palm tree, the bamboo, the sugar cane, and a stalk of wheat, rye or oats may serve as specimens. Most of the vegetables which minister to our sustenance belong to the endogenous division. Thus, all the species of grasses are endogenous. The smaller species clothe our fields with verdure and afford nourishment to cattle; the larger species furnish us with bread and sugar, for the reader may remember that not only the species commonly called grass which the cattle graze upon, but wheat, barley, rice, maize, oats, rye, and even the sugar-cane, the bamboo, and the palm-tree, are, botanically considered, grasses. Is it not wonderful that mankind subsists chiefly on grass! Linnæus, the celebrated Swedish naturalist, has remarked that the cow eats 276 species of plants, and rejects 218; the goat eats 449, and rejects 126; the sheep eats 347, and rejects 141; the horse eats 262, and rejects 212; and the hog, more nice in its taste than any of the rest, eats but 72 and rejects all the rest. Whether these animals reject certain plants on account of certain poisonous principles which they possess, or simply because of a peculiar nicety of taste in themselves, we shall leave to be determined by others.

Grasses are not excluded from any quarter of the globe, but the number of individuals, though not of species, is greatest in the northern temperate regions; also, they have become so transported from one region of the earth to another, that it seems now quite impossible to determine with certainty the native regions of many species. Oats and rye are mostly cultivated towards the north; barley and wheat in more temperate regions; maize is a staple product of America, and rice of Asia. The seed or rather the fruit of these afford sustenance to the greater portions of the human race. The analogy of the chemical composition of grasses as well as their external characters indicates their mutual affinities, pointing out the whole family as essentially nutritive vegetables. The grain or seed contains starch or gluten in abundance, mixed with a certain quantity of sugar, the amount of which increases toward the period of germination; they also contain a little fixed oil and various saline matters. Innocuity and the presence of nutritive principles are the grand characteristics of grasses physiologically considered. The Sugar-cane is supposed to be a native of South-eastern Asia. It was unknown to the ancient Greeks and Romans, as also was Sugar. From South-eastern Asia the cane was introduced into Arabia, and it thence was introduced into Egypt, Asia-Minor, Sicily, Italy and Spain. From the latter country it was transported to St. Domingo and the mainland of America. It is cultivated to a considerably large extent and furnishes much to the benefit of the human race. The corn-bearing grasses are appropriately denominated cereals, or plants of Ceres, the goddess of corn, among the ancient

Greeks and Romans. Amongst these wheat takes the first rank. It is more nutritive than any of the others, and is adapted to climes and tracts of greater diversity of character. Rice may be correctly described as a tropical water-grass, the conditions necessary to its growth being a hot atmosphere, and a swampy soil. These conditions exist in Asia, where rice is cultivated to a large extent, and in the southern temperate and tropical climates of America. The conditions necessary to the growth of rice are unfavorable to the health of man. The palm tree is a plant which furnishes a number of useful products, such as oil, wine, dates, cocoa, nuts, hemp, astringent matter, sugar, and spirit; also an excellent fruit is furnished by the banana, a species of palm tree. The maple tree affords a large amount of sugar to the people of the United States and Canada, who prepare and use that article to a great extent. The various species of apple tree furnish a fruit which is used in a variety of forms for human food. Also, the various species of peaches, plums, cherries, gooseberies, prunes, apricots, pine-apples, strawberries, raspberries, currants, grapes, etc, as well as the various species of wild fruits, too numerous indeed to mention here, and of a wholesome nature, all afford their stores of nutritive food for the sustenance of man. Also, if we enumerate the roots, bulbs, and tubers, which are cultivated by the farmer and gardener, such as parsnips, carrots, beets, turnips, potatoes, etc., we shall find that a large store is furnished from this source, also, for the maintenance of man and beast.

If we enumerate the forest trees we have the various species of the oak, fir, pine, cedar, ash, larch, wall-nut, hickory, elm, birch, hemlock, etc. which all contribute to supply man's wants, if not in the way of food, yet in other important ways.

Then there are the various species of flowering plants which adorn the fields and gardens, which are not of a poisonous nature, and which add such varied and diversified beauties to the prospect before us. During the summer season, when all nature is clothed with verdure, when the trees and plants are blooming with flowers and blossoms of varied hue, when the birds are warbling their melodious notes, when the various species of corn are growing and ripening in the fields, when the various kinds of domestic animals are seen to gambol and frolic about the lawns, and nature seems to smile benignantly in bringing forth an abundant supply for the wants of all her animate offspring, then does not our earth seem a present heaven!

If we take a survey of the various tribes of mankind we find a great variety of character and disposition displayed. The two extremes of evil and good are here comprised. Man is undoubtedly the most savage and brutal of all terrestrial animals, but is susceptible of becoming the most gentle, kind, and intelligent. In dealing with this part of our subject we shall first take a glance at the state of the uncivilized races of mankind, and at those nations by whom terrible scenes of barbarity are wont to be enacted and terrible deeds of atrocity are wont to be perpetrated, and then we shall take a glance at the races called civilized, both of the past and present.

Contemplate with us the character and disposition of savage tribes, of the New Zealanders, the South Sea Islanders, the Australian Bushmen, the Caffres, and numerous other African tribes; of the numerous nations of Indians of North and South America, of the ancient Mexicans, and of the Asiatic tribes of Huns, Tartars, etc., and what a horrid and disgusting picture of human cruelty, brutality, barbarism, and savage malignancy will be presented to the mind. The most prominent feature which appears in the character of savage nations is their disposition for war, and to inflict revenge for real or supposed injuries. The dismal effects of the principle of hatred directed toward human beings, the disposition to be engaged in war continually, and the savage ferocity of the human mind when unrestrained by moral and prudential considerations, are nowhere more strikingly displayed than in the islands scattered through the wide expanse of the Pacific and Indian oceans. Of the truth of those positions we have but too many melancholy examples, in the reports of missionaries and in the journals which have been published by navigators, from which we select a few. The first instance we shall adduce relates chiefly to the inhabitants of New Zealand. Captain Cook remarks, in relation to those islanders: "Their public contentions are frequent, or rather perpetual; for it appears, from their number of weapons and dexterity in using them, that war is their principal profession. The war-dance consists of a great variety of violent motions and hideous contortions of the limbs, during which the countenance also performs a part; the tongue is frequently thrust out to an incredible length, and the eyelid so forcibly drawn up, that the white appears both above and below as well as on each side of the iris, so as to form a circle around it; nor is anything neglected so as to render the human shape frightful and deformed. To such as have not been accustomed to such a practice they appear more like demons than men, and would almost chill the boldest with fear; at the same time they brandish their spears, shake their darts, and cleave the air with their patoo-patoos. To this succeeds a circumstance almost foretold in their fierce demeanor, horrid and disgraceful to human nature, which is cutting to pieces, even before being perfectly dead, the bodies of their enemies, and, after dressing them on a fire, devouring the flesh, not only without reluctance but with peculiar satisfaction." One cannot well conceive a more striking idea of the workings of pure malevolence, and of the rage and fury of infernal fiends, than the picture here presented of those savage islanders. These people, so far as European power and civilization has not reached them, live under perpetual apprehension of being destroyed by each other; there being few of these tribes who have not, as they believe, received wrong from some other tribe, which they are continually on the watch to avenge, and the desire of a good meal is no small incitement. "Many years will sometimes elapse before a favorable opportunity happens, but the son never loses sight of an injury that has been done his father. Their method of executing their horrible designs is by stealing upon the adverse party in the night, and if they find them unguarded, which is very seldom the case, they kill every one indiscriminately, not even sparing the women and children. When the massacre is completed they either feast and gorge themselves on the spot, or carry off as many of the dead bodies as they can, and devour them at home with acts of brutality too shocking to be described. If they are discovered before they execute their bloody purpose, they generally steal off again, and are sometimes pursued and attacked by the other party in their turn. To give quarter or to take prisoners make no part of their military law, so that the vanquished can save their lives only by flight. This perpetual state of war, and destructive method of conducting it, operates so strongly in producing habits of circumspection, that one hardly ever finds a New Zealander off his guard, either by night or by day." The implacable hatred which these savages entertain for each other is illustrated in the following short narrative, also by Captain Cook. "Among our occasional visitors was a chief called Kahoora, who, as I was informed, headed the party that cut off Captain Furneaux's people, and himself killed Mr. Rowe, the officer who commanded. To judge of the character of Kahoora from what I had heard from many of his countrymen he seemed to be more feared than beloved among them. Not satisfied with telling me that he was a very bad man, some of them even importuned me to kill him, and I believe they were not a little surprised that I did not listen to them, for according, to their ideas of equity, this ought to have been done. But if I had followed the advice of all our pretended friends, I might have extinguished the whole race; for the people of each village or hamlet by turns applied to me to destroy the others. One would have almost thought it impossible that so striking a proof of the divided state in which these people lived could have been assigned."

Similar dispositions are displayed by the inhabitants of almost all the other islands of the South Seas. The influence of Christianity does not as yet prevail very extensively among them. The following description is given by M. de la Perouse of the inhabitants of Maouna Orjolava, and the other islands in the Navigator's Archipelago:—"Their native ferocity of countenance always expresses either surprise or anger. The least dispute among them is followed by blows of sticks, clubs or paddles, and often, without doubt, costs the combatants their lives." With regard to the women he remarks:—"The gross effrontery of their conduct, the indecency of their motions, and the disgusting offers which they make of their favors rendered them fit mothers and wives for the ferocious beings that surrounded us."

The natives of New Caledonia are a race of a similar description. Captain Cook describes them as apparently a good-natured people, but subsequent navigators have found them to be the very reverse of what he described them,—as ferocious in the extreme, addicted to cannibalism, and to every barbarity shocking to human nature. The French navigator, the Admiral D'Entrecasteaux, in his intercourse with these people received undoubted proof of their savage disposition, and of their being accustomed to eat human flesh. Speaking of one of the natives who had visited his ship, and had described the various practices connected with cannibalism, he says: "It is difficult to depict the ferocious avidity with which he expressed to us that the flesh of their unfortunate victims was devoured by them after they had broiled it on the coals. This cannibal also let us know that the flesh of the arms and legs was cut into slices, and that they considered the most muscular parts a very agreeable dish. It was then easy for us to explain why they frequently felt our arms and legs, manifesting a violent longing; they then uttered a faint whistling which they produced by closing their teeth, and applying to them the tip of the tongue; afterwards opening their mouth they smacked their lips several times in succession. The characters of the islanders now described may be considered as common to the inhabitants of the New Hebrides, the Friendly Islands, the Marquesas, the Sandwich Islands, New Guinea, New Britain, the Ladrones, and almost all the islands that are scattered through the vast expanse of the Pacific Ocean. Captain Cook, in describing the natives of New Zealand, again remarks: "The inhabitants of the other islands of the South Seas have not even the ideas of indecency with respect to any object or to any action." Of the natives of Otaheite he declares: "They are all arrant thieves, and can pick pockets with the dexterity of the most expert London blackguard." When describing the societies distinguished by the name of Arreoy he declares as a characteristic of the female part of the community: "If any of the women happens to be with child, which in this manner of life happens less frequently than in ordinary cases, the poor infant is smothered the moment it is born, that it may be no incumbrance to the father, nor interrupt the mother in the pleasures of her diabolical prostitution." Another circumstance mentioned by the same navigator exhibits their former moral character in a still more shocking point of view. On the approach of war with any of the neighboring islands, or on other important occasions, human sacrifices were a universal practice. "When I described," says Captain Cook, "the Native at Tongabatoo, I mentioned that on the approaching sequel of that festival we had been told that ten men were to be sacrified. This may give us an idea of the extent of the religious massacres on that island. And, though we should suppose that never more than one person is sacrificed on any single occasion at Otaheite, it is more than probable that these occasions happened so frequently as to make a shocking waste of the human race, for I counted no less than forty-nine skulls of former victims lying before the Morai, where we saw one more added to the number. And, as none of these skulls had as yet suffered any considerable change from the weather, it may be inferred that no great length of time had elapsed since this considerable number of unhappy wretches had been offered on the altar of blood." He likewise informs us that human sacrifices were more frequent in the Sandwich than in the other islands. "These horrid rites," says he, "are not only had recourse to upon the commencement of war and preceding great battles, and other signal enterprises, but the death of any considerable chief calls for the sacrifice of one or more tow-tows, that is, vulgar or low persons, according to his rank, and we were told that ten men were destined to suffer on the death of Terreeoboo, one of their great chiefs."

With respect to the North American Indians (who have now almost disappeared from the Eastern States and Canada) it is the uniform description given of them by all who have travelled or lived among them in their wild state that, if we except hunting, war is the only employment of the men, and every other concern is left to the women. Their most common motive for entering into war is either to revenge themselves for the death of some friend, or to acquire prisoners who may assist them in their hunting, and whom they adopt into their society. In these wars they are savage and cruel to an incredible degree. They enter unawares the villages of their foes, and, while the flower of the nation are engaged in hunting, massacre all the children, women, and helpless old men, or make prisoners of as many as they can manage. But, when the enemy is apprised of their design, and is coming on in arms against them they throw themselves flat on the ground among the withered herbs and leaves which their faces are painted to resemble. They then allow a part to pass unmolested, when all at once, with a tremendous shout, rising up from the ambush, they pour a storm of musket-balls on their foes. If the force on each side continues nearly equal, the fierce spirits of these savages, inflamed by the loss of friends, can no longer be restrained. They abandon their distant war, they rush upon one another with clubs and tomahawks in their hands, magnifying their own courage and insulting their enemies. A cruel combat ensues; death appears in a thousand hideous forms, which would congeal the blood of civilized people to behold, but which increases the fury of these savages. They trample, they insult over the dead bodies, tearing the scalp from the head, wallowing in their blood like wild beasts, and sometimes devouring their flesh. The flame of war rages on until it meets with no resistance, then the prisoners are secured, whose fate is a thousand times more dreadful than theirs who have died in the field. The conquerors set up a hideous howling to lament the friends they have lost. They approach to their own village, the women with frightful shrieks come out to mourn their dead brothers, or their husbands. An orator proclaims aloud a circumstantial account of every particular of the expedition, and, as he mentions the names of those who have fallen, the shrieks of the women are redoubled. The last ceremony is the proclamation of victory; each individual then forgets his private misfortune, and joins in the triumph of his nation; all tears are wiped from their eyes; and, by a transition unaccountable to us, they pass in a moment from the bitterness of sorrow to an extravagance of joy. As they feel nothing but revenge for the enemies of their nation, their prisoners are treated with extreme cruelty. The punishments inflicted on such prisoners as are doomed to death are too shocking and horrible to be exhibited in detail; one plucks out the nails of the prisoner by the roots; another takes a finger into his mouth and tears off the flesh with his teeth; a third thrusts the finger mangled as it is into the bowl of a pipe, made red hot, and smokes it as if it were tobacco; they then pound his toes and fingers to pieces between two stones; they apply red hot iron to his mangled body; they pull off his flesh, thus mangled and roasted, and devour it greedily; and thus they continue for several hours, and sometimes for a whole day, until they penetrate to the vital parts and completely exhaust the spring of life. Even the women, forgetting the human as well as the female nature, and transformed into something worse than the reputed Furies, frequently outdo the men in this scene of horror, while the principal persons of the tribe sit round the stake to which the prisoner is fixed, smoking and looking on without betraying the least emotion. And, what is quite as remarkable, the prisoner himself endeavors to brave his torments with a stoical apathy: "I do not fear death," (he exclaims in the face of his tormentors,) "nor any kind of tortures; those that fear them are cowards, they are less than women. May my enemies be confounded with despair and rage! Oh! that I could devour them and drink their blood to the last drop"! Such is a faint picture of the ferocious dispositions, which, with a few modifications, have characterized the Indians of North and South America, and which we have reason to believe yet characterize those who are beyond the reach or influence of the white races. We ourself, have some experience of the character of the Indians who live in the neighborhood of the whites; for happening occasionally to be where they were, and observing their noisy conversation and their unruly gestures, we felt considerably alarmed for our own safety, and did not wish to be among them longer than our duties required.

If we cross the Atlantic and land on the shores of Africa we shall find the inhabitants of that continent exhibiting dispositions no less cruel and ferocious. Bosman relates the following instances of cruelties practised by the Adomeso Negroes, inhabiting the banks of the Praa or Chamah River: "Anqua, the king, having in an engagement taken five of his principal Anteso enemies prisoners wounded them all over: after which with a more than brutal fury, he satiated, though not tired himself, by sucking their blood at the gaping wounds; but bearing a more than ordinary grudge against one of them he caused him to be laid bound at his feet, and his body to be pierced with hot irons, gathering the blood that issued from him in a vessel, one half of which he drank, and offered up the rest to his god. On another occasion he put to death one of his wives and a slave, drinking their blood also, as was his usual practice with his enemies." * Dispositions and practices quite as abominable are exhibited in the Kingdom of Dahomey near the gulf of Guinea. An immolation of human victims for the purpose of watering the graves of the king's ancestors, and of supplying them with servants of various descriptions in the other world, takes place every year, at a grand festival which is held generally in April and May. The victims are generally prisoners of war reserved for the purpose, but should there be a lack of these, the number, between sixty and seventy, is made up from the most convenient of his own subjects. The immolation is not confined to this particular period; for at any time, should it be necessary to send an account to his forefathers of any remarkable event, the king despatches a courier to the shades, by delivering a message to whomsoever may happen to be near him, and then ordering his head to be chopped off immediately. It is considered an honor when His Majesty personally condescends to become the executioner in these cases, an office in which the king prides himself in being expert. The governor was present on one occasion, when a poor fellow, whose fear of death outweighing the sense of the honor conferred upon him, on being desired to carry some message to his father declared on his knees that he was unacquainted with the way, on which the tyrant vociferated. "I'll show you the way," and with one blow made the head fly many yards from his body, highly indignant that there should have been the least expression of reluctance. † On the thatched roofs of the guard-houses which surround the palace of this tyrant are ranged, on wooden stakes, numbers of human skulls; the top of the wall which encloses an area before it is stuck full of human jaw-bones, and the path leading to the door is paved with skulls.

In the Kingdom of Ashantee similar practices uniformly prevail. "When the king of this country," says Dupuis, "was about to open the

* Dupuis, Journal in Ashantee.

† McLeod's Voyage to Africa.

campaign in Gaman, he collected together his priests to invoke the Royal Fetische (idol) and perform the necessary orgies to ensure success. These ministers of superstition sacrificed thirty-two male, and eighteen female victims, as an expiatory offering to the gods; but the answers from the priests being deemed by the council as still devoid of inspiration, the king was induced to makes *a custom* at the sepulchres of his ancestors, where many hundreds bled. This, it is affirmed, propitiated the wrath of the adverse god." The same king when he returned from the campaign, having discovered a conspiracy, decreed that seventeen of his wives along with his own sister should be strangled and beheaded. His sister's paramour, and all those of the same party, were doomed to the most cruel deaths, at the grave of the king's mother. While these butcheries were transacting the king prepared to enter the palace; and in the act of crossing the threshhold of the outer gate was met by several of his wives whose anxiety to embrace their sovereign lord impelled them thus to overstep the boundary of female decorum in Ashantee; for it happened that the king was accompanied by a number of his captains, who accordingly were compelled to cover their faces with both their hands, and fly from the spot. This is said to have enraged the monarch, though his resentment proceeded no further than words, and he returned the embraces of his wives; but another cause of anger soon after occurred, and he was inflamed to the highest pitch of indignation, and in a paroxysm of anger, caused these unhappy beings to be cut into pieces before his face, giving orders at the same time to cast the fragments into the forest to be devoured by birds and beasts of prey, nor did the atonement rest here; for six more unhappy females were impeached of inconstancy, and they also expiated their faults with their lives. Like another Ulysses, His Majesty then devoted himself to the purification of his palace, when to sum up the whole horror of these bloody deeds, two thousand wretches selected from the Gaman prisoners of war, were slaughtered over the royal death-stool in honor of the shades of departed kings and heroes. We are not to imagine that such fiendish and malignant dispositions are confined to kings and the ruling order of society. Wherever such ferocious passions are displayed among barbarous chieftains, they pervade to a greater or less extent the great mass of the people, and almost every one in proportion to the power with which he is invested perpetrates similar atrocities. The following instance, selected from Major Gray's "Travels in Africa in 1824," will corroborate this position, and also show for how many acts of cruelty and injustice the abettors of the infamous traffic in slaves are accountable. The Kaartan force which the Major accompanied had made 107 prisoners, chiefly women and children, in a predatory excursion into Bondoo, for the purpose of obtaining a supply of slaves. The following is an account of the manner in which they were dragged along: "The men were tied in pairs by the necks, their hands secured behind their backs; the women by the necks only, but their hands were not left free from any sense of feeling for them, but in order to enable them to balance their immense loads of corn or rice, which they were obliged to carry on their heads, and their children on their backs. I had an opportunity, says Major Gray, of witnessing, during this short march, the new-made slaves, and the sufferings to which they are subjected in their first state of bondage. They were hurried along, tied, at a pace little short of running, to enable them to keep up with the horsemen, who drove them on as Smithfield drovers do fatigued bullocks. Many of the women were old, and by no means able to endure such treatment. One in particular would not have failed to excite the tenderest feelings in the breast of any one, save a savage African. She was at least sixty years old, in the most miserable state of emaciation and debility, nearly doubled together, and with difficulty dragging her tottering limbs along. To crown the heart-rending picture, she was naked save from her waist to about half way to the knees. All this did not prevent her inhuman captor from making her carry a heavy load of water, while with a rope about her neck he drove her before his horse; and whenever she showed the least inclination to stop he beat her in the most unmerciful manner with a stick. The inhabitants of all the interior of Africa, and round its northern, eastern and western coasts, display in almost every tribe the most inhuman and depraved dispositions. The Algerines are characterized as the most cruel and dangerous pirates, base, perfidious and rapacious, to the last degree. No oaths or ties, human or divine, will avail to bind them, when their interest interferes. Whatever respect they pretend to pay to their prophet Mahomet, gold is the only idol which they really worship. The emperors of Morocco are notorious as a set of rapacious and blood-thirsty tyrants, who have lived in a state of habitual warfare with Christian nations, and in the perpetration of deeds of injustice and cruelty. The Gallas, on the borders of Abyssinia, are a barbarous and warlike nation. They are hardy and of a ferocious disposition, trained to the love of desperate achievements, taught to believe that conquest entitles them to the possession of whatever they desire, and to look upon death with the utmost contempt; and, therefore, in their wars they fight with the most determined resolution, and neither give nor expect any quarter. The inhabitants of Adel, too, are of a warlike disposition, and most frequently live in enmity with those around them. The Feloops are gloomy and unforgiving in their tempers, thirsting for vengeance, even in the hour of dissolution, and leaving to their children to avenge their quarrels. The inhabitants of the grain coast, especially the Mulattoes, are said to be a most abandoned set of people. The men are drunkards, lewd, thievish and treacherous, and the women are the most abandoned prostitutes, sacrificing themselves at all times, and to all sorts of men, without the least degree of restraint. *

The natives of Ansico, which borders on Angola, live by plundering all who happen to fall in their way, some of whom they kill and others they keep slaves. The Boshemen are land pirates, who live without laws and without discipline: who lurk in thickets to watch the passage of travellers and shoot them with poisoned arrows, in order to seize their cattle. "The natives of Congo," says M. de la Brosse in his 'Travels along the Coast of Angola,' 1793, are extremely treacherous and vindictive. They daily demanded of us some brandy for the use of the king and the chief men of the town. One day this request was denied, and we had soon reason to repent it; for all the English and French officers having gone to fish on a small lake near the sea-coast, they erected a tent for the purpose of dressing and eating the fish they had caught, when amusing themselves after the repast seven or eight negroes, who were the chiefs of Loango, arrived in Sedans, and presented their hands according to the custom of the country. The negroes privately rubbed the hands of the officers with a subtle poison, which acts instantaneously, and accordingly five captains and three surgeons died on the spot." The Moors are characterized by Mungo Park as having cruelty and low cunning depicted on their countenances. Their treachery and malevolence are displayed in their plundering excursions againt the negro villages. Without the smallest provocation, and sometimes under the fairest professions of friendship, they will seize upon the cattle of the negroes, and sometimes upon the people themselves. The Bedouins are plunderers of the cultivated lands and highway robbers; they watch every opportunity of taking vengeance on their enemies, and their animosities are transmitted as an inheritance from father to children. Even the Egyptians, who are farther advanced in civilization than the tribes to which we have alluded, are characterized by excessive pride, vindictive tempers, inordinate passions,and various species of moral turpitude. There is a trait in the character of the women of this nation, adverted to by Sonini in his "Travels in Egypt," which is particularly odious and horrible. On discovering any partiality in their husbands for other females, they are transported into a most unbounded and jealous fury. Such are their deceit and vindictiveness on these occasions, that they instil into the blood of their faithless or suspected husbands a slow and mortal poison. They meditate their revenge in silence, and they enjoy the diabolical satisfactio.. of taking off an unhappy being by a lingering death. It is said their own persons supply the horrid means of perpetrating their malicious designs on their husbands, and that they mix with their aliment a certain portion of an ingredient of a poisonous nature, which infallibly induces a slow languor

* Cook's Universal Geography.

and consumption, and in time brings the wretched victims to the grave. The symptoms of the disease are dreadful. The body desiccates, the limbs become exceedingly weak, the gums rot, the teeth loosen, the hair falls off, and at length, having dragged out a miserable and tortured existence for a whole year or more, the unhappy being dies in the most excruciating torments.

If we pass from Africa to the regions of Asia we shall find its inhabitants of a similarly depraved character, and practising similar principles in all the various ranks of its population. Here tyranny in its most degrading and cruel forms reigns supreme and uncontrolled over a superstitious a degraded, and an idolatrous race of mankind. The following, in relation to a petty tyrant of Persia, may serve as a specimen of Asiatic tyranny: "The governor, Zulfecca Khan, is pronounced to be a cruel and unprincipled tyrant; unfortunately for the people he has the ear of the sovereign, and they have no resource against his rapacity. He pays to the Crown 7000 tomauns * a year, but it is asserted that he collects from the district 100,000. His oppression was so grievous that the inhabitants, wearied out, went in a body to the king to complain; but His Majesty only referred them back to their tyrant, who, exasperated at their boldness, wreaked upon them a cruel vengeance. It is said that he maimed and put to death upward of a thousand of both sexes, cutting off the hands, putting out the eyes, and otherwise mutilating the men; and cutting off the noses, ears and breasts of the women. The people, desponding and broken-hearted after this, paid in so far as they were able the rapacious demands of their oppressor, and the natural consequence, ruin and desolation, has ensued." †

Sir John Chardin gives the following account of the inhabitants of Mingrelia, particularly the women: "The people are generally handsome, the men strong and well made, and the women very beautiful, but both sexes are very vicious and debauched. The women, though lively, civil and affectionate, are very perfidious; for there is no wickedness which they will not perpetrate, in order to procure, to preserve, or to get rid of their gallants. The men likewise possess many bad qualities. All of them are trained to robbery, which they study both as a business and as an amusement. With great satisfaction they relate the depradations they have committed, and from this polluted source they derive their greatest praise and honor. In Mingrelia falsehood, depredation, and theft are good actions; and whoredom, bigamy, and incest, are esteemed as virtuous habits. The men marry two or three wives at a time, and keep as many concubines as they choose. They not only make a common practice of selling their

* A tomaun equals about $3.02.

† Frazer's Journey to Khorazan.

children, either for gold or in exchange for wares and provisions, but even murder them or bury them alive, when they find it difficult to bring them up."

The Tartars, who occupy vast regions of the high table-lands of Eastern Asia, are uniformly described by travellers as a rude, plundering, and uncultivated race of men. "There is something frightful," says Smellie, "in the countenances of the Calmuck Tartars. All of them are wandering vagabonds, and live in tents made of cloth and skins. They eat the flesh of horses, either raw or a little softened by putrefying under their saddles. No marks of religion, or of any decency in their manners, are to be found amongst most of these tribes. They are fierce, warlike, hardy, and brutally gross. They are all robbers, and the Tartars of Daghestan, who border on civilized nations, have a great trade in slaves, whom they carry off by force, and sell to the Persians and Turks." *

The Arabians, like the Tartars, live in a state of wildness and lawless independency; their chiefs authorize rape, theft, and robbery. They hold virtue in no estimation, and glory in almost every species of vice. They roam about in the desert, and attack caravans and travellers, wherever they fall in with them, whom they frequently plunder of their property and murder. The Chinese, though undoubtedly more civilized than most of the tribes already mentioned, and though they merit praise for their industry, perseverance and ingenuity, are as despicable in their moral characters, and as destitute of true benevolence, as almost any nation on the earth. Avarice is their leading passion, and in order to gratify it they practice every species of duplicity and fraud. They are not wont to be influenced by motives either of honesty or humanity; and they surpass every other nation in private cheating. Captain Cook observes that, the danger of being hanged for any crime being excepted, "there is nothing, however infamous, which the Chinese will refuse to do for gain." In this declaration he concurs with most writers on the Chinese, both ancient and modern. The Burmans are a lively inquisitive race, irascible and impatient; while in peace, they give proof of a certain degree of gentleness and civilization; in war, they display the ferocity of savages. The Malays, though inhabiting a country beautiful and delightful in the extreme; where refreshing gales and cooling streams assuage the heat; where the soil teems with delicious fruits; where the trees are clothed with a continual verdure, and the flowers breathe their fragrant odors, are a people remarkably ferocious in their manners. They go always armed, except the slaves, and would think it a disgrace to go abroad without their poiniards. The inland inhabitants of Malacca, called Monucaboes, are a barbarous people, delighting in doing continued mischief to their neigh-

* Smellie's Philosophy: Natural History.

bors, on which account, it is said, no grain is grown in Malacca, but what is in gardens enclosed with the thickest hedges, or deep ditches; for when the corn is grown on the open plain the Monucaboes never fail to set fire to it.

Chardin describes the Persians as warlike, vain, and ambitious of praise, exceedingly voluptuous, prodigal, luxurious and addicted to gallantry. Although this country is regarded by the Western nations as one of the most civilized in Asia, it is well known that the wars and the fiendish cruelties in which the despots of Persia have been engaged, have changed many of the provinces of that country into scenes of sterility and desolation; and much of the miseries of famine, which has recently been desolating that country, is owing to its misgovernment.

The Hindoos are effeminate, luxurious, and practised in the arts of dissimulation. They can caress those whom they hate, and behave with the utmost affability and kindness to those whom they intend to deprive of existence by the most sanguinary means. Though they seldom scold or wrangle, they often stab each other insidiously, and without any public quarrel gratify a private revenge. The destruction of infants, the immolation of widows, the drowning of aged parents, which prevail among them, and the cruel and idolatrous rites which distinguish their religious services, are too well known to require description.

The Turks though grave, sedate, and rather hypochondriac, yet when agitated by passion are furious, raging, and ungovernable, dissimulative, jealous, suspicious and vindictive. They are superstitious and obstinately tenacious in religious matters, and, until of late, did not ordinarily exercise benevolence or even humanity towards those whose religion differed from theirs. Interest appears their supreme good, and, when that comes in competition, all ties of religion, consanguinity and friendship are, with the generality of them, speedily dissolved. They have deprived of their liberty, and to a great extent of their wealth, those who have been subjected to their iron sceptre, and have plunged them into the depths of moral and mental debasement. Their devastations and cruelties, and the deeds of injustice and horror which they have committed, are detailed upon the pages of history, and they are scarcely surpassed by the atrocities of the most savage hordes of mankind.

Such is a partial review of the moral state of the savage and semi-civilized races of mankind, and shall we find a review of the nations called civilized to present a favorable contrast to it? Shall we find that the general moral goodness of the nations called civilized compares favorably with the radical and general moral badness of the nations we have passed in review? Each intelligent person can answer this for himself. What one nation can be pointed to as a good moral example for all other nations to follow? It will be much easier to find an individual man whose moral example would be worthy of being imitated by all the inhabitants of his own nation and all mankind than it would be to find a nation whose moral character, as a nation, would be worthy of being imitated by all other nations.

In the moral world, as well as in the physical, there are degrees of approximation to perfection. The physical universe, of course, always exists perfectly constituted, but within the range of our observation we find changes continually taking place in nature. There is first the blade, then the ear, after that the full corn in the ear. The moral world exists in relation to man, and so changes to suit his changeable nature that we hear of moral badness as well as moral goodness. And then there are degrees of approximation from a very bad to a very good moral character. The word moral, derived from the Latin word mos, mores, meaning customs, manners, usages, etc., will clearly show the distinction between the physical and moral world, and that the moral world has special reference to rational beings. People's morals are their manners, customs, usages, etc., in their intercourses which each other; and the morals of an individual are his or her manners, customs, usages, practices, etc., in relation to one's self and to others. Hence, as the manners and customs of a people react in forming their permanent character, we hear of a good or bad moral character, national as well as individual. As mankind has always existed, so mankind has always had, in some sort, manners, customs, usages, etc., and so the moral world is always co-existent with the physical. But the moral world exists especially in reference to man; he may be said to have created it for his own purposes; and if by any catastrophe, now unknown to us, the race of man should entirely perish from the earth, one world would perish with him, the moral world, which he has created for his own purposes. The original thinker in his first excursions is apt to suppose that that which goes by the name of moral world is not worthy of the name world. What, he says, have not all the lower orders of animals their peculiar habits as well as man; habits, which in the case of some of them, as the beaver, the dog, the mole, and the bee, amount to what might be called manners and customs? Or, is the routine of mankind in their intercourses with each other, in accordance with established rules or laws, called social, political and religious, worthy of the name of world as compared with the physical world? But such an one should bethink himself that the term world (the Greek representative of which is *cosmos*, signifying order, or systematic arrangement,) involves the idea of system and order; and the fundamental idea of true morality is order. Thus, the law of Moses, contained in the Ten Commandments, is called the Moral Law, because it contains a system of rules which, if perfectly and universally observed, would ensure the preservation and continuance of order among all human beings.

Thus, the distinction is clearly seen between the physical and moral world; and that, if by any means all mankind ceased to exist, the moral world would cease to exist with them; but the physical world would still remain, and the earth, not an atom of matter less by the disappearance of man from it, would continue to exist, and to revolve upon its axis, and round the sun, and day and night would continue to take place upon it, and the seasons would come and go in succession as they do now, and the changes in nature would continue to take place in their seasons, in the main, always as they now do.

It will be remembered that this is a supposed case only to show man's real importance, if we may so speak, and his real position in existence. But on the other hand, we believe that, as man has always existed, so he will never cease to exist, and so the world he has created, the moral world, will never cease to exist. And, moreover, as he is a changeable being he will continue to change his moral system, modifying it, remodelling it, and creating it anew: as, for example, a nation may do which may change its moral system in part, or may change it in whole, social, political, and religious, every century more or less, and may thus create a new moral world as often as it sees fit. The importance, then, of the adoption and practice permanently of a good moral system, such as that contained in the Ten Commandments, is here clearly recognized.

And now let us briefly review the state of moral character of the nations called civilized. Among the ancients the Greeks and Romans are understood to have been the most civilized nations. They were those which are thought to have attained the highest perfection in art and literature. They were those which, of all the ancients, modern nations most delight to imitate in respect to their arts, literature, and arms. The Greek and Roman languages and literature are taught in our academies and colleges, and the laws of Licurgus and Solon, of Numa and Justinian, are studied by our undergraduates. But what information do the records of history afford us as to the moral character of these nations. Wars and intrigues, treachery and oppression, and all sorts of crime comprise most of it. In the earliest periods of which history gives us any information, we find these nations engaged in wars. The war of the Grecian States with Troy, an account of which we have in the "Iliad" of Homer, although it is not recorded in history proper, yet is acknowledged by our ablest modern historians to have taken place. This war, having been prosecuted for ten years, ended in the downfall of Troy; and, though we have no certain information as to the numbers that fell on both sides, yet, judging from the numbers said to have been engaged, we know the loss of life must have been very great. Troy is said, according to the common belief, to have fallen in the year 1184 before Christ. We mention this war to show what we meet with in the very beginnings of Grecian history, and as experience teaches that history repeats itself, we may believe that this war was but a repetition of what had been taking place in prehistoric ages. After this followed the first and second Messenian wars carried on between Sparta and Messenia for a period of many years, during which many battles were fought with incredible fury and great numbers lost their lives. Then followed the Persian wars, carried on first by Darius the Persian, against the Grecian colonies in Asia Minor, and afterwards by Darius and his successor Xerxes against Greece itself. The great battle of Marathon, was fought between the Greeks and Persians in the reign of Darius, in which many thousand Persians were slain. Darius, humbled at his defeat, entrusted, at his death, the prosecution of the war against Greece to his son Xerxes. The army which the latter led into Greece was the most numerous of which we have any account in the annals of history, the largest of the expeditions of the crusades of sixteen centuries afterwards not coming nearly up to it. According to the statement of Rollin, which is founded on the statements of Herodotus, a historian of those times, of Isocrates, and Plutarch, this army consisted of a million seven hundred thousand foot, eighty thousand horse, and twenty thousand men for conducting the carriages and camels. On crossing the Hellespont, the strait which separates Europe from Asia, an addition was made to it from other nations of three hundred thousand, which made his land forces amount to two million one hundred thousand men. His fleet consisted of twelve hundred and seven vessels, each carrying two hundred and thirty men, in all two hundred and seventy seven thousand six hundred and ten men, which was augmented by the European nations with twelve hundred vessels, carrying two hundred and forty thousand men. Beside this fleet the small galleys, transport ships, etc., amounted to three thousand, containing about two hundred and forty thousand men. Including servants, eunuchs, women, and sutlers, and others who usually follow an army, it is reckoned that the whole number of souls that invaded Greece with Xerxes amounted to five millions, and nearly three hundred thousand souls. After remaining some time in Greece, nearly the whole of this vast army, along with the fleet, was routed and destroyed. Mardonius, one of the lieutenants of Xerxes, whom the latter at his departure left to prosecute the war in Greece with three hundred thousand men, was finally defeated and slain by the Greeks at the battle of Platææ, and only three thousand of this vast army is said to have escaped destruction. This account of the invasion of Xerxes appears on the whole to be exaggerated.

After this followed the first and second Peloponesian wars between the Greeks themselves, the two leading states, Athens and Sparta, being engaged against each other. These wars were carried on for very many years with varying success, and great loss of life to both sides. And preceding and following all these there were endless wars and contentions between the petty Grecian States themselves, in which were displayed the basest intrigue, perfidy, treachery, dishonesty and animosity. They made truces with each other only to break them when they got a fair opportunity; nor did they lose any occasion which presented itself of inflicting damage on each other when at war, attacking each other at night, and murdering and robbing all they could. And it should be borne in mind that the Greeks were a shrewd, cunning people; they united the cunning and treachery of the fox with the boldness and ferocity of the lion and the tiger; and in very numerous individual cases the wisdom of the sage with the courage of the warrior.

The opening history of the Romans also represents that people as engaged in war. The founders of Rome are represented in mythical tradition as descended from the Trojans, who, after the fall of Troy, emigrated to Italy under the leadership of the Trojan chief, Æneas. Romulus and Remus, the descendants of Æneas on their mother's side, and who are represented as having the god Mars for their father, are said to have founded the city, Rome, about the year 753 B.C. In a dispute which arose between the two brothers, as to the name to be given to the new city, Romulus is said to have slain his brother Remus, and so the city was called Rome after the name Romulus. (This, as we have mentioned, is derived from tradition, and is not at all to be relied on as authentic history; indeed there are reasons to believe the city, Rome, may have been an old city, before the time it is said to have been founded by Romulus and Remus.) But it goes on to say: The new city being well filled with men who flocked to it from all sides, but there being a scarcity of women, Romulus, in order to obtain wives for his citizen-subjects, is said to have made application to the neighboring communities, with that in view; but his proposal being treated with contempt, he resolved to obtain by stratagem what had been denied his honorable request. He invited certain tribes of the Sabines and Latins to come to Rome to witness certain festive games, and when they were assembled his Romans fell upon the daughters of their guests and carried them off by force. In consequence of this Rome became involved in a war with the Sabines, which, however, was brought to an amicable conclusion by the intervention of the women, who threw themselves between the two armies and declared themselves willing to share the fate of their new husbands. After this Romulus is said to have waged successful war against Fidenæ and the Etruscan town of Veii, the latter of which he compelled to give up a portion of its territory. His reign is said to have extended over a period of thirty-eight years, 753—716 B.C., and his death was as marvellous as his birth; for while he was reviewing his people his father, Mars, descended in a tempest and bore him up to heaven. Under the name of Quirinus he was afterwards worshipped as a god for a period of nearly eleven hundred years, from the time he is said to have lived to the establishment of the Christian religion, in the empire, by Constantine, A.D. 330. The same honors were paid him as to his father Mars, and it was believed that he watched for the interest of the state he had founded. This may have been one cause of the invincibility of the Romans in battle, that they thought themselves watched over, favored, and assisted by the founder of their state. Men often believe a lie as if it were the truth; but firmly, though blindly, believing it, it is as truth to them. Although this account, as that of the war of Troy, is mythical, it nevertheless shows us the warlike practices of these people in early historic times, and as we find them to be at the very beginning of their history, so we may certainly conclude them to have been before.

From the reputed time of Romulus to that of the Sicilian and Carthaginian wars, for a period of between three and four hundred years, the Romans were perpetually engaged in contests with the Italian tribes. The Etruscans, the Latins, the Marsians, the Hernicans, the Æquians, the Pelignians, the Umbrians, the Lucanians, and the Samnites, were all subjugated by Rome. She then proceeded to subdue the Grecian States of Southern Italy, and, after continuing the war for many years, during which time the Romans fought many and hard battles, especially with Pyrrhus, King of Epirus, who had come from Greece with an army to assist these Grecian colonies, Rome finally succeeded in conquering both Pyrrhus and all the Grecian States of Southern Italy, and in establishing her government over these States.

In more modern times we have a counterpart for Rome in the Anglo-Saxon Heptarchy; for after, by conquest or otherwise, the seven Saxon kingdoms were brought under the power of the king of Wessex, their forces being concentrated, they expanded by degrees on all sides, and, under a succession of Norman princes, brought into subjection the remaining parts of South Britain, and eventually Ireland. Scotland was united to the government in after times, and by peaceful means. But as Rome did not cease to advance her conquests after she had subdued Italy and Sicily, neither did the Anglo-Saxons. when they had subdued Britain and Ireland; but they advanced in all directions in enterprise and arms, until to-day the sun never sets upon the Anglo-Saxon race and language, and their influence in arts and arms is far more than commensurate with the countries they inhabit. But the comparison in other respects stands thus,—if in the acquisition of territory England slew her thousands, Rome did her tens of thousands. It is to be hoped that, henceforth, England will take care that she add not largely to her cup of blood by war.

Carthage was originally a colony of Phœnicians who, about the year 800 B.C., settled on the northern coast of Africa. These colonists increased their dominions by inroads on the neighboring tribes, and, being a naval power, by degrees became masters of almost every island in the Mediterranean. Thus Carthage may be truly said to have become great at the expense of her neighbors. Their efforts to conquer Sicily brought them into collision with the now formidable forces of Rome. The conflicts between Rome and Carthage are distinguished in history by the name of the Punic Wars, Punic meaning Phœnician, for Carthage, as we have said, was a Phœnician colony. The first Punic war, beginning B.C. 264, lasted twenty-four years; the second seven, and the third four years and some months. In the last contest the city of Carthage was destroyed to its foundations by the Romans. It was delivered up by Scipio, the Roman general, to be plundered by the soldiers; its gold, silver, statues, and other treasures amounting to 4,470,000 pounds weight of silver were carried to Rome; its towers, ramparts, walls and all the works which the Carthaginians had raised in the course of many centuries, were levelled to the ground. Fires were set to the edifices of the once proud metropolis, which consumed them all; not a single house, it is said, escaped the fury of the flames. And although the fire began in all quarters, and burned with great violence, it continued for seventeen days before all the buildings were consumed. Thus perished a city which contained 700,000 inhabitants, and which had waged so many ferocious wars with neighboring nations—a terrible example of the destructive effects produced by malevolent passions in war, and of the retributive justice of the Governor of the universe. The destruction of human life in the wars which Rome waged with Carthage is beyond all specific computation. During the space of sixteen years Hannibal, the Carthaginian general, sacked no less than fourteen hundred towns, and destroyed three hundred thousand of his enemies, and we may safely reckon that nearly an equal number of his own men were cut off by the opposing Roman armies; so that several millions of human beings must have been sacrificed in these bloody and cruel wars.

The following is a summary statement of the number of human beings that were sacrificed in a few of the battles recorded in history, as fought for the most part by the Greeks and Romans against their enemies. In the battle of Issus, between Alexander the Great, at the head of the Greeks, and Darius the Persian, there are said to have been slain 110,000; in the battle of Arbela, two years afterwards, between the same two despots, 300,000. In the siege of Jerusalem by Vespasian and Titus, according to Josephus, there were destroyed 1,110,000. And there are said to have been slain in Jerusalem in the year 170 B.C., by Antiochus Epiphanes, celebrated for having compelled the Jews to worship his image, which he introduced to their temple, 40,000. In the year 101, B.C., in an engagement had between the Romans under Caius Marius, their consul, and the German tribes of Cimbri and Teutons, in transalpine Gaul, there are said to have been slain of these barbarians, aside from what fell on the Roman side, 200,000 men,—some historians say 290,000; and it is related that the inhabitants of these countries in which the battle occurred, made fences for vineyards out of the bones. In the ensuing year the Romans, under the command of the same consul, slaughtered 140,000 of the Cimbri, and took 60,000 prisoners. In the year 105 B.C. the Romans in a single battle with the Cimbri and Teutons lost upwards of 80,000 men. In the battle of Cannæ the Romans were surrounded by the forces of Hannibal and cut to pieces, after an engagement of only three hours; the carnage became so dreadful that even the Carthaginian general cried out to spare the conquered. Above 40,000 Romans lay dead on the field, and 6000 of the Carthaginians. What a horrible exhibition of the rage and fury of diabolical passions must have taken place on this occasion; and what a dreaful scene must this field of battle have presented, when we consider that, in the mode of warfare of those days, the slain were literally mangled and cut to pieces! In the battle between Scipio and Hasdrubal 40,000 are said to have fallen. At Cyrene there are said to have been slain of Romans and Greeks, by the Jews, 220,000; in Egypt and Cyprus in the reign of Trajan, 240,000; and in the reign of Hadrian, 580,000 Jews. After Julius Cæsar had carried his arms into the territories of the Usipetes in Germany, he is said to have defeated them with such slaughter that 400,000 perished in one battle. (This most probably is exaggerated.) In the battle of Chalons, between the Huns, under Atilla, and the Romans, there perished about 300,000. In the year 631 A.D. there are said to have been slain by the Saracens in Syria, 60,000. In the invasion of Lombardy and Milan, by the Goths, no less than 300,000. In A.D. 734 by the Saracens in Spain, 370,000. In the battle of Yermark, 150,000. In the battle between Charles Martel and the Mahometans, 350,000, at the least computation, are said to have been slain. In the battle of Muret, in A.D. 1213, between the Catholics and Albigenses, 32,000, are said to have fallen. In the battle of Cressy, between the English and French, in 1346, 50,000. In the battle of Halidon Hill, in 1333, 20,000. In the battle of Agincourt, in 1415, 20,000. In the battle of Towton, in 1461, 37,000. In the battle of Lepanto, in 1571, 52,000. In the battle of Fontenoy, 100,000.

The destruction of human life in the wars that accompanied and followed the invasions of the barbarous nations who overthrew the Roman Empire in the West is beyond all specific calculation. It forms an era in history extremely degrading to the human species. In the war which was waged in Africa, in the reign of the Emperor Justinian, Procopius remarks: "It is no exaggeration to say that *five millions* perished by the sword and famine and pestilence." The same author states that during the twenty years' war which this Emperor carried on with the Gothic conquerors of

Italy the loss of the Goths amounted to above *fifteen millions;* nor does this appear altogether incredible when we remember that in one campaign 50,000 laborers died of hunger.

About the beginning of the thirteenth century arose the very cruel and bloodthirty tyrant, Zingis Khan. With immense armies, some of them amounting to a million of men, he overrun and subdued the Kingdom of Hya, in China, Tangut, Kitay, Turkistan, Karazum, Great Bucharia, Persia, and part of India, committing the most dreadful cruelties and devastations. It is computed that during the last twenty-two years of his reign no less than 14,470,000, were butchered by this merciless scourge of mankind. He appeared to the people of the East like an infernal fiend, breathing out destruction wherever he went, and the doctrine which he preached after conquest was utter extermination.

About the same time when this monster was ravaging the Eastern world those mad expeditions distinguished by the name of Crusades were going forward in the West. Six millions of infatuated mortals, raging with hatred and thirsting for blood, assumed the image of the cross and marched in successive expeditions, in tumultuous confusion, to the confines of Palestine, in order to recover the city of Jerusalem from the hands of the Mahometans. In these *holy wars*, as they were impiously called, more than 850,000 Europeans are said to have been sacrificed, before they obtained possession of Nice, Antioch, and Edessa. At the capture of Jerusalem in 1099, about 75,000 are said to have been slain; and at the siege of Acre 300,000. For nearly two hundred years these wild expeditions continued to go forward, and were urged on by proclamations issued from the papal and kingly thrones, and by fanatical sermons from the pulpit, until several millions of deluded wretches perished from the earth; for the greater part of those who engaged in the crusades either died from hardships endured on the march or were slain or taken prisoners. At this period, and for many centuries before, the wide expanse of Europe and Asia exhibited little else than one great field of battle, in which nations were dashing against each other, conquerors ravaging kingdoms, tyrants exercising the most awful cruelties, superstition and revenge immolating their millions of victims, and tumults, insurrections, slaughter, and universal alarm, banishing peace and tranquility from the abodes of men, and subverting the moral order of society. The European states were distracted by the incessant disputes between the popes and the emperors; the interior of every European kingdom was torn in pieces by the contending ambition of the powerful barons; in the Mahometan Empire the caliphs, sultans, and emirs, waged continual war; new sovereignties were daily rising and daily being destroyed, and amidst this universal slaughter and devastation the whole earth seemed in danger of being laid waste, and the human race to suffer an extermination.

In the latter part of the 14th century arose Tamerlane, one of the successors of Zingis Khan. This ruthless conqueror followed in the footsteps of his predecessor, the cruel Zingis. Putting himself at the head of large armies he overran Persia, Turkestan, Kipzak, Russia and Hindostan, ravaging as he went, levelling cities with the dust, cruelly destroying their inhabitants, and committing the most horrible depredations. He also conquered the Turks of Asia Minor and carried the Sultan Bajazet into captivity, as it is said, in ar iron cage. Whole nations were crushed under the iron heel of this conqueror. The historian Gibbon when speaking of him says: "The ground which had been occupied by flourishing cities, was often marked by his abominable trophies, *by columns or pyramids of human heads;* and perhaps his conscience would have been startled if a priest or a philosopher had dared to number the millions of victims, whom he sacrificed to the establishment of peace and order." * Such is the motive that invaders generally avow for their action—that they may establish order in the nations which they invade, but too often it happens that instead of bringing order and tranquility they bring to them ruin and devastation. By the Crimean War, carried on between France, England and Russia, there were killed 784,991. By the Italian war of 1859, 45,000. By the war with Schleswig-Holstein, 3,500. In the American civil war, of the Northern army there were killed 281,000; of the Southern army, 519,000. In the war of 1866 between Prussia, Austria and Italy, 45,000. In distant and various wars in Mexico, Cochin China, Morocco, St. Domingo, Paraguay, etc., 65,000; making a total of one million seven hundred and fifty thousand men swept off by war in the space of fourteen years, between 1853 and 1866. And in carrying on these wars it is estimated there was spent at the least calculation nine thousand five hundred and sixty-five millions of dollars; an amount of money which, if put to the use of benefiting humanity, might have transformed the whole moral and social condition of civilized nations for the better. It is said the entire loss of Germany in the late war it had with France was something like 180,000 men, rather more than one half of whom are invalided; and it is certain the loss on the part of France was not less but perhaps much greater; and this war also was carried on at a corresponding rate of expense.

It may be remembered that the instances we have adduced are only a few circumstances in the annals of warfare. And yet in a few of the instances last stated we are presented with a scene of horror which includes the destruction cf between fifty and sixty millions of the human race, besides the other various kinds of suffering which war entails. Language can scarcely be found strong enough to express the emotions of the mind

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* Gibbon's Rome.

when it seriously contemplates the horrible scene. And is it not melancholy to reflect that in the present age, which boasts of its improvements in science, in civilization and religion, neither reason, nor humanity, nor christianity, nor benevolence, has yet availed to stop the progress of destroying armies, and to set a mark of ignominy upon the nations that delight in war. To counteract this most irrational and deplorable propensity by every means which reason or humanity can suggest should be the duty of every one who is desirous to promote the present and future benefit of his species.

For our review of the moral character of the civilized nations we have chosen Greece and Rome, and the nations immediately connected with them, as the most fit representatives of ancient times; and in continuing this review we shall confine it to those nations which have arisen out of the Roman Empire, as the fittest representatives of civilization in modern times. It would not answer to choose out any one of these nations as the fittest national representative of civilization in modern times, for each of them would be unwilling to be classed as less high in that respect than any of the others. It becomes our duty, therefore, to take a glance at each of them so far as our limits will allow, and see how they appear to stand with respect to moral character.

We have given proof of the warlike dispositions which were displayed in the Greek and Roman empires, and in a few instances of other nations also that waged war with them and on their borders; and now it will be well to slightly examine what dispositions are displayed by these modern nations, while at the same time they may be considered in connection with their religious institutions. As to the dispositions displayed by these modern nations pride and selfishness are prominent characteristics in them all. All these nations are more or less addicted to war, and pride and selfishness are the prime movers to the wars which they wage.

Russia has proceeded in her career of self-aggrandizement for the last two centuries, absorbing one nation after another against their will, until her dominions now extend across the whole continent of Asia from the China Sea to the Baltic; and from Mount Caucasus and the frontiers of Tartary to the frozen ocean. Russia has to a large extent made herself great at the expense of her neighbors; starting from her northern deserts, in the time of Peter the Great, she has extended her dominions, until she is now equal in extent of territory to any other nation on the globe. Her government is strictly despotic. Her religion is Christian of the Greek model, which we shall have occasion to speak of in the latter part of the book. The mass of her peoples, until lately serfs, are generally ignorant and of a servile spirit. Her penal laws are exceedingly severe; the severest punishments are frequently inflicted for the most trivial offences. At the will of the emperor, and often for very slight offences, men are bound in irons and transported to the frozen regions of Siberia, there to drag out a most miserable existence, until death or the term of their banishment puts an end to their sufferings. The knout is one of the most common instruments of punishment used in Russia. This instrument is a thong made of the skin of the elk or the wild ass, and so hard that a single stroke cuts the flesh to the bone. The following description is given by Olearius of the manner in which he saw the knout inflicted on eight men, and one woman, only for the crime of selling brandy and tobacco without a license: "The executioner's man, after stripping them down to the waist, tied their feet, and took one at a time on his back. The executioner stood at three paces distance, and, springing forward with the knout in his hand, whenever he struck the blood gushed out at every blow. The men had each twenty-five or twenty-six lashes; the woman, though only sixteen, fainted away. After their backs were thus dreadfully mangled they were tied together two and two; and those who sold tobacco having a little of it, and those who sold brandy a little bottle put about their necks. They were then whipped through the city of Petersburgh, for about a mile and a half, and then brought back to the place of their punishment and dismissed." This is what is termed the moderate knout, for when it is administered with the utmost severity, the executioner, striking the flank and ribs, cuts the flesh to the bowels, and therefore many die of this merciless and inhuman punishment. The punishment of the pirates and robbers who infest the banks of the Volga is another act of savage cruelty peculiar to Russia. A float is built whereon a gallows is erected, on which is fastened a number of iron hooks, and on these the wretched criminals are hung alive by the ribs. The float is then launched into the stream, and orders are given to all the towns and villages on the borders of the river, that no one upon pain of death shall afford the least relief to any of these wretches. These criminals sometimes hang in this manner three, four, and even five days alive. The pain produces a raging fever, in which they utter the most horrid lamentations, imploring the relief of water and other liquids. During the reign of Peter the Great the robbers who infested the various parts of his dominions, especially the banks of the Volga, were hung up in this manner by hundreds and thousands, and left to perish in the most dreadful manner. The boring of the tongue, and the cutting of it out, are practised yet in Russia as an inferior species of punishment. It is much to be hoped that the time will soon come when governments will see and admit the folly and injustice of such proceedings. Punishment administered beyond the desert of the offence can have no other tendency than to demoralize the minds of the people, to blunt their natural feelings, and to render criminal characters still more desparate; and hence we need not wonder at what travellers affirm respecting the Russians, that they are very indifferent as to life or death, and undergo capital punishment with unparalleled apathy and indolence. It matters little what the name of the religion is that is professed by a government which practices, or allows to be practised in its dominions, such tyranny, brutality and cruel barbarism. In order to show itself civilized and a worthy apostle of its faith to foreign peoples, a government should show itself exemplary at home by dealing righteously, benevolently, and beneficently with its own people.

Prussia and Russia may be said to have attained a conspicuous national existence at the same time. In the year 1701 Frederick, the Margrave or Count of Brandenburgh, deeming himself strong enough to make good his pretensions against the nations which might choose to oppose him, crowned himself king, and publicly announced that his name henceforth was not elector of Brandenburgh, but king of Prussia. At the same time Peter the Great was engaged in the work of building the City of St. Petersburgh, and of making Russia a naval power, after having a few years previously prepared himself for this task, by practising as a shipbuilder in an English dockyard. Both of these nations have since then under successive rulers made great advances to power. We have stated by what means Russia enlarged her dominions to such a great extent; and shall we now inquire by what means Prussia has come by her power and attained to the supremacy among the German States which she now enjoys? Was it by peaceable or by warlike measures? Mainly by war. True, Prussia owes much for her present eminency to the intelligence of her people; and this is, of course, owing to the system of education that is established and carried out in that country. Now the proper object of a system of education is to diffuse a knowledge of the sciences, the useful arts, and of any other branch of knowledge the acquisition of which may tend to the happiness and well-being of the people. But the system of education established in Prussia includes the teaching of the military art as well as the other arts. And it may probably be argued that the art of war is a necessary and useful one. There is no necessity of it if men but keep the principles of pride and selfishness in their own nature in due subordination to the principles of godliness, which they can do by having right reason rule. Nor can the greatness that is derived from war be called true greatness. What, it may be asked, is a nation to look on inactively and see itself invaded, desolated, and absorbed by an enemy without offering any resistance? This sometimes would be the wisest policy for a nation in such circumstances. Some of those nations, for example, which have been absorbed by Prussia herself during her career of conquest and by Russia might have done better had they thus acted. Since they were not able effectually to repel, it would have been wiser for them to have submitted to the invader, without actively resisting him, by which course they would at least have saved the lives of those who fell, and perhaps obtained better terms from the aggressor. But if a strong nation is attacked what course should it pursue? Intelligent non-resistance would in this case even be the best course to follow, and by peaceful measures to obtain the best measures obtainable; it is also by far the most praiseworthy. But each nation, when it feels itself greatly aggrieved by another, no matter how limited its resources for offence and defence are as compared with those of the other, is apt to feel itself equally strong, just as a small weak man feels when he is provoked to combat by a large athletic one. Well, as there is no necessity of either of these men striking the other, nor of the one that may have been struck, striking in return, so there is not the slightest need of a nation, whether it may be powerful or weak, striking either in aggression or defence. Intelligent non-resistance on the part of a nation, as of an individual, makes the aggressor feel ashamed of his conduct, and is the means of saving life and limb and property, and of securing the blessings of happiness and peace to many people who should otherwise suffer. But the question is often and very inconsiderately asked; who, when struck or insulted, can abstain from striking or insulting in his turn. Any one can abstain from it if he will but act considerately. If a man returns an insult he degrades himself to the level of him who insults him; but if one try to kill him, he should endeavor to not be killed. Reason should always be allowed to govern; passion or malevolence not for a moment. We have ourself always acted on the principle of intelligent non-resistance, and mean to do so as long as we live. The principle of good-will to men, men of every character and temper, should be cultivated by all, and no principle contrary to this should be allowed to occupy the breast for a single moment. If men are weak enough to strike or insult, they are so from ignorance or the depravity of their nature; such should be looked upon with compassion, and their good, not their evil and destruction, should by every means be sought; when they come to fully understand what they are, and what they should be and do, they will be strikers and insulters no longer. Example is ever more powerful than precept, in the case of nations as well as individuals. But, as in the case of two men who are about to quarrel, the law holds that one accountable who strikes first, why may there not not be an international law established among the civilized nations, which no one nation will be allowed to transgress? But it may be said that transgression of that law would imply the use of compulsory means to enforce obedience to it, and that this means might necessarily be war. If it were stipulated by the international law that all the nations agreeing to it should remain unarmed, that military principles should not be taught nor warlike implements manufactured or retained by these nations, then war could not be the means resorted to in such a case. But it may be said that when a nation would feel inclined to transgress or to secede from the international confederacy it might insidiously import arms and equipments of war from some other nations outside of the league, and so prepare itself to effectually accomplish its object. To prevent the occurrence of such a breach it would be wise for the confederacy to embrace within itself as many as possible of the nations of the earth, even those they would deem uncivilized; to bring all these if possible to live and abide by the stipulations of the international law; so that there might be no place left from whence to import the means and implements of war. Cannot such a state of things be brought about? It can be effected, first by the civilized nations among themselves; then by their gradually bringing into their confederacy all the other nations. The first step to be taken to this good end is the universal education of the masses of the people high as well as low in every nation, in the principles of self-denial, charity and true humility; and to this end, the principles of military discipline should not be taught in the scools, nor should anything be taught which would tend to foster or cultivate a warlike spirit. There should be no panegyrics delivered by the teachers nor found in the school-books upon the virtues of warriors of past ages or of the present; nor should an Alexander, a Cæsar, a Frederick, a Bonaparte, a Wellington, or even a Washington, so far as he was a warrior, be held up to the admiration or the imitation of the students; only the sciences and the arts which tend to peace should be taught; the principles of pride and selfishness should be not only suppressed but eradicated; and the principles of true virtue, of honest industry, of charity, and intelligent humility, should be universally inculcated and exemplified to the youth. Such a state of things, then, as we have contemplated might be begun to be brought about by the universal education of the masses, commencing with all the youth of the present generation; and, as the people would be continually advancing to a higher state of knowledge and civilization, the nations would become more peaceful, stable, and prosperous, would cultivate more the sciences and arts which tend to peace, and would become more closely united to each other in the bonds of charity and mutual good-will. We have before explained how that man creates the moral world, and that the great object of a moral system is to enable men to live in association with each other according to order and right. Now this being so that moral system is certainly imperfect, and unworthy of the name of world, which does not provide that men *shall not kill each other* by means of war. It implies not order, but disorder, and all its train of evil consequences. To the end that a better system may be established, and that as universally as possible, much may now be begun to be done by rulers and men of power and influence in all nations, yea and by every teacher, every parent, and every individual both subjectively and objectively. This education, which as we have said is the first step towards the bringing in of a state of things for the better, permanently, must be as universally diffused as possible, and individually subjective as well as objective; for each one must educate him or herself in the principles and practices of self-denial, humility and all the kindred principles which pertain to godliness, as well as teach others, as far as one, can the same principles and practices. Then would love be the motive power to action, instead of, as before, pride and selfishness.

But to return to our main subject, Prussia has to a great extent aggrandized herself, as Russia did, at the expense of her neighbors. It has subdued one nation after another by force of arms; it has domineered over Austria; it has humiliated France, and by its course of war and bloodshed it has attained the supremacy in the German States; and in other respects also the moral character of the Prussians is not what it ought to be. It has long enforced a very severe penal code. The following account, is given by a traveller who was in Berlin in 1819, of the execution of a man for murder, which shows that the execution of criminals in Prussia is frequently attended by a species of cruelty worthy of the worst days of the Inquisition: "Amidst the parade of executioners, officers of police, and other judicial authorities, the beating of drums, and the waving of flags and colors, the criminal mounted the scaffold. No ministers of religion appeared to gild the horrors of eternity, and to soothe the agonies of the criminal; and no supplicatory prayer closed his quivering lips." "Never," says the narrator, "shall I forget the one bitter look of imploring agony that he threw around him, as, immediately in stepping on the scaffold, his coat was rudely torn from his shoulders. He was then thrown down, the cords fixed around his neck, which were drawn until strangulation almost commenced. Another executioner then approached, bearing in his hands a huge wheel, bound with iron, with which he violently struck the legs, arms, and chest, and lastly the head of the criminal. I was unfortunately near enough to witness his mangled and bleeding body still convulsed. It was then carried down for interment, and in less than a quarter of an hour from the beginning of his torture, the corpse was completely covered with earth. Several large stones which were thrown upon him hastened his last gasp; *he was mangled into eternity*." Punishments, as we have before said, should not be more than proportioned to the crimes for which they are inflicted, and in every case should be designed for the benefit of the criminal, or of society, or of both. If the life of the criminal is to be taken, the object of the punishment cannot be his benefit; and no benefit can accrue to society from his being treated with a greater degree of severity than his crime deserves. If the life of the criminal is not to be taken the object of the punishment should be his moral improvement, and the punishment should not be greater than he deserves. An unduly severe criminal code in any country is proof that that nation has yet to advance some degrees before it can be called civilized.

France is a nation which until very lately played an important part in the history of Europe. From being one of the provinces of the Roman

Empire she was raised to the position of an independent state by Clovis in the 5th century, A. D. In the latter part of the 8th century she was raised to a greater height of power by the conquests of Charlemagne; she afterwards lost a great part of the dominions which she acquired through him, and gained them again after a long interval through the conquests of Napoleon Bonaparte, but only to retain them for a very short time. France, before called Gaul, has as long as we have known her historically, been a nation addicted to war. She has, however, not been remarkably successful in war, never having attained to a very great degree of power, except under the two conquerors just named. Charlemagne is said to have carried on fifty-three campaigns. He was a remarkably ferocious and cruel man. On one occasion, it is said that he beheaded 4,500 Saxon prisoners on the same spot, which may serve as a specimen of the butcheries of this ferocious warrior This was the man who was crowned by Pope Leo in the church of St. Peter at Rome, in the last year of the 8th century; and who is also inscribed as a Saint of the Roman Church. In him the Roman Empire of the west was considered to have been revived after it had been overthrown and trampled upon for some centuries by the Goths, and Vandals, and other northern nations; and from that time till the withdrawal of the French troops from Rome, in the time of Napoleon III. France has almost always been a zealous supporter of the Papacy. We need not here detail the wars of the Bonapartes, their rise, progress, and terminations; they are very generally known, and equal in cruelty and the destruction of human life the battles of ancient times. We shall relate only a few instances of French barbarity in these wars. After the taking of Alexandria by Bonaparte, says the relater, "we were under the necessity of putting the whole of them to death at the breach. But the slaughter did not cease with the resistance. The Turks and inhabitants fled to their mosques, seeking protection from God and their prophet; and then men and women, old and young, and infants at the breast, were slaughtered. This butchery continued for four hours, after which the remaining part of the inhabitants were much astonished at not having their throats cut." From what follows we can see that all this bloodshed was premeditated. "We might have spared the men whom we lost," says General Boyer, "by only summoning the town; but it was necessary to begin by confounding our enemy." After the battle of the Pyramids, it is remarked by an eye witness, "the whole way through the desert was tracked by bones and bodies of men and animals, who had perished in these dreadful wastes. In order to warm themselves at night they gathered together the dry bones and bodies of the dead, which the vultures had spared, and it was by a fire composed of this fuel that Bonaparte lay down to sleep in the desert."* Miot gives the following description of a scene

* Miot's Memoirs.

at Jaffa: "The soldier abandons himself to all the fury which an assault authorizes. He strikes, he slays, nothing can impede him. All the horrors which accompany the capture of a town by storm are repeated in every street, in every house. You hear the cries of violated females calling in vain for help to those relations whom they are butchering. No asylum is respected. The blood streams on every side; at every step you meet with human beings groaning and expiring, etc." Sir Robert Wilson, when describing the campaign in Poland, relates, that "the ground between the woods and the Russian batteries, about a quarter of a mile, was a sheet of naked human bodies, which friends and foes had during the night mutually stripped, not leaving the worst rag upon them, although numbers of these bodies still retained consciousness of their situation. It was a sight which the eye loathed, but from which it could not remove." In Labaume's "Narrative of the Campaign in Russia," we are presented with the most horrible details: palaces, churches, and streets enveloped in flames; houses tumbling into ruins, hundreds of the blackened carcasses of the wretched inhabitants, whom the fire had consumed, blended with the fragments; hospitals containing 20,000 wounded Russians on fire, and consuming the miserable victims; numbers of half-burned wretches crawling among the smoking ruins; females violated, and massacred; parents and children half-naked, shivering with cold, flying in consternation with the remains of their half-consumed furniture; horses falling in thousands, and writhing in the agonies of death; roads covered for miles with thousands of the dying and the dead, heaped one upon another, and swimming in blood, and these dreadful scenes rendered still more horrific by the shrieks of young females, of mothers, and children, and the piercing cries of the wounded and the dying, invoking death to put an end to their agonies." It is probable that some of our readers have been so affected by the description already given, that they have turned away their eyes in disgust from such an appalling spectacle of suffering and horror, but these are only a few instances out of thousands which the authentic histories of the French wars present before us. What untold sufferings have been caused by the wars which France has carried on in our own day! Wars with Russia, with Austria, with Prussia, and last the fratricidal war which was waged at Paris between its own citizens at the termination of the late war with Germany. Yet France has long been considered a leading civilized nation of Europe. The French nation have been characterized as a vain, immoral, and licentious people, in their social state, especially the inhabitants of their chief cities; and these their sins may have sometimes brought destruction upon that people; but we are aware that the suffering and destruction of the many are often caused by the pride and selfishness of a few, very often by the will of an individual, as we believe that last war with Germany may have been which humbled France to the dust, and caused such immense loss and suffering to her people.

The penal code in France has also been extremely severe. The execution of Damiens in 1757, for attempting to assassinate Louis XV., was accompanied with tortures, the description of which is enough to harrow the feelings of the most callous nature, tortures which could scarcely be exceeded in intensity, even though they were invented by an infernal fiend; and yet they were beheld with a certain degree of apathy by a surrounding populace, and even counsellors and physicians could talk together deliberately about the best mode of tearing asunder the limbs of the wretched victim, with as much composure as if they had been dissecting a dead subject or carving a fowl.

France has also distinguished itself for its massacres on account of religion. Of these, that of the French Protestants, on the Feast of St. Bartholomew, August 24th, 1572, was, perhaps, one of the most diabolical acts of perfidy and cruelty which have stained the character of that nation. Everything connected with this unexampled conspiracy and assassination was atrocious and horrible. Ties of the most sacred nature were violated; superstitious zeal was changed into an impious frenzy; and filial piety degenerated into sanguinary fury. Under the direction of the infamous Duke of Guise, the soldiers and the populace, *en masse*, at the signal of the tolling of a bell, flew to arms, seizing every weapon that came in their way; and thus rushing in crowds to every quarter of the city of Paris, no sound was heard but the terrible cry, "Kill the Huguenots!" Everyone distinguished for being attached to the reformed faith, without any distinction of rank, age or sex, was indiscriminately massacred. The air resounded with the horrid cries and blasphemous imprecations of the murderers, the piercing shrieks of the wounded and the groans of the dying. Headless trunks were every moment thrown into the court-yards or the streets, the gateways were choked up with the bodies of the dead and dying, and the streets presented a spectacle of mangled limbs and human beings dragged by their butchers in order to be thrown into the Seine. Hotels and public buildings were reeking with blood; death and desolation reigned on every side, and in all quarters carts were seen loaded with dead bodies, destined to be cast into the river, whose waters were for several days polluted with tides of human gore. The infuriated assassin, urged on by the cry that "it was the King's will that the very last of this race of vipers should be crushed and killed," became still more furious in the slaughter; in proof of which one Cruce, a jeweller, displaying his naked and bloody arm, vaunted aloud that he had cut the throats of more than four hundred Huguenots in one day. The number of victims thus slaughtered in the city of Paris amounted to above 6,000; and, in the provinces, at the same time, perished about 60,000 souls. The news of this massacre was welcomed at Rome with the most lively transports of joy. The Cardinal of Lorraine gave a large reward to the courier, and interrogated him in such a manner upon the subject as plainly to indicate that he had been previously aware of the intended catastrophe. Cannons were fired, bonfires were kindled, and a solemn mass celebrated, at which Pope Gregory XIII. assisted, with all the splendor which the Papal Court was accustomed to display on the happening of events the most significant and of the most important consequences.*

In the civil wars on account of religion in France, in the early part of the seventeenth century, it is computed that about a million of men lost their lives; and nine cities, 400 villages, 2000 churches, and 10,000 houses were burned and destroyed during their continuance, besides the many thousands of men, women and children, which were cruelly butchered; and 150,000,000 livres were spent in carrying forward these slaughters and devastations. It is said of Louis XIII., who prosecuted these wars, by one of his biographers and panegyrists, Madame de Motteville, that "what gave him the greatest pleasure was his thought of driving heretics out of the kingdom, and thereby purging the different religions which corrupt and infect the Church of God."

But France has distinguished herself for a fanatical persecuting spirit as well in an atheistical as in a religious or superstitious point of view. The first revolution in France, in 1789, was a revolution not merely in politics and government, but in religion, in manners, and in the common feelings of human nature. It is stated on good authority that a little before this revolution a numerous assembly of *French Literati* being asked in turn at one of their meetings by their president, "whether there was any such thing as moral obligation, answered in every instance that there was not." Soon after that revolution the great body of the French infidels who then ruled the nation not only denied all the obligations which bind us to truth, justice, and kindness, but pitied and despised, as a contemptible wretch, that man who believed in their existence. Atheism was publicly preached and its doctrines disseminated among the mass of the people. A professor was even named by Chaumette to instruct the children of the state in the mystery of Atheism. De La Metherie, the author of a philosophical journal, when discussing the doctrine of crystallization, made the wild and monstrous assertion, "that the highest and most perfect form of crystallization is that which is vulgarly called God. In the National Convention, Gobert, Archbishop of Paris, the Rector Vangirard, and several other priests, abjured the Romish religion, and for their abjuration they received applauses, and the fraternal kiss. The convention decreed that

* Memoirs of Henry the Great.

all the churches and temples of religious worship, known to be in Paris, should be instantly shut up, and that every person requiring the opening of a church or temple should be put under arrest as a suspected person and an enemy of the State. The consequences of the universal operation of such principles, and such a high-handed course of procedure on the part of those in authority, were such as might have been expected. They are written in characters of blood. A scene of inhumanity, cruelty, malignity and insatiable rapacity was presented to the world, which excited in the mind of every virtuous spectator amazement and horror. Savage atrocities were committed, which would have been shocking in the most barbarous and unenlightened age; and perhaps at no time and in no country was there more licentious practices and moral degeneracy displayed. The ties of friendship were severed, the claims of consanguinity disregarded, and a cold-blooded selfishness pervaded the great mass of society. "The kingdom appeared to be changed into one great prison; the inhabitants converted into felons, and the common doom of man commuted for the violence of the sword and the bayonet, and the stroke of the guillotine," Such was the rapacity with which destruction was carried on that, in the short space of ten years, not less than three millions of human beings are supposed to have perished in that country, chiefly through the outworking of the malevolent principles of the human heart, and the seductions of a false philosophy. The following is a brief sketch of some of the scenes to which we allude, drawn by one who was an eye-witness and an actor in several parts of that horrible drama: "There were," says this writer, "multiplied cases of suicide, prisons crowded with innocent persons, permanent guillotines, perjuries of all classes, parental authority set at nought, debauchery encouraged by an allowance for those called unmarried mothers, and six thousand divorces in the city of Paris within a little more than two years; in a word whatever is most obscene in vice and most dreadful in ferocity." * Notwithstanding the incessant shouts of "liberty and equality," and the boasted illumination of philosophy. the most cruel persecutions were carried on against all those whose religious opinions differed from the system adopted by the State. While infidelity was in power it wielded the sword of vengeance with brute ferocity against the priests of the Romish Church, who were butchered wherever found, hunted as wild beasts, frequently burned alive, or drowned in hundreds together, without accusation or trial. At Nantz, 360 priests are said to have been shot, and 460 drowned. In one night [illegible]8 were shut up in a barge, and drowned in the Loire, 292 priests were massacred during the bloody scenes of the 10th August, and the 2nd September, 1792; and 1135 were guillotined under the government of the National Convention, from the month

* Gregoire.

of September, 1792, until the end of 1795; besides vast numbers who, hunted by the infidel republicans like owls and partridges, perished in different ways throughout the provinces of France. The bloody scenes which have been enacted in Paris in our own day, when Darboy, the archbishop, and several priests, besides thousands of other people, were killed by the Communists and Nationalists in their mutual struggle, correspond to the scenes we have just depicted. And the fact of these infidels or atheists, when they came into power, carrying on such violent persecutions plainly shows that the persecuting spirit is not confined to one sect, be they called papist or atheist, but is simply the working out of the evil principle in man. Men, however, are always inclined to leave the blame of their diabolical actions upon other things than themselves, often upon mere names or ideas. We gather also from the foregoing history of the reign of atheism in France, that, when a nation becomes too enlightened for its established religion or superstition, it is sometimes apt to discard it altogether, and to adopt a system of principles the opposite to those of the old. The same thing takes place in the case of individuals. There is danger in such a course, and there hardly ever is any necessity of adopting extreme opinions upon one side or the other. Changes in the moral world as in the natural take place gradually. A plant does not come to maturity in a moment nor a child to manhood in a day. Time is required for the intelligent adoption of a creed both by an individual and a nation; and the truth is best arrived at and maintained by preserving the mean between opposite extreme opinions. A national religion should not be discarded by the state until a better substitute can be made for it; and the new system if established should receive the moral support and protection of the government of the state; if not established as in republics, where all religions are equally tolerated, but yet has become so generally prevalent as virtually to supplant the old, it should receive at least the moral support and protection of the government. Violent changes in any department of the moral world are productive of disorder; and since, as we have said before, the fundamental idea of morality is order, when a change in any department of the moral system is required, not only the change itself but the best manner in which it can be brought about is to be considered by those who are to effect it. The object of government is not only to preserve order among the people but also to subserve and advance their interests and highest good; and the necessity of the worship of the Deity being generally recognized as conducive to the happiness and order of the people, governments may well give their moral support and protection to that system of religion which combines simplicity with truth, and which can be practised most intelligently by the masses of the people.

As corroborative of the idea advanced with respect to the licentious character of the French, especially the Parisians, we extract the following from Sir Walter Scott's visit to Paris in 1815.

"The Palais Royale, in whose saloons and porticoes vice has established a public and open school for gambling and licentiousness, should be levelled to the ground with all its accursed brothels, and gambling houses, rendezvous the more seductive to youth as being free from some of those dangers which would alarm timidity, in places of avowedly scandalous resort. In the Salon des Etrangers, the most celebrated haunt of this Dom-Daniel, which I had the curiosity to visit, the scene was decent and silent to a degree of solemnity. An immense hall was filled with gamesters and spectators. Those who kept the bank and managed the affairs of the establishment were distinguished by the green shades they wore to preserve their eyes, by their silent and grave demeanour, and by the paleness of their countenances exhausted by their constant vigils. There was no distinction of persons, nor any passport required for entrance save that of a decent exterior; and on the long tables which were covered with gold, an artizan was at liberty to hazard his week's wages, or a noble his whole estate. Youth and age were equally welcome, and any one who chose to play within the limits of a trifling sum, had only to accuse his own weakness, if he was drawn into deeper or more dangerous hazard. Everything appeared to be conducted with the most perfect fairness. The only advantage possessed by the bank, which is, however, enormous, is the extent of the funds by which it is enabled to sustain any reverse of fortune; whereas most of the individuals who play against the bank are in circumstances to be ruined by the first succession of ill luck: so that ultimately the small ventures merge in the stock of the principal adventurers, as rivers run into the sea. The profits of the establishment must indeed be very large to support its expenses. Besides a variety of attendants who distribute refreshments to the players gratis, there is an elegant entertainment with expensive wines, regularly prepared about three o'clock in the morning for those who choose to partake of it. With such temptations around him, and where the hazarding an insignificant sum seems at first venial or innocent, it is no wonder that thousands feel themselves gradually involved in the vortex whose verge is so little distinguishable, until they are swallowed up with their time, talents, fortune, and frequently also both body and soul. This is vice with her fairest vizard; but the same unhallowed precinct contains many a secret cell for the most hideous and unheard of debaucheries; many an open rendezvous of infamy, and many a den of usury and treason; the whole mixed with a vanity fair of shops for jewels, trinkets, and baubles, that bashfulness may not need a decent pretext for adventuring into the haunts of infamy. It was there that the preachers of revolution found, amidst gamblers, desperadoes and prostitutes, ready auditors of their doctrines, and active hands to labor in their vineyard. It was here that the plots of the Bonepartists were adjusted; and from hence the seduced soldiers, inflamed with many a bumper to the health of the exile of Elba, under the mystic names of Jean de l'Epée, and Corporal Violet, were dismissed to spread the news of his approaching return. In short from this central pit of Acheron, in which are openly assembled and mingled those characters, and occupations, which in all other capitals are driven to hide themselves in separate and retired recesses; from this focus of vice and treason have flowed forth those waters of bitterness of which France has drank so deeply." Now if such a state of things as is here set forth existed at head quarters, right in the departments of the Royal Palace, what must we think existed in other and less public places in Paris, and in France? The great mass of a people are generally imitative, inclined to follow the example set them in high places.

We submit a statement of the affairs of the French capital for the year ending September 1803, given by the prefect of police to the Grand Judge. During this year 490 men and 167 women committed suicide; 81 men and 69 women were murdered, of whom 55 men and 52 women were foreigners; 664 divorces; 155 murderers executed; 1210 persons condemned to the galleys, etc.; 1626 persons to hard labor; and 64 marked with hot irons; 12,076 public women were registered; large sums were levied from those wretched creatures, who were made to pay from 25 to 50 dollars each monthly, according to their rank, beauty or fashion; 1552 kept mistresses were noted down by the police; and 380 brothels licensed by the prefect. From the number of divorces it appears that marriage was looked upon as a mere temporary connection from which the parties might extricate themselves when they pleased, and illegitimate children, especially in Paris, are numerous beyond what they are in any other city. It seems hardly conceivable that a government should debase itself to authorize the practice of such licentiousness as is here represented, and to derive a large revenue from such infamous and polluted sources. No government which authorises or countenances such practices may expect to thrive or be perpetuated. Such practices enervate a people, yea destroy them body and soul. They are sure to bring down upon the nation in which they exist, sooner or later, the retributive justice of the Governor of mankind. May it not truly be said that the humiliations to which France was subjected at the termination of the first empire and in the late war with Germany, when her whole armies were taken into captivity, which was succeeded by the mutual slaughter of her own people at Paris, were so many visitations on this people for their wickedness? They doubtless were. And not only that, but we fail to see that the sympathetic refinement, which is derived from a too free intercourse of the sexes with each other, while unmarried, is worthy of the name of civilisation. It is altogether too contemptible and base for the name. Men and women should deny themselves if they cannot afford to live in honorable marriage. And men and women, be they young or old, should prefer to live on the humblest fare, and clothed with the coarsest garments, even though their means were sufficient to afford them a daintier kind, rather than practice luxurious living, or any species of licentiousness, or squander the time and talents which they possess in a too free intercourse with each other. Thus from the review we have been able to give of the moral character of the French, as indicated by their history, it is evident that though they are esteemed a civilized nation they are yet far behind true civilization, and that, if they ever attain a high national character for morality, they will have to alter radically and completely their present moral principles and practices.

In taking a review of the moral character of the Spaniards, as indicated by their history, we find it a good deal as we have found it in the case of the French. From the earliest historical records we have of Spain we find that country to have been the scene of savage warfare, on which the most ferocious passions were displayed. There the Romans, the Goths, the Vandals, the Moors and the Arabs, fought and reigned at different periods. During certain periods of her history, Spain possessed great power as a nation, and, as France, she attained her power by war, and lost it in the same way. In the employment of war, and otherwise, the Spaniards have displayed the most savage ferocity, and the most brutal as well as the most refined and exquisite cruelty. Spain has always been a champion of the Romish religion, and in this country that diabolical tribunal of the Inquisition was firmly established and manipulated. Considering indeed the inhuman and refined cruelties which have been practised by Spain on account of religion or superstition, that country may, with propriety, be called the peculiar seat of Satan. In the Netherlands alone, from the time that the edict of Charles V. was promulgated against the reformers, more than 100,000 persons were hanged, beheaded, buried alive, or burned, on account of professing the reformed religion. The prisons were crowded with supposed heretics, and the gibbet, the scaffold and the stake filled every heart with terror. The duke of Alva, Spanish general to the Netherlands, and his bloodthirsty tribunal, spread universal consternation throughout the provinces; and, though the blood of 18,000 persons who in five years had been given up to execution for heresy, cried for vengeance on this persecutor, and his abettors, yet they gloried in their cruelty. Philip II., in whose reign these atrocities were committed, hearing one day that thirty persons had a little before been burned at an Auto da Fé (Act of Faith), required that a like execution should be performed in his presence; and he beheld with joy forty victims devoted to torments and to death. One of them, a man of distinction, requesting a pardon: "No," replied he coolly, "were it my own son I would give him up to the flames, if he obstinately persisted in heresy."

The atrocities which the Spaniards committed on their conquests of some of the West Indian Islands, Mexico, and Peru, are almost beyond credibility that they should be performed by man, if we did not otherwise know the character of that people. The island of Hispania was their first settlement in the new world. They forced the inhabitants to labor as slaves for them, digging gold, and, when the object of their cupidity was exhausted, they exterminated them, and the other natives most barbarously. Of two millions of inhabitants which the island contained when discovered by Columbus in 1492, scarcely 150 were alive in 1545, only about fifty years afterwards. The conquest of Mexico by Cortes and his followers was marked with equal horrors. During their whole progress through that country the route of the Spaniards was marked with carnage, injustice, perfidy and deeds of atrocious cruelty. On one occasion sixty caciques or chiefs of the Mexican Empire, and 400 nobles were burned alive with the utmost coolness, and deliberation; and, to complete the horrors of the scene, the children and relations of the wretched victims were assembled and compelled to be spectators of their dying agonies. On another occasion when the inhabitants of the city of Mexico were celebrating a festival, and all the people, especially the nobles, were dressed in their richest decorations, under a pretence of a pretended conspiracy, the Spaniards, in order to seize upon their valuable ornaments fell upon them unsuspecting, and slaughtered 2,000 of the nobles. Every right was violated by the Spaniards, which is generally held sacred by hostile nations. On every trivial occasion the natives were massacred in great numbers, their lands apportioned among the Spaniards, the inhabitants reduced to the condition of slaves, and forced to labor, without payment, on all their public works, while the officers, distributed into different provinces, imitated all the excesses and barbarities of their avaricious commander.

In the siege of Mexico alone no less than 100,000 natives are said to have fallen by the sword, beside those who perished by famine and other causes connected with warefare; but, in their retreat from the capital, the Spaniards suffered a just retribution for their enormities, for numbers of them were butchered by the enraged Mexicans, and those who were taken alive were carried off in triumph to the temples, and sacrificed, with all the cruelty which revenge could invent, to the god of war, while their companions at a distance heard their dismal screams and piteous lamentations.

Equal atrocities were committed in the expedition of Pizarro to Peru. In order that they might obtain the golden treasures of this country, they resorted to the basest treachery, and exercised the most cold-blooded cruelties. Under the fairest professions of amity they seized upon the Inca or Emperor of Peru, who had received them in a friendly manner and had commanded his attendants to offer the strangers no injury, and

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slaughtered, with deliberate and unrelenting fury, above 4000 of his attendants, who never offered the least resistance, after which they passed the night in the most extravagant exultation over the plunder they had acquired from the bodies of the slain. The Inca, in order to regain his liberty, promised them as many vessels of gold as would fill an apartment 22 feet long, 16 feet wide and 8 feet high, and, after having collected the promised treasure from all parts of his kingdom, and fulfilled his agreement, they not long after, under the most frivolous pretext, condemned him to be burned alive. The booty they acquired by such atrocious means amounted to about ten millions of dollars in gold. The day appointed for the division of this prey was the festival of St. James, the patron saint of Spain; and, although assembled to divide the spoils of an unoffending people, obtained by treachery, cruelty and slaughter, they had the hypocrisy and audacity to commence the transaction with a solemn invocation of the name of God, as if they expected heaven's blessing to descend upon the wages of their iniquity. It would be difficult to conceive that any beings exist in any region of the universe of a worse moral character than these Spaniards proved themselves to be ; and it shows what an ineffably bad being man is capable of becoming when he chooses to work out the evil principles of his nature, and to give reins to his depraved passions and propensities. Here, indeed, we find the one characteristic extreme, that of badness ; let us see before we finish our review of the nations called civilized whether we shall be able to find the other extreme that of goodness; for in the beginning of this review we stated that the two extremes exist in principle in man, either of which he may develope if he chooses, to an almost unlimited degree.

The cruel practice of bull-fighting has, until lately, been in vogue in Spain, almost every large town in that country having an arena set apart for the purpose. We shall give a concise description of a bull-fight in Madrid, from a traveller who was present at it in 1803: "The Spanish bull-fights," he says, "are certainly the most extraordinary exhibitions in Europe; we were present at one of them this morning. The places in the amphitheatre were nearly all filled at half-past nine, and at ten the corregidor came into his box, upon which the trumpet sounded, and the people rose and shouted from the delight that the show was to begin immediately. Four men in black gowns then came forward, and read a proclamation enjoining all persons to remain in their seats. On their going out of the arena, the six bulls that were to be fought this morning were driven across, led on by a cow with a bell round her neck. The two picadores (the men who were appointed to fight with the furious animals) now appeared, dressed in leathern gaiters, thick leathern breeches, silk jackets covered with spangles, and caps surmounted with broad-brimmed white hats; each rode a miserable hack, and carried in his hand a long pole, with a goad at the end. As soon as they were prepared a door was opened, and the first bull rushed in. In the course of the contest I felt first alarmed for the men and then for the horses. Soon the accidents of the men withdrew my pity from the beasts; and, latterly, by a natural and dreadful operation of the mind, I began to look without horror on the calamities of both. The manner of the fight is this: The bull rushes in and makes an attack, severally, upon the picadores, who repulse him, he being always, upon these occasions, wounded in the neck; and, after a few rencontres, he becomes somewhat shy; but, at the same time, when he does rush on, he is doubly dangerous. He follows up the attack and frequently succeeds in overthrowing both horse and rider. As long as the horse has strength to bear the picadore he is obliged to ride him. This morning one of these wretched animals was forced to charge with his guts hanging in festoons between his legs. His belly was again ripped open by the bull, and he fell for dead; but the attendants obliged him to rise and crawl out! This seems the cruelest part of the business—for the men almost always escape, but the blood and sufferings of thirteen horses were exhibited in the short space of two hours; four men were hurt: one, who was entirely overturned with his horse upon him, was carried out like a corpse; but the spectators, totally disregarding this melancholy sight, shouted for his companion to renew the attack. The bull, during his first rage and subsequent fury during many rounds, begins to feel weakness, and declines further attacks on the horsemen. Upon this a loud shout re-echoes through the theatre, and some of the attendants advancing stick his gored neck full of arrows, which cause him to writhe about in great torment. When the efforts he makes under these sufferings have considerably spent his strength, the corregidor makes a motion with his hand, and the trumpet sounds as a signal to the matador to despatch him. This is a service which requires great skill and bravery; for the madness of the bull and the torture he endures prompt him to destroy every one around. The matador advances with a red cloak in one hand and a sword in the other. He enrages the bull with the cloak until, at length, getting opposite to him, he rushes forward and the sword pierces his spinal marrow, or, what is more common, is buried to the hilt in his neck; upon which he turns aside, at first moaning, but a torrent of blood gushes from his mouth, and he staggers round the arena and falls. The trumpets sound; the mules, ornamented with ribbons and flags, appear to drag the wretched victims out by the horns, and the horsemen to prepare for the attack of a fresh animal. In the evening a show began at half-past four, and ten bulls were brought forward. To tame them before the matador approached, a new expedient was resorted to, most infamously cruel, namely, the covering of the darts with sulphur and fireworks. The torments of these were so dreadful that the animals, whose strength was fresh, raged about terribly, so that the assistants were forced to use great agility to get from them. There were many hair-breadth escapes. One of the animals, in pursuit of a man, leaped the barrier of the arena, which is about eight feet high. A second bull was still more furious, and made more tremendous attacks. In one of them he pinned the man and horse against the barrier, got his horns under the horse and lacerated him dreadfully; in a moment afterward he lifted him up and threw the man with such force through one of the apertures as to kill him on the spot. He was borne past the box in which we were, with his teeth set and his side covered with blood; the horse staggered out, spouting a stream of gore from his chest. The remaining picadores renewed the charge, and another came in with shouts to take the dead man's place. One of these had his horse's skin dreadfully ripped off his side, and when he breathed the entrails swelled out of the hole; to prevent which the rider got off and stuffed in his pocket handkerchief.*

Another traveller adds: "I have seen eight or ten horses torn, and their bellies ripped open, fall and expire in the field of battle. Sometimes these horses, affecting models of patience, of courage, of docility, present a spectacle at which it may be allowable to shudder. You see them tread under their feet their own bloody entrails, hanging out of their open sides, and still obey for some time the hand that guides them.†

Such are some of the amusements which were long practised in Spain, and which fascinated all classes from the prince to the peasant. It is said they were prohibited in 1805, to the deep regret of the most numerous part of the nation, and that another entertainment, an image of the bull-fight, was substituted in their place, and is still in some places retained. The bull-fights may be said to have represented the gladiatorial shows which were held at Rome, and in the principle cities of the Roman empire for many centuries; in which gladiators (swordsmen) trained for the purpose—for the most part slaves or prisoners of war—fought with wild beasts for the entertainment of the people, who, in great numbers, surrounded the amphitheatre. These gladiatorial exhibitions were abolished by the Emperor Honorius, in A.D. 404.

The cruel practice of the bull-fight does not argue a high state of civilization for the nations that delight in it. Under an impression of his great superiority in the scale of being, over the brute creation, man has always been accustomed to treat the lower orders of animals with excessive cruelty. This, however, does not seem so much to be wondered at since he is so cruel to his own kind; it is all the working out of the evil principle within him. We may assume with certainty that the sufferings of these bulls and horses, wounded and dying, were quite as intense and exquisite, as were those of the wounded and dying men. And these animals were equally worthy of pity, if not more so, since they were not the cause

* Travels through Spain and Portugal in 1803.

† Bourgoing's Modern State of Spain.

of their sufferings, which were altogether unnecessary, and could as well have been avoided, and since they could not speak to make their sufferings known. Men should remember that the lower orders of animals have *feelings* as they have themselves, and are susceptible in most cases, if not all, of as exquisite pain and suffering. We are often very much affected at seeing animals, especially horses, treated with such inconsideration and cruelty. They are made to draw too heavy loads, to travel too fast, and to work too long hours, upon, perhaps, a scanty allowance of food by men who seem as thoughtless as they are themselves, and infinitely more cruel. We have been a short time ago in a large city where the practice is to a great extent to yoke but one horse to a hack, which in all other cities with which we are acquainted is accustomed to be drawn by two horses, and still this horse is made to travel equally fast up and down hill, and to draw equally heavy loads, (as many as they can get into the carriage,) as if there were two horses attached. When men come to know what they really are, and that all other animals have feelings as well as themselves, and are as susceptible of pain and suffering; that they are always under the Creator's eye, who is every where present to see and know what they do; and that they are accountable for the manner in which they treat these animals which He has entrusted to their care, which are also His creatures, they will then recognize the propriety, as well as necessity, of treating their animals more considerately and better than they have generally hiterto been accustomed to treat them.

The empire of Austria has long been a leading state in Europe. Until the ascendancy of Prussia in our day she had the pre-minence among the German states. Like Russia and Prussia, in later times, she made herself great at the expense of her neighbors, absorbing one neighboring state after another until she attained her present dimensions. She comprises in her dominions various nations and languages, and her people generally are less enlightened than are the other German nations. The prevailing religion in Austria is that of Rome, and this nation like France has always been a stout supporter of the Papacy. As that state rose out of part of the Roman Empire, and has always been under the influence of Rome, most that will be necessary to say here with regard to its moral character is that it partook of the character of the Roman Empire in its two aspects of civil and religious, and the character of the Roman Empire we shall have to speak of more fully in the latter part of this book. Savage warfare has always there been practised; the principles of the Inquisition have there been carried out; and the Romish Church, as in other European states, has for many centuries there held sway both over the souls and bodies of men. So that in our review of the moral character of Rome, which will have especial reference to the doings of the Roman Church, we may have glimpses of that of Austria, as

Austria since her rise has always been a principal member of that Church.

The modern Kingdom of Italy has very lately been formed. From a comparatively limited extent of territory, comprised in the state of Sardinia, Victor Emmanuel, with the assistance of some able and talented statesmen, has extended his dominions over all Italy. He has even added the Papal States to his dominions, and made the city Rome his national capital, He is a man who, (whatever his secret motives may have been, they are best known to himself) for doing so well for his people and for humanity at large, in the circumstances in which he was placed, is entitled to the consideration and respect of all civilized nations, and of all good people. Much fault has been found with him by Roman Catholics for having appropriated the Papal States; but in appropriating the Papal dominions he only took away from the Pope what did not belong to the Pope, and what, according to the voice of the people, the Pope was misgoverning, and restored to the Kingdom of Italy its ancient capital. The popes have been accustomed to claim the Papal States and the city Rome as their dominions by right of donation by Constantine, which donation they claimed to have been confirmed nearly five hundred years after by Charlemagne. But history goes to prove the said donation of Constantine to have been a fiction, most probably of the eight century, and its confirmation by Charlemagne to have been no better; for although both Pepin, the father of Charlemagne, and Charlemagne himself had pretended to make gifts and promises to the Popes of these dominions, yet Charlemagne at his death reckoned the city of Rome and the territories nonimally governed by the Pope as part of his dominions; of this we may have occasion to speak again in the latter part of the work. The Pope, therefore, had no right to the dominion of Rome except the right of possession; and the vote taken in the Papal dominions to ascertain the will of the people on the subject plainly proved that they wished the government transferred to the King of Italy. It was then a matter of duty as well as of right for him to assume the government of the Papal dominions. It is much to be hoped that he will proceed even farther in his laudable course, and, as he has been the liberator of Italy civilly, become also its liberator religiously from the shackles of Papish or Romish idolatry. The Italians only need to become more generally and liberally educated in order to fit them for this more perfect freedom. But to this universal education they need to be encouraged and assisted, and, as in Prussia, required to attend by the government. In time past in that country education was not only not permitted or encouraged, but positively interdicted. A royal Sardinian edict, published in 1825, " directs that henceforth no person shall learn to read or write, who cannot prove the possession of property above the value of 1500 livres, (about 300 dollars.) The qualification for a student is the possession of an income to the same amount." The people of Italy, as well as those of the other European states, have too long been prevented from education, and kept enslaved, body and mind, by the diversified machinery of the civil and religious power of the Catholic church. But Italy, as the other European states, is a warlike power, and maintains a large standing army ; yet it is hoped that, in the process of time, when her people have become enlightened by education and true religion, Italy, which has been the scene of so many conflicts, and has drunk the blood of so many myriads of the human race, shall become a peaceful nation ; her government joining heartely with the other civilized nations in disbanding their armies and police, and in inaugurating and maintaining a reign of peace and righteousness in the world. There is much to be done, and some time will be required, in bringing the people of Italy, as well as of the other European nations, to that degree of enlightenment and civilization which we wish they had now attained. The sooner the movement is made in the direction we have indicated, and persistently carried out, the sooner will this great end be attained. The present and future rulers of Italy and of each of the other European states may, if they but will, do much toward the enlightenment and highest good of their people.

England is a nation of great power and influence. If it be enquired by what means this nation has come by her dominions, it may be answered that it was mainly by force of arms. The seven states of the Saxon Heptarchy waged war among themselves. After they had become united, and their power became concentrated, England, under the Norman and other princes, carried on destructive wars with Scotland, Wales, Ireland, and France, in the last-named country of which she maintained her power for some centuries. Scotland, however, become united to England in more modern times and by peaceable means ; and the rise of the English power to its present state has been mainly accomplished since the union of these two countries nearly three centuries ago, since when the united nation has been called Great Britain. By her conquests on sea she has secured the possession of extensive colonial territories, and by the maintenance of a great naval power she retains them. England's naval wars have been destructive of life, and very fertile in the increase of her power. Her wars with France, with the Dutch, with her own colonies in America, with Russia, with India and China, have been ferociously carried on, and with great loss of life and property to the people of these countries as well as to herself. By savage warfare, then, England has attained and maintains her power and influence among the nations of the earth.

Without adverting to the oppressive landlord and tax system which is in practice in Great Britain and Ireland, by means of which the great mass of the people cannot do much more in the acquisition of wealth than obtain a bare subsistence, in order the better to illustrate the moral character of Great Britain as a nation, we shall bring forward one or two instances of the manner in which she has accumulated her wealth.

In another age it will perhaps scarcely be believed, and in this age it is very little known, that Great Britain, distinguished for her zeal in propogating christianity throughout the heathen world, has for many years derived a revenue from the worship of the idol Juggernaut, and other idols of similar description at Gya, Allahabad, Tropetty, and other places in Hindostan. From the year 1813 to 1825, there was collected, by order of the British Government, from the pilgrims of Juggernaut alone about 1,360,000 rupees or $850,000, a great part of which was given to the support and maintenance of the abominable worship of this idol. Dr. Buchanan, in his "Christian Researches," states, from official accounts, that the annual expense of the idol Juggernaut presented to the British Government is as follows:—

	RUPEES.		DOLLARS.
Expenses of the table of the idol	36,115	or	22,570
" of his wearing apparel	2,712	or	1,695
Wages of his servants	10,057	or	6,295
Contingent expenses at the different seasons of pilgrimage	10,989	or	6,865
Expenses of his elephants and horses	3,030	or	1,890
Expenses of his annual state carriage or car, and tower of the idol	6,713	or	4,195
	Rup.69,616	or	$43,510

Forty-three thousand five hundred and ten dollars, paid annually by the British Government for the support of one idol, Juggernaut! Some of our readers will say they never expected that Britain, which has displayed so much zeal in the dissemination of Bibles and Testaments and Tracts and orthodox Christian doctrine, would be guilty of any such practice. In the item "wages of servants" is included the wages of the courtesans that are kept for the service of the temple.

Mr. Hunter, the collector of the pilgrim tax for 1806, told Mr. Buchanan that three state carriages were decorated that year at an expense of upwards of one thousand dollars, with English broadcloth and baize. The following items show the gain of this association with idolatry at some of the principal idol stations in India:—

	RUPEES.
Net receipt of Pilgrim tax at Juggeruaut for 1815	135,667
" " at Gya for 1816	182,876
" " at Allahabad for 1816	73,053
" " at Kashee-poor, Surkuree, Sumbal aud Kawa, 1816	5,683
" " at Tripetty and Madras, for 1811	152,000
	549,279

A rupee, though generally considered to be only of the value of half a crown or about sixty cents, is said to be received in the case of the pilgrims of India as equivalent in value to one pound sterling or five dollars to an inhabitant of England; so that in this point of view rupees may be considered as equivalent to pounds sterling or five dollar pieces.

Mr. Hamilton, in his "description of Hindostan," as quoted by Mr. Peggs in his "Pilgrim Tax in India," states, with respect to the district of Tanjore, that "in almost every village there is a temple with a lofty gateway of massive architecture, where a great many Brahmins are maintained partly by an allowance from government. The Brahmins are here extremely loyal on account of the protection they receive, and also for an allowance granted them by the British Government, of 45,000 pagodas or 18,000 pounds annually, which is distributed for the support of the poorer temples." One can scarcely conceive of anything more inconsistent than the conduct of a nation, that professes itself to be Christian and will not allow that it is idolatrous, supporting a system of idolatry the most revolting, cruel, lascivious and profane? Yet a member of the British Parliament, C. Bullen, Esq., in his letter to the Court of Directors relative to Juggernaut in 1813, says: "I cannot see what possible objection there is to the continuance of an established tax, particularly when it is taken into consideration what large possessions in land and money are allowed by our government in all parts of the country for keeping up the religious institutions of the Hindoos, and the Mussulmans." From all parts of India multitudes of idol-worshipers or pilgrims annually travel many hundred miles to pay homage to the different idols alluded to above. A tax is levied on those pilgrims graduated according to the rank or circumstances of the pilgrim, and amounting from one to twenty or thirty rupees. Those travelling to Allahabad, for example, are taxed at the following rates; on every pilgrim on foot, one rupee; on every pilgrim with a horse or a palanquin, two rupees; on every pilgrim with an elephant, twenty rupees, etc. Vast numbers of deluded people flock to these temples every year.

In 1825, the number that arrived at Juggernaut was estimated at 225,000, and in some years they have been calculated to amount to more than a million. The deprivations and miseries endured by these people are almost inconceivable. Dr. Buchanan, who visited the temple of Juggernaut in 1806, gives the following statement: "Numbers of pilgrims die on the road, and their bodies generally lie unburied. On a plain near the pilgrim caravansera, one hundred miles from Juggernaut, I saw more than one hundred skulls; the dogs, jackels, and vultures seem to live here on human prey. Wherever I turn my eyes I meet death in one shape or other. From the place where I now stand, I have a view of a host of people, like an army, encamped at an outer gate of the town of Juggernaut, where a guard of soldiers is posted to prevent them from entering the town until they have payed the tax. A pilgrim announced that he was ready to offer himself a sacrifice to the idol. He laid himself down on the road before the car as it was moving along, with his arms stretched forward. The multitude passed him leaving the space clear, and he was crushed to death by the wheels. How much I wished that the proprietors of Indian stock would have attended the wheels of Juggernaut, and seen this peculiar source of their revenue. I beheld a distressing scene this morning in the place of skulls, a poor woman lying dead or nearly so with her two children by her, looking at the dogs and vultures, which were near. The people passed by without noticing the children. I asked them where was their home, they said they had no home, but where their mother was. Oh, there is no pity at Juggernaut. Those who support his kingdom err, I trust from ignorance; they know not what they do."

"The loss of life," says Colonel Phipps, "by this superstition probably exceeds that of any other. The aged, the weak, the sick, are persuaded to attempt this pilgrimage, as a remedy for all evils. The number of women and children is also very great, and they leave their families and their occupations to travel immense distances with the delusive hope of obtaining eternal bliss. Their means of subsistence on the road are scanty, and their light clothing and little bodily strength are little calculated to encounter the inclemency of the weather. When they approach the temple they find scarcely enough left to pay the tax to government, and to satisfy the rapacious Brahmins; and, on leaving Juggernaut with a long journey before them, their means of support are often quite exhausted. The work of death then becomes rapid, and the route of the pilgrims may be traced by the bones left by the jackals and vultures, and the dead bodies may be seen in every direction." It may be said, therefore, without any extravagance, that a certain portion of the British nation luxuriate upon the nicest dainties, and the choicest finery derived from the intolerable sufferings and the life's blood of the Hindoos! Do they? With regard to the number that perish on such occasions, Rev. Mr. Ward estimates that 4,000 pilgrims perish every year on the route to and at holy places, an estimate which is considered by others as far below the truth. Captain F—— estimates those who died at Cuttack and Pooree, and between the two stations, at 5,000. What a number of these deluded wretches must die before they reach their homes, many of them coming three, six or nine hundred miles! Mr. M——, the European collector of the tax at Pooree estimated the mortality at 20,000.

Juggernant is the most celebrated station of idolatry in India. All the land within twenty miles is regarded as holy; but the most sacred spot is enclosed by a wall 21 feet high, forming a square of about 65 feet. Within this area there are about fifty temples, but the most conspicuous building consists of one lofty stone tower 184 feet high, and 28½ feet square inside. The idol Juggernaut, his brother Bulbudra, and his sister

Subadra occupy this tower. The roofs are ornamented with representations of monsters; the walls of the temple are covered with statues of stone representing Hindoo gods with their wives in attitudes grossly indecent. The three idols alluded to are wooden busts six feet high, having a resemblance of the human head, and are painted white, yellow and black, with frightfully grim and distorted countenances. They are clothed with spangled broadcloth furnished from the export warehouse of the British Government. The car on which Juggernaut is drawn measures 43½ feet high, has 16 wheels of 6½ feet diameter, and a platform 34½ feet square. The ceremonies connected with this idolatrous worship are in many cases exceedingly revolting and obscene. At Ranibut, in the Province of Gurwall, is a temple sacred to Rajah Ishwara, which is principally inhabited by dancing women. The initiation into this society is performed by anointing the head with oil taken from the lamp, placed before the altar, by which act they make a formal abjuration of their parents and kindred, devoting their future lives to prostitution; and the British government by giving annually 512 rupees to the religious mendicants who frequent this temple, directly sanction this system of obscenity and pollution? Many temples of impurity exist in other places in Hindostan. Tavernier mentions a village in which there is a pagoda to which all the Indian courtesans come to make their offerings. This pagoda is decorated with a great number of naked images. Girls of eleven and twelve years old, who have been bought and educated for the purpose, are sent by their mistresses to this pagoda to offer and surrender themselves to this idol. If, as we have seen, the French Government authorize prostitution at home, what do they more than the British Government does in India, only that they act a little more directly in the matter? Such an abominable practise is sure to bring its equivalent measure of punishment, sooner or later, upon the nation whose government allows or supports it.

In order to induce ignorant devotees to leave their homes, and commence pilgrimages to these scenes of impurity and idolatry a set of avaricious villains, termed pilgrim-hunters, are employed to traverse the country, and by all manner of falsehoods to proclaim the greatness of Juggernaut and their idols. They declare, for example, that the idol has now so fully convinced his conquerors (the British) of his divinity, that they have taken his temple under their own superintendency, and that they expend 60,000 rupees yearly to provide it with an attendance suitable to his dignity. These pilgrim-hunters *are paid by the British Government.* If one of them can march out 1,000 persons and persuade them to undertake the journey, he receives 1500 rupees if they be of the lower class, and 3000 rupees if they are persons belonging to the highest classes. And, what seems a very natural consequence, the procedure of the British Government in relation to this system has led many of the natives to suppose that the British people approve of the idolatrous worship established in India. A Hindoo enquired of a missionary: "If Juggernaut be nothing what does the company take so much money from those who come to see him?" Mr. Lacy, a missionary, who went to succour the destitute on the road to Cuttack, during one of the festivals, relates the following incident: "You would have felt your heart moved to hear, as I did, the natives say:—'Your preaching is a lie, for, if your Saviour and your religion are thus merciful, how do you then take away the money of the poor and suffer him to starve?' It is indeed no wonder that when the natives see a poor creature lying, about to die for want, they should reflect that the two rupees he has paid as a tax would have supported his life." Nor should it be a pleasing reflection to an English mind that these two rupees form precisely the difference between life and death to many who have perished for want on their way home. Another missionary relates: "Passing one evening a large temple I caught a sight at one of the idols and exclaimed, sinful, sinful!! The native who was with me asked: 'Sir, is that sinful for which the company gives thousands?' A man said to me a few days ago, 'If the government does not forsake Juggernaut, how can you expect that we should'?" In this way the efforts of the Christian missionaries to convert the Hindoos are in many instances rendered of no avail. Could not the British nation endure to be less wealthy, and refrain from increasing their stock of riches by the support and encouragement of such a polluted system of idolatry, attended with such an amount of suffering, deprivation and death to the people of Indio? But, doubtless, the great body of the British people are ignorant of any such practice being authorized or countenanced by their government. Or, do the British Government carry on this vile business till now? People should prefer to live on herbs, and go clothed in the coarsest garments, rather than luxuriate on the most delicious fare, clothed in the finest and costliest garments, derived from such an unspeakably abominable and polluted source.

Another glaring instance of British moral or immoral character is found in their imposition by force of the drug opium upon the Chinese. We have stated before that opium is derived from the juice of the poppy plant, which is cultivated largely in India. We shall now state some facts in relation to this subject from the work of a late writer on China, a Christian missionary, who has lived among the Chinese for a number of years, and is fully conversant with this subject: "The profits of the opium trade to Great Britain are enormous not less than twenty to twenty-five millions of dollars a year. According to the estimate of an English newspaper, published in China, * the total profit from the time when the trade

* *The North China Herald* of Shanghai.

began until the year 1854 were, in round numbers, three hundred and ten millions of dollars, and from that time to the present it is three hundred and forty millions more. The total is about six hundred and fifty millions in sycee silver, that is, silver without alloy payed by weight. This is the actual net profit to the produce upon a trade which amounts to from sixty to eighty thousand chests a year, which are worth in all from forty to sixty millions of dollars. The extent of the responsibility of the British government for the production and sale of opium I prefer, says the writer, to state in the words of one of its own subjects. The Calcutta correspondent of the *London Times* thus presents the case for the consideration of the readers of that influential paper: 'What,' says he, 'are the facts? As to Bengal, I have gone through the poppy fields of Shahabad ,and have witnessed every detail of the manipulation in the enormous go-downs of Patna. Under a severe contract law, twice as penal as any that has ever been proposed for ordinary agricultural purposes, and scouted by England, advances of money are annually made to the peasants of Behar, Benares, and elsewhere. (It will be remembered that the opium is grown in British India, and is thence exported to China, and that the British government has, by means of war, compelled the Chinese government to admit it to their country in which its sale is now legalised, as is well known by the latter to the great detriment of the Chinese people.) The state lies out of these advances for a year. Its establishment of highly-paid officials, and oppressive or colluding native subordinates, supervises every detail, the preparation of the fields, the sowing, the weeding, the scraping of the capsules, the collection of the crude juice, its transit to the state factory, and its sale in Calcutta. Yet, in spite of its establishments, smuggling is the rule. The state of the case is this: China will have opium just as England will have gin, and Scotland whisky. All facts go to show that the abuse of opium in China, though great, is by no means equal to that of alcohol in Europe. The moral question is, not whether China may be supplied with opium, but whether England as a nation, as the ruling power of India, ought, in its official and national character, to grow, manufacture and export the drug, the use of which has, after two or three wars, been legalized in China. Yet this is the position of England at this moment in relation to three-fourths of the opium imported from India?' What is the effect of the opium trade upon Christian missions? The writer and every man who has been engaged in the work of preaching the gospel, healing the sick, instructing the young, and disseminating the word of God, knows that the incessant and bitter objection urged by all classes to his efforts is that it is impossible that nations which carry opium in the right hand can carry any boon of mercy in the left. It (the opium traffic) is planting seeds of enervation, crime, and disease in the Chinese, who are coming to our shores, and creating corresponding vexation and injury to us; it keeps the sword of war continually unsheathed and wet with blood, the torch of conflagration constantly burning, and every puff of hostile wind distributing its sparks amidst materials which are ever ready to burn hotly; it makes the benevolent efforts of the preacher of the Gospel of mercy and of the Christian physician and teacher appear like shallow and abominable hypocrisy, and the word of God itself something false and hateful when offered by hands imbrued with so stupendous a crime against humanity and justice, against the conscience of man, and against the law of Heaven." Here we find a Christian nation itself the cause of the Gospel being virtually excluded from China, with its teeming population of four hundred millions of people. The same author says: "Would that it were possible to say that the hands of American merchants have not been stained by connivance with the crime of the opium trade in China! We are grateful to God that it it has not been made 'an official and national business to grow, manufacture and export the drug' by any other nation than Great Britain, and its Indian dependencies. But our ships have helped to convey and distribute the poison; our merchants have partaken to some extent of the profits of the work; and we have given it a garment of respectability by the deceitful pleas with which we have palliated its enormity." That unjust practice of forcing its commodities upon other nations against their will has of old been the policy of England. The reader may remember that the war which resulted in the independence of the United States, which, until then, were British colonies, arose from the British government having undertaken to compel the colonists to receive its cargoes of tea against their will. In the case of the Americans they did not succeed in their undertaking, but in that of the Chinese they did, after two or three wars, so that now the sale and use of the drug is legalised in that country. Great Britain, therefore, notwithstanding the progress she has made in the sciences and the arts, and the great efforts she has made in the dissemination of religious and other kind of knowledge, has yet much national injustice to answer for, and still far to advance before she has attained to true civilization, of which the practice of true Christian morality is the beginning and the ending: "Do unto others as you would have others do unto you."

Another unfavorable feature in the moral character of the British nation is the severity of its penal code. Among the variety of actions which men are daily liable to commit no less than 160 have been declared by Act of Parliament to be felonies without benefit of clergy, or, in other words, to be worthy of instant death. Those who are found guilty of high treason are condemned by the law "to be hanged on a gallows for some minutes, then cut down while yet alive, the heart to be taken out and exposed to view, and the entrails burned." Though the most cruel part of this statute is said never to have been inflicted in modern times, yet its existence on the statute book (does it now exist?) is a disgrace to the British nation, a disgrace which should be got rid of as quickly and as far as possible. Instead of diminishing the number of offenders experience teaches that crimes are almost uniformly increased by an undue severity of punishment. This was strikingly exemplified in the reign of Henry VIII., remarkable indeed for the number of its crimes, which certainly does not seem to have arisen from mildness of punishment. In that reign alone, says his historian, 72,000 executions took place *for robberies alone;* exclusive of the *religious murders*, which are known to have been so numerous as to amount, on an average, to six executions a day, Sundays included, during the whole reign of that monarch. The design of the institution of government is, or ought to be, to subserve the benefit of the governed, to advance their highest interests; but the government which will carry on such a wholesale slaughter among its people as that under the English monarchs did seems certainly to have another object in view, not the benefit, but the injury and destruction of its people.

If we enquire after the moral character of the United States as a nation, we shall find that it, too, has been affected with many of those imperfections which we have seen so glaringly to be in the case of those we have reviewed. By war it attained its existence as a nation, and by the exercise of war it has maintained its independence and integrity, as well as extended its dominions. By the war of the revolution, ending in 1776, the independence was acheived, and by that of 1812 it was maintained. The United States has also carried on a war with Mexico, as a result of which the territories of the former have been extended westward to the Rio Grande and the Pacific Ocean, over Southern California. The States have also carried on another great war with its own people, dark and fratricidal in its character, and which, though it may be thought to be productive of many good results, yet there are many reasons to deplore.

It appears that the wars which the first colonists carried on with the Indian tribes arose from their peculiar situation in relation to those tribes; but there are reasons to believe that the Indians were taken advantage of in too many cases by the white settlers of the Atlantic states. In their advance inland they drove the Indians before them, and gradually exterminated them as they advanced. If it be enquired what has become of all the Indian tribes which once inhabited the Northern, the Southern, and the Western states to the Missisippi River; what has become of all the Indians that three centuries ago inhabited the Continent of America now thickly inhabited by white people; the answer is plain; they have in the main been exterminated by the whites, gradually, by means of war, and secretly. Many strange but likely stories are told by some of the old settlers around the Great Lakes of the ways in which they have known the Indians to be got rid of. And the means employed in one section of the country to get rid of them, or means equally effective, may have also been employed in other sections for the same purpose. Some of the Indians, doubtless, made their way into British America, still beyond the reach of the whites, and some of them are provided for by the United States Government in territories apportioned to them for a residence; but the greater part of the Indians must necessarily have suffered extermination by the whites in their gradual settlement of the country. Since the formation of the United States Government, however, the Indians that have submitted to it have been liberally death with, and a like liberal treatment has always been given by the British Government to the Indians settled within their North American possessions. And it may, perhaps, be considered that the Indians by their uncalled-for aggressions on the new comers were, to a great extent, the cause of their own destruction. The two races might have lived together peaceably and prosperously if they had mutually cultivated and exercised toward each other the proper temper and spirit,—there was abundant room for all on the wide continent of America,—but they were mutually jealous, it appears, and suspicious of each other; either did not feel themselves safe in the neighbourhood of the other; and thus arose their mutual warfare. Heretofore, in the history of mankind, we observe that when two races, speaking different languages, and differing from each other perhaps only triflingly in other respects, came face to face on the same soil, human barbarity has generally necessitated the yielding of the one to the other. Instead of the principle of benevolence, that of malevolence is usually practised in such cases. Cannot a new era, an era of benevolence, of self-denial, of humility and peaceful industry be inaugurated? It can, if each one living will do their part towards it by always cultivating and exercising the right temper and spirit.

The existence of slavery so long in the United States was the greatest moral reproach to the nation. The way, also, in which it was got rid of is a reproach. The pride and haughtiness of certain individuals of the rival parties—slave and free—kindled the flame of war, which for four years waged with such destructive violence. The result of the war—the abolition of slavery—was great, but how much better it would have been had the same result been accomplished by peaceful measures and means. Slavery is an evil, which every one must conscientiously know to be an evil. But because an evil exists must an equal evil be perpetrated in order to get rid of it? Should the proud hearts of the leaders of the South and North not bend to an act of legislation by which the slaves might be emancipated by means of an equitable purchase, and slavery abolished? The thing was not impracticable, for it had been done before by the British Government in the case of their West Indian slaves. Or, on the other hand, should not those who held the slaves in bondage have acted benevolently toward them and set them free, and put them to work at a fair wages? It is time that such benevolence were exercised by human beings toward each other. It is said to be more blessed to give than to receive. Men have but a short time to live on this earthly scene, and though they be rich or poor, they will be all the happier and better for doing all the good that lies in their power, by acting benevolently and beneficently toward each other. There is no doubt of this. Let each one realize it for one's self. Your Creator is everywhere present, recognizes all your acts, and will be sure to reward the good acts, and, if you are unable to act, the good-will and intentions. You are also an accountable being, and will in yourself experience the consequences of your evil, whether of omission or of commission. A small moiety of the treasure which was expended in carrying on that atrocious war—the result of pride and selfishness in a few—might have been sufficient to have bought the slaves out at a fair price. And how many fathers, and husbands, and brothers, and sons, whom that war has laid low, would now be alive, a help and a comfort to their friends, and a blessing to their country! The emancipated negroes would be equally well off,—perhaps better,—the country much more prosperous, and the people much happier. America, both South and North, would thus have given proof of a higher state of civilization, and of a higher moral character, than it now can be admitted to have attained. How long before men come to realize that their duty is to deny self, to subdue and eradicate pride, and to act benevolently and charitably toward each other! May there not be less crime of a private and of a public nature committed in the United States? Will not each individual, old and young, male and female, in the republic, leave nothing undone which they can do to bring about the era of righteousness, and peace, when all shall enjoy and be satisfied with the fruits of their own integrity, industry, and strictly moral living? The country which has hitherto been the refuge of the poor and oppressed of all nations may thus be rendered of still greater benefit to mankind.

Heretofore in our review of the moral character of the civilized nations we have spoken of Rome and its empire with reference mainly to its civil aspect. Now we shall inquire what information history affords us as to the character and doings of the Catholic Church, whose head was the Pope. Hitherto we have not found that the nations called civilized are exalted to a very great degree above those called uncivilized, in point of true morality, (although they are exalted in some degree,) so that our readers may ere this have begun to suppose that if the nations called civilized have much in their moral character to entitle them to the name civilized, it must be found in the religion they profess. We shall see.

The New Testament teaches us of the characters of the founders of the christian church. They are all said to be men distinguished for self-denial, for humility, for charity, and for active industry in the cause which they espoused, and endeavoured to promote. During the early ages of Christianity a goodly portion of the same spirit was manifested by the greater number of those who enrolled themselves as the followers of Christ. Even in the midst of the reproaches and persecutions to which they were subjected during the two first centuries of the Christian era, a meek and forgiving disposition, and a spirit of benevolence toward one another, and toward all mankind, distinguished them from the heathen around and constrained even their enemies to exclaim: "Behold how these Christians love one another!" But no sooner was the church combined with the state in the days of Constantine than its native purity began to be sullied, and Pagan maxims and wordly ambition began to be blended with the pure doctrines of Christianity. Many of its professed adherents, overlooking the grand practical bearings of the Christian system, began to indulge in vain speculations concerning its doctrines which they could not understand; to substitute a number of unmeaning rites and ceremonies in the place of love to God and man, and even to persecute, and destroy all those who refused to submit to their opinions and decisions. Pride and ambition usurped the place of humility and meekness, and the foolish mummeries of monastic and ascetic superstition and austerity were substituted in the place of the active duties of justice and benevolence. Saints were deified; the power of the clergy was magnified; religious processions were appointed; pilgrimages were performed to the tombs of the martyrs; monasteries and nunneries without number were erected; prayers were offered up to the departed saints; the doctrine of the Trinity was instituted; the Virgin Mary was recognized as a species of inferior deity; the sign of the cross was regarded as capable of securing victory in all kinds of trials and calamities, and as the surest protection against the influence of malignant spirits; the bishops aspired after wealth, magnificence, and splendour, which they have not yet ceased to do; errors in religion were punished with civil penalties and bodily tortures; and the most violent disputes and contentions disturbed every section of the Catholic Church; while the mild and beneficent virtues of the religion of Christ were either discarded or thrown into the shade. Of these and similar dispositions and practices we might give details which would fill many volumes, and which would convince every impartial mind that the true lustre of Christianity was sadly obscured, and its heavenly spirit almost extinguished, amidst the mass of superstitious observances, of vain speculations, and of angry feuds and contentions, which prevailed. Millot, in speaking of the state of the church in the days of Constantine and the succeeding emperors, justly remarks: "The disciples of Christ were inspired with mutual feuds, still more implacable and destructive than the factions that were formed for or against different emperors. The spirit of contention condemned by St. Paul became almost universal. New sects sprung up incessantly and combatted each other. Each boasted its apostles, gave its sophisms for divine oracles, pretended to be the depositary of the faith, and used every effort to draw the multitude to its standard. The church was filled with discord; bishops anathematized bishops; violence was called in to the aid of argument, and the folly of princes fanned the flame which spread with such destructive rage. They played the theologists, attempted to command opinions, and punished those whom they could not convince. The laws against idolaters were soon extended to heretics; but what one emperor prescribed as heretical was to another sound doctrine. What was the consequence? The clergy, whose influence was already great at court, and still greater among the people, began to withdraw from the sovereign authority that respect which religion inspires. The popular ferments being heightened by the animosities of the clergy, prince, country, law or duty were no longer regarded. Men were Arians, Donatists, Priscillianists, Nestorians, Eutychians, Monothelites, etc., but no longer citizens, or, rather, every man became the mortal enemy of those citizens whose opinions he condemned. This unheard-of madness for irreconcilable quarrels on subjects which ought to have been referred to the judgment of the church, never abated amid the most dreadful disasters. Every sect formed a different party in the state, and their mutual animosities conspired to sap its foundations." *

At the period to which these observations refer two erroneous maxims appear to have generally prevailed, which tended to undermine the gospel system of morality, and which were productive of almost all the contentions, tumults, and massacres, which distinguish that era of the Christian church. These were, first, that religion consisted in the belief of certain abstract and incomprehensible dogmas, and in the performance of a multitude of external rites and ceremonies; and, second, that all heresies or differences of opinion on religious points ought to be extirpated by the arm of the civil power. Than such maxims nothing can be more repugnant to reason or subversive of genuine morality, or more inconsistent with the genius and spirit of the true religion of Christ. And yet, to this time they are acted upon by four fifths of the Christian world, notwithstanding the numerous examples which history furnishes of their futility and erroneous tendency. We shall state only two or three instances referring to this period. The Emperor Theodosius came to the throne of the Roman empire in the year 379, A. D. Being originally a pagan he was baptised into the Christian church in the second year of his reign, during a severe illness, which threatened his life, and on his recovery he professed great zeal for

* Millot's Modern Hist. Vol. 1.

that church. Soon after his baptism, he dictated the following edict: "It is our pleasure that all the nations which are governed by our clemency and moderation should steadily adhere to the religion which was taught by St. Peter to the Romans, which faithful tradition has preserved, and which is now professed by the Pontiff Damasus, and by Peter, bishop of Alexandria, a man of apostolic holiness. According to the teaching of the apostles, and the doctrines of the Gospel let us believe the sole deity of the Father, the Son, and the Holy Spirit, under an equal majesty and a pious trinity. We authorise the followers of this doctrine to assume the name of Catholic Christians; and as we judge that all others are extravagant madmen, we brand them with the infamous name of heretics, and declare that their conventicles shall not longer usurp the respectable name of churches. Beside the condemnations of divine justice they must expect to suffer the extreme penalties which our authority, guided by heavenly wisdom, shall think proper to inflict upon them." *

Theodosius declared apostates and Manicheans incapable of making a will or receiving any legacy; and, having pronounced them worthy of death, the people thought they had a right to kill them as proscribed persons. He enacted a law condemning to the flames cousins-german, who married without a special license from the emperor. He appointed inquisitions for the discovering of heretics. He drove the Manicheans from Rome as infamous persons, and on their death ordered their goods to be distributed among the people. In the space of ten years, he promulgated at least fifteen severe edicts against nonconformists and heretics, more especially those who rejected the doctrine of the Trinity which, under his reign, was established by law; and to deprive them of every hope of escape he sternly enacted that if any laws or rescripts should be alleged in their favor, the judges should consider them as the illegal productions either of fraud or forgery. Leo, another emperor, "commanded every person to be baptised under pain of banishment, and made it a capital offence for any one to relapse into idolatry after the performance of that ceremony;" as if men could be made Christians by a forced baptism or by a law of the state. Such edicts clearly showed that whatever zeal those princes or the clergy might manifest in favor of the Christian religion, they were totally devoid of the true spirit, and ignorant of the means by which its benevolent objects were to be accomplished.

To illustrate the manner in which such edicts were carried into effect, the following instance may be stated: Hypatia, the daughter of Theon, the celebrated geometrician of Alexandria, exceeded her father in learning, and gave public lectures in philosophy with the greatest success; nor was she less admirable for the purity of her virtues, joined to an uncom-

* Gibbon's Rome.

mon beauty, and every accomplishment that could adorn human nature. But that excellent woman, because she would not accept of the established religion, and was supposed to be active against St. Cyril, the bishop, became an object of detestation to the Christian multitude. A set of monks and desperadoes, headed by a priest, seized her in the open street, hurried her into a church, where they stripped her naked, lacerated her body with whips, cut her in pieces, and publicly burned her mangled limbs in the market-place.* St. Cyril, who was suspected of having fomented this tragedy, had previously attacked the synagogues, and driven out the Jews; their goods were pillaged, and several persons perished in the tumult. Such conduct plainly demonstrates the tendency of the human mind to abuse power, for the purpose of revenge and persecution; and illustrates, also, what the ideas of these persecutors were of their pretended religion.

About this time, and afterwards also, vain speculations about abstruse and incomprehensible subjects occupied the minds and the time of theologists, engendered religious quarrels and disputes, and burst asunder the bonds of affection and concord. A play upon words and vain subtleties were substituted for clear conceptions and substantial knowledge; which, instead of directing the faculties of the human mind to the proper objects, tended to obscure the light of reason, and to usher in the long night of ignorance, characterized as the Dark Ages. It was a prevailing madness with these early theologists, who were obstinately tenacious of their opinions, and it has been too much the case with certain modern theologists to dispute about doctrines which they claimed to be incomprehensible, to render them more obscure by their attempts to explain them, never giving the proper explanation, and perpetually to revive the most angry contentions.

The Arians rejected the divinity of Christ in order to maintain the unity of God; the Nestorians denied that Mary is the mother of God, and gave two persons to Jesus Christ to support the opinion of His having two natures. The Eutychians, in order to maintain the unity of the person, confounded the two natures in one. This sect became divided into ten or twelve branches, many of them, as the Gnostics of the Primitive Church, maintaining that Christ was merely a phantom or appearance of flesh, but not real flesh. The Monothelites maintained that Christ had only one will, as they could not conceive two free wills to exist in the same person. Another sect maintained that Christ's body was incorruptible, and that from the moment of His conception He was incapable of change and of suffering. This chimera the Emperor Justinian attempted to establish by an edict. He banished the patriarch Eutychius, and several other prelates

* Millot's Modern History.

who opposed his sentiments, and was preparing to tyrannize over the consciences of men with still more violence, when, after a long reign, death interposed, and removed him from this earthly scene.

In such vain and preposterous disputes as these the minds of professed Christians were occupied, notwithstanding the perils with which they were then encompassed by the invasion of the barbarians. Councils were held to determine the orthodox side of a question; anathemas were hurled against those who refused to acquiesce in their decisions; princes interposed their authority, and the civil power stood ready to compel men to profess what they did not believe and could not understand, while the essential truths of religion were overlooked, and its morality disregarded. "Religion," says Millot, "inspires men with a contempt of earthly vanities, a detestation of vice, and indulgence for the frailties of our neighbors, invulnerable patience in misfortune and compassion for the unhappy; it inspires us with charity and heroic courage, and tends to sanctify every action in common and social life. How sublime and comforting the idea it gives of the Divinity; what confidence in His justice and infinite mercy; what encouragement for the exercise of every virtue; wherefore, then, such errors and excesses on religious pretences? It is because heresy, starting up under a thousand different forms, incessantly startles the faith by subtleties and sophistry, by which almost the whole energy of men's mind is absorbed in the contest. Disputes engender hatred; from hatred springs every excess; and virtue, exhausted with words and cabals, loses her whole power." How well it would be for the cause of genuine Christianity, and how promotive of the happiness of mankind, if the present and future generations would profit by the experience of the past!

As we advance in the history of the Christian Church through the Middle Ages the prospect becomes still more dark and gloomy: the human mind at that period appears to have lost its wonted energy and power of determination; the light of reason seemed well-nigh extinguished; sophisms and absurdities of all kinds were swallowed and left undigested, and superstition displayed itself in a thousand different forms; morality was smothered up under a heap of ceremonies, and arbitrary observances obtained the name of devotion; relics, offerings, pilgrimages, and pious legacies were thought capable of opening the gate of heaven to the most wicked of men; the Virgin Mary and the souls of departed saints were invoked; splendid temples and shrines were erected to their honor, and their assistance was entreated with many fervent prayers; an irresistible efficacy was attributed to the bones of martyrs, and to the figure of the cross, in defeating the temptations of Satan, in warding off all sorts of calamities, and in healing the diseases of the body and of the mind; works of piety and benevolence, as in Romish countries at the present day, were viewed as consisting chiefly in building and embellishing churches and chapels, in endowing monasteries, in hunting after the relics of martyrs, in procuring the intercession of saints by rich oblations, in worshiping images, in pilgrimages to holy places, in voluntary acts of mortification, in solitary masses, and in a variety of similar services which could easily be reconciled with the commission of the most abominable crimes; so that the worship of the invisible Deity, the Creator of all, was exchanged for the worship of hair, bones, fragments of fingers and toes, tattered rags, images of saints, and bits of rotten wood, supposed to be the relics of the cross; the canonizing of saints became the fruitful source of frauds and abuses throughout the Christian world; lying wonders were invented, and fabulous histories and legends composed to celebrate exploits that were never performed, and to glorify persons that never had a being; and absolution from the greatest crimes could be easily obtained either by money or by penance. During the eighth and ninth centuries, there were perpetual contests as to images, whether or not they should be worshiped; one emperor permitted, another prohibited, their worship. An emperor, in the beginning of his reign, as Leo the Isaurian, bows down in abject homage to them, and thereby secures the favor of the Pope and his prelates; in the latter part of his reign he breaks them to pieces, and thereby obtains their displeasure and active opposition. Hence arose the term Iconoclasts, or Image breakers, in contradistinction to image-worshipers. The sect of the Iconoclasts was supported by six Emperors, and the whole Catholic church was involved in a noisy conflict between these two opposing parties for a period of one hundred and twenty years.

The absurd principle that religion consists of acts of austerity produced the most extravagant behaviour in certain devotees and reputed saints. They lived among the wild beasts; they ran naked through the lonely desert, with a furious aspect, and with all the perturbations of madness and frenzy; they prolonged their wretched lives by grass and wild herbs; avoided the sight and conversation of men, and remained almost motionless for several years exposed to the rigor and inclemency of the seasons; and all this was considered as an acceptable method of worshiping the Deity, and of obtaining His favor.

But of all the instances of superstitious frenzy which disgraced those times none was held in higher veneration than that of a certain order of men called Pillar Saints. These were persons of a most singular and extravagant turn of mind, who stood motionless on the top of pillars, expressly raised for this exercise of their patience, and remained there for several years the objects of the admiration and applause of a stupid and wondering populace. This strange superstitious practice began in the sixth century, and continued in the East for more than six hundred years. The name and genius of Simeon Stylytes have been immortalized by the invention of this aerial penance. At the age of thirteen years, the young

Syrian deserted the profession of a shepherd, and threw himself into a monastery. After a long and painful novitiate, in which he was repeatedly saved from pious suicide, Simeon established his residence on a mountain, about thirty or forty miles to the East of Antioch. Within the space of a Mandra, or circle of stones, to which he had attached himself by a ponderous chain, he ascended a column, which was successively raised from the height of nine to that of sixty feet, from the ground. In this last and lofty station the Syrian monk resisted the heat of thirty summers, and the cold of as many winters. Habit and exercise instructed him to maintain his dangerous situation without fear or giddiness, and successively to assume the different postures of devotion. He sometimes prayed in an erect attitude with his arms outstretched in the figure of a cross, but his most familiar practice was that of bending his meagre skeleton from the forehead to the feet; and a curious spectator, after numbering 1244 repetitions of this act, at length desisted from the endless account. The progress of an ulcer in his leg might shorten, but it could not disturb this celestial life; and the patient monk expired without descending from his column. This voluntary martyrdom must have gradually destroyed the sensibility both of the mind and body; nor can it be presumed that fanatics who unnecessarily torment themselves are susceptible of any lively impression for the rest of mankind. A cruel unfeeling temper has distinguished the monks of every age and country; their stern indifference is inflamed by religious hatred, and their merciless zeal has strenuously administered the office of the Inquisition.

To the same irrational principle are to be attributed the revolting practices of the Flagellants, a sect of fanatics who chastised themselves with whips in public places. Numbers of persons of this description of all ages and sexes made processions, walking two by two, with their shoulders bare, which they whipped until the blood ran down in streamlets, in order to obtain the mercy of God and appease his anger against their wickedness. They held, among other things, that flagellation was of equal virtue with baptism and the other sacraments; that the pardon of all sins would be obtained by it, without the merits of Jesus Christ; that the old law of Christ was soon to be abolished, and that a new law, enjoining a baptism of blood to be administered by whipping, would be substituted in its place. The enormous power that came to be vested in the ecclesiastical rulers was another source of immorality, and of the greatest excesses. The Pope and the clergy reigned over the greatest part of the Catholic church without control, and made themselves masters of almost all the wealth in every country in Europe. Many of them perpetrated crimes of the deepest dye, and the laity, thinking themselves able to purchase the pardon of their sins for money, followed without scruple the example of their pastors. Every Christian country swarmed with lazy monks, and the most violent contentions, animosities and hatred reigned among their different orders, as well as between all ranks and orders of the clergy. "Instead of consecrating ecclesiastical censures solely to spiritual purposes, they converted them into a weapon for defending their privileges, and supporting their pretensions. The priesthood, which was principally designed to bless, was most frequently employed in cursing. Excommunication was made the instrument of damning instead of saving souls, and was inflicted according to the dictates of policy or revenge." The great and powerful, even kings and emperors, were excommunicated when it was designed to rob or to enslave them; and this invisible engine, which they wielded with an effective and a sovereign hand, was used to stir up dissensions among the nearest relations, and to kindle the most bloody wars. The generality of priests and monks kept wives and concubines without shame or scruple, and even the papal throne was at some times the seat of debauchery and vice. The possessions of the church were either sold to the highest bidder or turned into a patronage for the bastards of the incumbents. Marriage, wills, contracts, the interests of families and courts, the state of the living and the dead were all converted into instruments for promoting their credit and increasing their wealth. It was, therefore, a necessary consequence of such a state of things that vices of every description abounded, that bad morals prevailed, and the benevolence of the divine law was trampled under foot.

The ignorance and superstition which the corruptions of Christianity introduced were dexterously improved by the ecclesiastical rulers to enrich themselves, and drain the purses of the deluded masses. Each rank and order of the clergy had its peculiar method of fleecing the people and increasing its revenues. "The bishops," says Mosheim, "when they wanted money for their private pleasures, granted to their flock the power of purchasing the remission of the penalties imposed upon transgressors by a sum of money, which was to be applied to certain religious purposes, or, in other words, they published indulgences, which became an inexhaustible source of opulence to the episcopal orders, and enabled them to form and execute the most difficult schemes for the enlargement of their authority, and to erect a multitude of sacred edifices, which augmented the external pomp and splendor of the church. The abbots and monks, equally covetous and ambitious, had recourse to other methods for enriching their convents. They carried about the country carcases and relics of the saints in solemn procession, and permitted the multitudes to behold, touch, and embrace those sacred and lucrative remains, at certain fixed prices. By this raree-show, the monastic orders often gained as much as the bishops did by their indulgences."* The Pope at length assumed the chief power

Mosheim's Hist., 12th Cent.

over this profitable traffic, and "when the wants of the church, or the demon of avarice prompted them to look out for new subsidies, published not only a universal but a plenary remission of all the temporal pains and penalties which the Church had annexed to certain transgressions. They even audaciously usurped the authority which belongs to God alone, and impiously pretended to abolish even the punishments which are reserved in a future state for the workers of iniquity, a step which the bishops, with all their avarice and presumption, had never once ventured to take."*

By the sale of such indulgences the money was obtained by means of which the magnificent structure of St. Peter's Church at Rome was built. Pope Leo X. published a system of indulgences, suited to all ranks and characters of men, and offered a plenary remission to all who would contribute their money to the furtherance of this and other projects he had in view; so that the foundations of this edifice, which has been so much admired, were laid, and its superstructure reared by the most diabolical and impious means, by the exercise of perfidy and insatiable avarice, and by the usurpation of the prerogatives of the Deity. This daring impiety was carried to such a pitch that indulgences were farmed out to the highest bidders, who, to make the most out of their bargain, procured the ablest declaimers, and the most eloquent preachers, to extol the efficacy, and enhance the va ue, of such wares. A graduated scale of prices was arranged for the remission of sins of every description, not even excepting the most horrid crimes, such as the murder of a father, mother, or wife; so that for ninety livres, or a few ducats, or a less sum, a pardon might be procured from the "Apostolic Chancery," for crimes which all civilized nations determined to be worthy of death. All the provinces of Europe were in a manner drained to enrich those ghostly tyrants, who were perpetually gaping after new accessions of wealth, in order to augment the numbers of their friends, and the stability of their dominions; and every stratagem was used to rob the subject without shocking the sovereign, and to levy taxes under the specious mask of religion.

Such was the shameless rapacity which then prevailed, that even in the age of ignorance and servility, the eyes of the people began to open, and to perceive the vileness, impiety, and false pretensions of the ecclesiastical orders. Not alone private persons, but princes and sovereign states began to exclaim loudly against the despotic dominion of the Popes, the fraud, avarice, and injustice that prevailed in their councils, the arrogance and extortion of the legates, and the unbridled rapacity and licentiousness of the clergy and monks, until at length the Protestant

* Mosheim's Hist., 12th Cent.

† Id.

reformers, with the double object, doubtless, of strengthening their own cause and weakening that of their opponents, brought to light such a scene of extortion and profligacy as had never before been exhibited with such effrontery in any country under heaven.

The public worship of the Deity was at that time little more than a pompous round of ceremonies, adapted rather to dazzle the eye of sense than to enlighten the understanding, or affect the heart. The sermons of the clergy were little else than fictitious reports of miracles, and prodigies, insipid fables, wretched quibbles, and senseless jargon, which deceived the multitude instead of instructing them. The authority of the holy Mother Church, the obligation of obedience to her decisions, the merits and virtues of the saints, the dignity and glory of the Blessed Virgin, the efficacy of relics, the adorning of churches, the endowing of monasteries, the utility of indulgences, and the burnings of purgatory, were the principal subjects on which the clergy descanted, and which employed the pens of eminent doctors of divinity, because they availed to fill the coffers of the Mother Church, to augment her magnificence, and to advance her temporal interest as represented in the Papacy.

A certain class of persons connected with the Romish Church, designated by the title of the "Pope's Nephews," have always distinguished themselves by their arrogance and rapacity. An Italian writer of the 17th century, who appears to have been a moderate Catholic, when sketching the characters of the existing cardinals, and the Pope's Nephews, relates, among other curious and melancholy pieces of history, the following circumstance: "A friend of mine had the curiosity to calculate the money that had been given to the Nephews, and he began at the year 1500, and, after a great deal of pains he found issuing from the treasury of the Church, above seventy millions of double ducats,* all delivered into the hands of their kindred. And this is to be understood of visible moneys; for of private and invisible sums there may perhaps be twenty millions more. And those Romans that are within the town, and have more time to cast up what has been extorted from them, if they would take the pains to examine it more strictly, I am satisfied would find it much more." The author, like a zealous Catholic, makes the following reflection on this fact: "If these seventy millions of double ducats had been spent in persecuting heretics, or in making war upon infidels, where would any infidel be? These seventy millions would have been enough to have overrun all Asia, and, (which is of importance too,) the princes would have contributed as much more had they seen the Popes more tenacious against their kindred, and more free to the soldiers who were fighting for Christ."

* A double ducat is about $2.50 in silver, or about $5.00 in gold.

The same author states that " Innocent X., to satisfy the fancy of a kinswoman, spent a hundred thousand crowns upon a fountain, yet with great difficulty could scarce find forty thousand to supply the emperor in his wars with the Protestants;" and " this good Pope would nevertheless leave to his cousin, to the house of Pamphylia, and other houses allied to that, above eight millions of crowns, with which sum they flourish in Rome to this very day." Again : " The Barbarini were in Rome at the same time, and enjoyed a rent of four hundred thousand crowns, and yet in a war of so much importance to the Catholic religion they could not find forty thousand. But Oh God ! (I speak it with tears in my eyes) against the most Catholic princes of Italy whole millions were nothing ; they could turn the cross into the sword to revenge their particular injuries ; but, in the relief of the emperor who was vindicating the Christian faith, they could not find so much as a few hundreds." " The infidels laugh, and the heretics rejoice to see the wealth of the Church so irreligiously devoured, while the poor Christian weeps at their merriment." " The heat and passion which the Popes show hourly for their Nephews to gain principalities for them, to bestow pension upon pension upon them, to build palace upon palace for them, and to fill their coffers with treasures to the brim is that which cools the resolution of the zealousest prince, and exasperates the infidels in their wicked designs. A great shame it is indeed that the heretics should have more ground to accuse the Catholics than the Catholic has to impeach the heretic." And he adds the following apostrophe in reference to this subject : " Oh God ! to what purpose will they keep so many jewels at Loretta, so much consecrated plate at Rome, so many abbeys for their Nephews, so much wealth for the popes, if, abandoning their Commonwealth, and refusing it that humane supply that is necessary for the celestial glory, it be constrained to submit to the Ottoman power, which is threatening it now with the greatest effect ? If the wealth of the Popes be devoured, the benefices of the cardinals given to the priest of Mahomet, the abbeys of the Nephews usurped by the Turks, the sacred vessels at Rome profaned by these infidels, and the seraglio adorned with the gems of the Loretta, God grant my eyes may never see that spectacle ! * " Thus it appears, from the testimony of Catholic writers, that the immense sums which were wrested from the people by every species of fraud and extortion, instead of being applied to the maintenance and defence of the Church, as was pretended, (which application, in the state in which the Church was then, would not have been an over-good one either), were wasted in luxury and extravagance by the Popes and their minions in selfish gratifications, in riot and debauchery, in accumulating wealth on the heads

* See a volume in Italian entitled " Il Cardinalismo di Sancta Chiesa." Or the History of the Cardinals of the Roman Church.

of their relatives and favorites, most of whom were infidels and debauchees, in gratifying the pride and avarice of courtesans, and in the most romantic and ambitious projects. The single structure of St. Peter's at Rome is said to have cost the enormous sum of sixty millions of dollars, and in our age and country would have cost, at least, three times that amount. What immense sums, then, must have been expended on similar objects intended merely for worldly ostentation by the Catholic hierarchy throughout the whole of christendom, besides the millions that were expended in their pursuits of tyranny, sensuality and debauchery. The mind, when it reflects upon it, is almost overwhelmed at the thought that such sacrilegious enormities should have been so long continued with impunity, and that such immense treasures should have been consecrated for so many ages to the support of the kingdom of darkness, while the true Christian church was allowed to pine away in poverty, and compelled to hide its head in dens and caves of the earth.

The Pope's revenues, as a temporal prince, at the beginning of this century, have been calculated to amount to at least a million of pounds sterling, or five millions of dollars a year, arising chiefly from the monopoly of corn, the duties on wine and other products. Over and above these, vast sums were continually flowing into the papal treasury from all the Roman Catholic countries for dispensations, indulgences, canonizations, annats, the pallia, the investitures of bishops and archbishops, and other resources. It is computed that the monks and regular clergy who were absolutely at the Pope's devotion did not amount to less than two millions of persons, dispersed through all the Roman Catholic countries, to assert his supremacy over princes, and to promote the interest of the Church. The revenues of these monks and priests did not fall short of two hundred millions of pounds sterling, or a thousand millions of dollars, besides the casual profits arising from offerings and the people's bounty to the church, who are taught that their salvation depends upon this kind of charity. In Spain alone the number of ecclesiastics, including the parochial clergy, monks, nuns, syndics, inquisitors, etc., amounted to 188,625. The number of archbishops was eight, and of bishops forty-six. The archbishop of Toledo alone had a revenue, which, according to the most moderate computation, amounted to four hundred and fifty thousand dollars a year. In Portugal, in 1732, there were reckoned above 300,000 ecclesiastics out of a population of less than two millions. The patriarch of Lisbon had an annual revenue of one hundred and fifty thousand dollars, and the revenue of the patriarchal church above $570,000. It is stated by Mr. Locke in the diary of his travels that the expense of the ecclesiastical establishment in France, at the time that he resided in that country, amounted to about twenty-four millions of pounds sterling, or one hundred and twenty millions of dollars. This may give some idea of what must have been the immense treasures of wealth collected by the Roman Popes and bishops, prior to the Reformation, when the whole of the European nations were in subjection to them, and when the newly discovered countries in the Western world were plundered to augment their revenues and to satiate their rapacity!

The theological speculations in which these ecclesiastics indulged corresponded to their degrading practices, and tended to withdraw the mind from the substantial realities both of science and virtue; sophisms and falsehoods were held forth as demonstrations. They attempted to argue after they had lost the rules of common sense. The cultivation of letters, as well as of the arts, was neglected; eloquence consisted in futile declamations; and true philosophy was lost in the abyss of scholastic and sophistical theology. They endeavoured to render theology a subject of metaphysical speculation, and of endless controversy. A false logic was introduced which subtilized upon *words*, but gave no ideas of *things*, which employed itself in nice and refined distinctions concerning objects and operations, which lay beyond their limited understandings, and which *could not* be understood. The following are only a few instances out of many that might be brought forward of the questions and controversies which occupied the attention of bishops and scholarly doctors, and gave rise to furious contentions: Whether the conception of the Blessed Virgin was immaculate? Whether Mary should be denominated the mother of God or the mother of Christ? Whether the bread and wine used in the Eucharist were digested? In what manner the will of Christ operated; and whether He had one will or two? Whether the Holy Spirit proceeded from the Father and the Son or only from the Father? Whether leavened or unleavened bread ought to be used in the Eucharist? Whether souls in their intermediate state see God or only the human nature of Christ? It was disputed between the Dominicans and Franciscans whether Christ had any property. The Pope pronounced the negative proposition to be a pestilential and blasphemous doctrine, subversive of the Catholic faith. Many councils were held at Constantinople to determine what sort of light it was which the disciples saw on mount Tabor. It was solemnly pronounced to be the eternal light with which God is encircled, and which may be termed his energy or operation, but is distinct from his nature or essence. The disputes respecting the presence of Christ in the Eucharist led to this absurd conclusion, which came to be universally admitted: "that the substance of the bread and wine used in that ordinance is changed into the real body and blood of Christ," and consequently when a man eats what has the appearance of a wafer, or a piece of bread, he really and truly eats the body and blood and soul of Christ; and when he afterwards drinks what has the appearance of wine, he drinks the very same body and blood, and soul, which, perhaps not a minute before, he had wholly and entirely eaten!

At the period to which we now allude the authenticity of a suspected relic was proved by bulls. Councils assembled and decided upon the authority of forged acts with regard to the antiquity of a Saint, or the place where his body was deposited; and a bold impostor needed but to open his mouth to persuade the multitude to believe whatever he pleased. To feed upon animals strangled or unclean, to eat flesh on Tuesday, eggs and cheese on Friday, to fast on Saturday, or to use unleavened bread in the service of the mass, were by some considered as indispensable duties, and by others as vile abominations. In short the history of the period is a reproach to the human understanding, an insult offered to reason, and a libel on the benevolent spirit which breathes through the true religion of Christ.

Nothing can be more directly opposed to the spirit which this religion inculcates, than the temper and conduct of many, if not all, of those who arrogated to themselves the character of being "God's vicegerents on earth," and who assumed to themselves the sole direction and control of the Christian church. In persons who laid claim to functions so sacred and divine it might have been expected that, at least, the appearance of piety, humility and benevolence would have been exhibited before the Christian world. But the history of the Popes and their satellites displays almost everything which is directly opposed to such heavenly virtues. Their avarice, extortion, and licentiousness became intolerable and excessive, even to a proverb. To extend their power over the kingdoms of the earth, to increase their wealth and revenues, to live in opulence and splendour, to humble earthly rulers, to alienate the affections of their subjects, and to riot in the lap of luxury, sensuality, and debauchery, seemed to be the great objects of their ambition. Instead of acting as the heralds of mercy, and the ministers of peace, they thundered anathemas against all who dared to call in question their authority; kindled the flames of discord and civil wars, armed subjects against their rulers, led forth hostile armies to the battle, and filled Europe with confusion, devastation, and carnage. Instead of applying the mild precepts of Christianity and interposing their authority for reconciling enemies, and subduing the jealousies of rival monarchs, they on many occasions delighted to widen the breach of friendship and to fan the flame of animosity and discord. Dr. Robertson, when adverting to the personal jealousies of Francis I, and Charles V, remarks: "If it had been in the power of the Pope to engage them in hostilities, without rendering Lombardy the theatre of war, nothing would have been more agreeable to him than to see them waste each other's strength in endless quarrels. *

Some of our readers may have ere this become impatient and digusted with the characters which have been drawn of those ghostly leaders of the

* Robertson's Charles V.

people. They may, however, remember that these are but a few of the facts of a similar kind which history presents before us, and that they are not exaggerated. The Son of Man comes into the world not to destroy men's lives but to save them ; but in such instances we behold his pretended vicars preparing and arranging the elements of discord, laying a train for the destruction of thousands, and tens of thousands, and taking a diabolical delight in contemplating the feuds, the massacres, and the miseries, which their infernal policy had created. The decrees from the papal throne, instead of breathing the mildness and benevolence of the gospel, became thundering curses and sanguinary laws, and a set of fanatic enthusiasts or a lawless banditti were frequently appointed to carry them into effect. Not resting satisfied with the insurrections and the desolations they had caused among the European nations, they planned an expedition for the purpose of subduing Western Asia, and consequently of massacring its inhabitants. Urban II, about A. D., 1095 travelled from province to province levying troops, even without the consent of their princes, preaching the doctrine of "destruction to the infidels," and commanding the people in the name of God to join in the *holy war*. Peter the Hermit, represented by historians as a man of a hideous figure and aspect, covered with rags, walking barefooted and speaking as a prophet, inspired the people everywhere with an enthusiasm similar to his own. St. Bernard ran from town to town haranging the populace, performing pretended miracles, and inducing all ranks, from the emperor to the peasant, to enroll themselves under the banner of the cross. Thousands of wicked and abandoned debauchees were thus collected ; and bishops, priests, monks, women and children were all enrolled in the *holy army*. A plenary absolution of all their sins was promised, and if they died in the contest they were assured of a crown of martyrdom in the world to come. With hearts burning with fury and revenge this army of banditti, without discipline, or a sufficiency of provisions, marched in wild confusion through the Eastern parts of Europe, and at every step of their progress committed the most horrible outrages. So inveterate was their hatred of the Jews wherever they found them that many of these unfortunate beings, both men and women, murdered their own children in the midst of the despair to which they had been driven by those infuriated madmen ; and when they had arrived at Jerusalem, and had taken the city by assault, they made a universal slaughter of the infidels. Such was the way in which the successors of the apostles and the vicars of Christ displayed their general benevolence, and their love to the souls and bodies of men.

The establishment of the Inquisition is another mode in which the tyranny and cruelty of the church of Rome have been displayed. The office of inquisitors of the faith was first instituted under Theodosius, and was, doubtless, retained and exercised to a greater or less extent in all the ages subsequent to him. But the Court of the Inquisition, which became so terribly notorious, was founded in the Twelfth Century, by Father Dominic and his followers, who were sent by Pope Innocent III, in order to excite the Catholic princes to extirpate heresy, and was, some time after, put into execution in Spain with awful effect. It is scarcely possible to conceive of any institution more diametrically opposed to the dictates of justice and humanity, and to the genius of the religion of the Gospel, than is this infernal tribunal. The proceedings against the unhappy victims of that court were conducted with the greatest secrecy. The person granted them as counsel was not permitted to converse with them, except in the presence of the inquisitors; and when they communicated the evidence to the accused persons they carefully concealed from them the name of the authors. The prisoners were confined for a long time until they themselves by the application of the torture became their own accusers; for they were neither told their crime nor confronted with witnesses. When there was no shadow of proof against the accused person, he was discharged after suffering the most cruel tortures, a tedious and dreadful imprisonment, and the loss of the greatest part of his effects. When he was convicted and condemned, he was led in procession with other unfortunate victims on the festival of the "Auto da fé" (Act of Faith) to the place of execution. He was there clothed with a garment painted with flames, and with his own figure surrounded with those of dogs, serpents, and devils, all open-mouthed, as if ready to devour him. Let the reader for a moment imagine himself in this situation, at the mercy of these fiendish men, simply because he could not conscientiously confess his belief of their absurd doctrines; he will thus the better realize the position of these victims. Such of the prisoners as declared that they died in communion of the church of Rome were first strangled, and then burned to ashes. Those who died in any other faith were burned alive. The priests told them that they left them to the devil, who was standing at their elbow to receive their souls, and carry them with him into the flames of hell; as if there could possibly be any more real devil than these priests themselves, or any more real flames than those to which they subjected their victims. Flaming fuzees fastened to long poles were then thrust against their faces, until their faces were burned to a coal, which was said to be accomplished with the loudest acclamations of joy among the thousands of spectators. At last, fire was set to the furze at the bottom of the stake over which the criminals were chained so high, that the top of the flame seldom reached higher than the seat they sat on; so that they were roasted rather than burned. There could not be a more lamentable spectacle; the sufferers continually crying out while they were able: "Pity for the love of God" etc.; yet it is said to have been beheld by people of all sexes and ages, with transports of joy and satisfaction; and even the monarch, surrounded with his courtiers, has sometimes graced the scene with his presence, imagining in his wicked ignorance that he was performing an act highly acceptable to God. * And yet there are amongst us Protestants, calling themselves "High Churchmen" and what not else, who are really Papists and Jesuits except in name. How long before the cause of truth and humanity is asserted? How long before the preachers of deceit and falsehood are left to starve, to preach to the walls or to the winds? And what were the crimes for which those dreadful inquisitorial punishments were inflicted? Perhaps nothing more than reading a book which had been condemned as heretical by the holy office; assuming the title of a freemason; irritating a priest, or mendicant friar; uttering the language of a free thinker; declaiming against the celibacy of the clergy; insinuating hints or suspicions respecting their amours or debaucheries; or throwing out a joke to the dishonor of the Virgin Mary or, at most, holding the sentiments of a Mahometan, or a Jew, or of the followers of Luther or Calvin.

In the year 1725, the inquisitors discovered a family of Moors at Granada in Spain, peaceably employed in manufacturing silks, and possessing superior skill in the exercise of this profession. The ancient laws supposed to have fallen into disuse were enforced in all their rigor, and the wretched family was burned alive. †

On the entry of the French into Toledo during the peninsular war, Gen. Lasalle visited the place of the Inquisition. The great number of instruments of torture, especially those for stretching the limbs, and the drop-baths which cause a lingering death, excited horror even in the minds of soldiers, hardened in the field of battle. One of these instruments, singular in its kind for refined torture, and disgraceful to humanity and the name of religion, deserves particular description. In a subterraneous vault adjoining the audience chamber stood in a recess in the wall a wooden statue made by the hands of monks, representing the Virgin Mary. A gilded glory beamed round her head, and she held a standard in her right hand. Notwithstanding the ample folds of the silk garments that fell from her shoulders on both sides, it appears that she wore a breastplate, and upon a close examination it was found that the whole surface of the body was covered with extremely sharp nails, and small daggers or blades of knives, with the points projecting outwards. The arms and hands had joints and their motions were directed by machinery, placed behind the partition. One of the servants of the Inquisition was ordered to make the machinery maneuvre. As the statue extended its arms and gradually drew them back, as if she would affectionately embrace and press some one

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* Bourgoing's Modern State of Spain. Enc. Brit. Art. Inquisition.

† Id.

to her heart, the well-filled knapsack of a Polish grenadier supplied for this time the place of the poor victim. The statue pressed it closer and closer; and when the director of the machinery made it open its arms and return to its first position, the knapsack was found pierced two or three inches deep, and remained hanging on the nails and daggers of the murderous instrument.

This infamous tribunal of the Inquisition is said, between the years 1481 and 1759, to have caused 34,658 human beings to be burned alive; and between 1481 and 1808 to have sentenced 288,214 to * the galleys or to perpetual imprisonment. In the Auto of Toledo in February 1501, sixty-seven women were delivered over to the flames for Jewish practices. This tribunal was exceedingly severe in its action against the Jews, who suffered in great numbers, and, as the heretics, they were condemned for very slight offences. A priest, who did not put up for being a zealot, wrote thus of the Jews: "This accursed race were either unwilling to bring their children to be baptised, or if they did they washed away the stain on returning home. They dressed their stews and other dishes with oil instead of lard; abstained from pork; kept the Passover; ate meat in Lent; and sent oil to replenish the lamps of their synagogues, with many other abominable ceremonies of their religion. They entertained no respect for monastic life; and frequently profaned the sanctify of religious houses by the violation or seduction of their inmates. They were an exceedingly politic and ambitious people, engrossing the most lucrative municipal offices, and prepared to gain their livelihood by traffic, in which they made exorbitant gains, rather than by manual labor or mechanical arts. They considered themselves in the hands of the Egyptians, whom it was a merit to deceive and pilfer. By their wicked contrivances they amassed great wealth, and thus were often able to ally themselves by marriage with noble Christian families." The Inquisition entertained accusations against high and low, both Jews and Christians, upon pretexts the most frivolus as well as grave; and condemned by punishments, varying from death by fire to simple penance, delinquents who could not say they believed what to their mind was a lie. It accepted evidence, which even in its own day would not have been admitted in a civil Court of law; and the pretexts upon which condemnation frequently proceeded were such as to make them marvellous even in a barbaric age. Tortures of the most exquisite and excruciating kind were practised on the accused to make them confess or to induce them to accuse others; and the hateful system of espionage and secret prison-houses were adopted by the Inquisition at every place where its courts were established. The evidence on

* Histoire Abrégée de l'Inquisition.

which Jews were condemned would be simply ludicrous had it not been so terrible in its effects. An author of high standing remarks on this subject. "It was considered good evidence of the fact, i. e., Judaism, if the prisoner wore better clothes, or cleaner linen on the Jewish Sabbath than on the other days of the week; if he had no fire in his house the preceding evening; if he sat at table with Jews, or ate the flesh of certain animals, or drank a certain beverage held much in estimation by them; if he washed a corpse in warm water, or when one was dying turned one's face to the wall; or, finally, if he gave Hebrew names to his children, a provision most whimsically cruel, since, by a law of Henry II, he was prevented under severe penalties, from giving them Christian names." Such testimony being accepted the number of the condemned must, of course, be legion; and in the interval between the beginning of January and the beginning of November, 1481, the first year in which the Inquisition was put into terribly active force, in Spain, there had perished by fire in Seville no less than 298 persons. Notwithstanding the plague which in this year visited Seville, sweeping off 15,000 of the inhabitants, the Inquisition still continued its fiendish work; so that by the end of the year, or up to the ensuing first of January, 2000 persons, many of them the most learned and respectable of the day, had perished at the stake in the province of Audalusia. Twice that number having managed to escape were burned in effigy, and 17,000 were condemned to lesser punishments; of which the least must have been a terrible infliction. Some few years after this when one Deza came into power as Inquisitor-General in Spain, in the first eight years he presided at Seville, he caused 2,592 persons to be burned alive, to say nothing about 35,000 condemned to various other punishments, short of death, but illustrating that the tender mercies of the wicked are cruel. When the Reformation began to be proclaimed the work of the inquisitors increased and several hundreds of persons were annually burned alive in various parts of Spain, as the consequence. But not only in Spain did the Inquisition carry on its work so devilishly: in her colonies, especially in South America and Mexico, the cruel office was set up, and the Indians who escaped the cruelties of the colonists as civil governors, experienced the rigorous punishment of them as religionists, and destroyed themselves in large numbers rather than fall into their hands. It is wonderful that there was no actual rebellion against the Inquisition in Spain which continued for three centuries doing its terrible work of human destruction. Yet there was no uprising against it. Men hated but feared a tribunal, whose spies were all around, even in the bosom of the family, and which dealt its blows so secretly and suddenly, and with such awful effects. Nine hundred females were burned alive in the Dutchy of Lorraine in France for being witches, by one inquisitor. Under this accusation it is said that upward of 30,000 women have perished by the hands of the inquisitors*.

Torquemada, that infernal arch-inquisitor of Spain, brought into the Inquisition, in the space of fourteen years, no less than 80,000 persons, of whom 6,000 were condemned to the flames and burned alive with the greatest pomp and exultation; and of that vast number there was not, perhaps, a single person who was not more pure in religion and morals than their fiendish persecutors.†

Does the Deity, then, whom the Inquisition professes to serve, take such intense delight in the sufferings of human beings? Has that Being, whose sun cheers the habitations of the wicked as well as the good, commanded such blood-thirsty monsters to act as his ministers of vengeance, to torment and destroy his rational creatures? Does the doctrine of the Gospel, which they profess to believe, inculcate such practices? The very thought is absurd and blasphemous. If they would do as God requires of them, to do good and be good, live godly lives, no such institution as the Inquisition would ever exist, nor any other evil work. But it is men themselves, of their own free will, who inflict these sufferings upon their fellows. Man is the author, the agent, as he is the object of the cruelty. But some, perhaps, will suppose that *the devil* hardens man's heart, and prompts him to the perpetration of such infamous crimes as that of roasting his fellow-man over a slow fire. Well, that is a very true supposition in a certain sense. But who or what is the devil? Why, he is the man himself, who acts according to his own will and practices such unspeakable wickednesses. Yes, my readers, man himself is that evil being, by whatever name he may be called; of which fact you have partial evidence in the foregoing statements. Can anything be conceived of, as more intensely evil than a human being who will seize and subject his fellow-human beings to such unspeakable tortures as those peculiar to the Inquisition, and then roast them to death over slow fires, as we see these men to have done? The foregoing statements are of facts which we may believe to have occurred, just as if we were eye-witnesses of every one of them. The blood of these tens of thousands who have been so cruelly and mercilessly sacrificed, cries unto us from the ground, to tamper no longer with hypocrisy and deceit, to lay aside that old theory of a devil, or any Being leading men to do evil, other than themselves, and to make men stand on their own basis, and account them responsible for their conduct and acts. In a preceding part of this book we have shown that not only the earth on which we live is a concentration of spirit, but that man also is a spirit, and, behold, here we perceive in him the spirit of evil

* Inquisition Unmasked.

† Kaime's Sketches.

developed, we may say, to almost an infinite extent. The existence of cruelty in men evidences that the perpetrators of it are ignorant of the true God. They have no true knowledge of him, for if they had they would not be cruel. God is manifested in a human being patiently enduring for the truth, and for righteousness' sake amid all opposition from adverse influences, visible and invisible. And the devil is manifested in him who inflicts suffering undeservedly or wantonly upon the true and righteous man, or upon any human being. In short words God is manifested in the life and conversation of the truly good and righteous man; and the devil is manifested in the life and conversation of the evil and actively wicked man. And thus we have found a proper application for the term God, which means he that is good; and also of the term devil, which means he that is evil: and hence it is seen that the term Deity includes both of these, and infinitely more in its fullest extent, and as we have used it in the beginning of this book. In the New Testament the apostle John, in his 1st Epistle, says that "God is love"; and in the same Epistle, as well as in his 2nd, that "love is the keeping of the commandments"; and in another place of the New Testament it is said that "love is the fulfilling of the law"; therefore it is quite evident that God is manifested in the human being that keeps the commandments, or fulfils the law, which means the same thing; that is, in the man who truly is and does good, lives a life of godliness. But in the case before us, as we have said, man is the sufferer, and man inflicts the suffering. Man is the author and agent as well as the object of the suffering. When a man commits an offence against the laws of his country, the law looks to the man himself for satisfaction for it. It looks not after an imaginary being, of whatever name, for all that is of an imaginary being is the name it looks after; the real being, the direct perpetrator of the crime. The individual has committed an offence against mankind, and the latter looks to the individual himself for atonement for it. He would not be listened to, if, when brought before the judge, he sought to justify himself by leaving the blame of his crime upon an imaginary being. Even so there is no necessity any longer of men blaming any other being than themselves for the evil they commit. The life of godliness implies a denial of pride and of self; and here we repeat the true God is manifested in the character and conduct of the man who, in his daily walk and conversation, during his life-long, evinces self-denial, long-suffering, and humility, and gentleness, meekness, truth and righteousness, who, in short, cultivates and displays all the true Christian graces, subjectively and objectively. Men can be good if they will. They can also be evil if they will. Will men not henceforth universally choose to be good? How amiable the character of the man or woman who displays the spirit of charity and benevolence to all around, and to all mankind! And many, many such we have in the world in our time. But how unlovely the character of one who displays the spirit of hatred and malignity to one's fellow-human beings to the extent we have seen it displayed in the case of the inquisitors, or to a far less extent! The Deity is everywhere present, and though unseen, his character, as indicated by the beneficent operations of nature around us, and by the testimony of good men of the past, condemns the hellish practices of the infamous agents of the Romish superstition, whose character we have been reviewing.

The horrid practice of dragooning, which was used by the Romish church for converting supposed heretics, was another melancholy example of religious cruelties and fanaticism. In the reign of Louis XIV of France, his troops, soldiers, and dragoons, entered into the houses of the Protestants, where they marred and defaced their furniture, broke their looking-glasses; let their wines run about their cellars, threw about and trampled under foot their stock of provisions, turned their dining-rooms into stables for their horses, and treated the proprietors with the severest contumely and cruelty. They bound to posts mothers that gave suck, and allowed their sucking infants to lie languishing in their sight for several days and nights, crying, and gasping for life. Some they bound before a great fire, and after they were half roasted let them go. Some they hung up by the hair and some by the feet in chimneys; smoked them with wisps of hay until they were suffocated. Women and maids were hung up by their feet and by their armpits, and exposed stark-naked to public view. Some they cut and slashed with knives, and, after stripping them naked, stuck their bodies with pins and needles from head to foot, and with red hot pincers took hold of them by the nose and other parts of the body, and dragged them about the room until they made them promise to be Catholics, or until the cries of the wretched victims, calling upon God for help, induced them to let them go. If any endeavoured to escape from those cruelties they pursued them into the fields and woods, where they shot at them as if they were wild beasts; and they prohibited them from leaving the kingdom on pain of the galleys, the lash, and perpetual imprisonment. On such scenes of desolation and horror the Romish clergy feasted their eyes, and made them a matter only of laughter and sport.* What fiendish crimes for those calling themselves civilized to perpetrate! Could an American savage or a new Zealander have devised more barbarous and exquisite cruelties.

In the island of Great Britain the flames of persecution have sometimes raged with unrelenting fury. During the last two or three years of the short reign of Queen Mary, it is computed that 277 persons were committed to the flames, besides those who were punished by fines, confiscations, imprisonments, or otherwise. Among those who suffered by fire

* Enc. Brit. Art. Dragooning.

there were five bishops, twenty-one clergymen, eight lay-gentlemen, and eighty-four tradesmen; one hundred husbandmen, fifty-nine women, and four children. Hunter, a young man of about nineteen years of age, was one of the unhappy victims of the zeal of Queen Mary for Popery. Having been inadvertently betrayed by a priest to deny the doctrine of transubstantion he absconded to keep out of harm's way. Bonner, that notorious popish executioner, threatened ruin to the father if he did not deliver up the son. Young Hunter, hearing of his father's imminent peril, presented himself, and was burned to death instead of being rewarded for his filial piety. A woman of the island of Guernsey was brought to the flames without regard to her advanced pregnancy, and she was delivered of a child in the midst of the flames. One of the guards snatched the infant from the flames to save it, but the magistrate who superintended the execution ordered it to be thrown back, being resolved, he said, that nothing should survive which sprung from a parent so obstinately heretical.* The Protestant reformers also did somewhat in the work of persecuting and burning those who opposed their tenets; but their doings we shall have necessarily to advert to in the latter part of this book.

When we consider on the one hand the purity of faith and morals which generally distinguished the victims of persecution; and on the other, the proud pampered priests, and prelates, abandoned without shame to every species of wickedness, we can scarcely find words sufficiently strong to express the indignation and horror which arise in the mind when it views the striking contrast, and contemplates such scenes of impiety and crime. Could a religion which breathes peace and good will to men be more basely misrepresented; or do the annals of the human race present a more stricking display of the perversity and moral badness of mankind than we have in the case of the Catholic hierarchy? To represent religion as consisting in the belief of certain incomprehensible dogmas, and then to undertake to compel men to believe these dogmas, which they could not possibly understand, and to inspire them to benevolence by racks and tortures and fire, is as absurd as it is impious and profane, and represents the Deity as delighting in the torment and death, rather than willing the life and salvation, of his creatures.

Wherever religion is viewed as consisting chiefly in the observance of a number of absurd and unmeaning ceremonies, it is to be expected that the pure morality inculcated in the New Testament, and in the Ten Commandments, will seldom be exemplified in human conduct. This is strikingly the case in those countries, both of the Eastern and Western world, where the Catholic religion, both Greek and Romish, reigns supreme. Mr. Howison, in his " Foreign Scenes," when speaking of the priesthood in

* Kaime's Sketches.

the island of Cuba, says: "The number of priests in Havana exceeds four hundred. With a few exceptions they neither deserve nor enjoy the respect of the community. However, no one dares openly to speak against them. In Havana the church is nearly omnipotent and every one feels himself under its immediate jurisdiction. Most persons, therefore, attend mass regularly, make confessions, uncover when passing a religious establishment of any kind, and stand still on the streets or stop their volantos, the moment the vesper bell begins ringing. But they go no farther, and the priests do not seem at all anxious that the practice of such individuals should correspond to their profession. The priests show by their external appearance that they do not practice these austerities, which are generally believed to be necessary concomitants of a monastic life. The sensual and unmeaning countenances that encircle the altars of the churches, and the levity and indifference with which the most sacred parts of the service are hurried through, would shock and surprise a Protestant were he to attend mass with the expectation of finding the monks those solemn and awe-inspiring persons which people who have never visited Catholic countries often imagine them to be." This account of Mr. Howison we know to correspond with fact; for we have had a like account from a person who had resided in Cuba for some time. Of the city of Montreal in Canada the Roman Catholics number much the largest part of the population. The Church of Rome flourishes there, and its worship is carried out with great pomp and ceremony. We were present there one Sunday of late, June 11th 1871, when the Feast of *Corpus Christi* was celebrated with great eclat. A grand procession took place, which when moving extended nearly a mile and a half in length. There were the various orders of the nuns, the Gray, Black nuns, etc; and of the clergy, Friars or Monks, each having (as we suppose) its appropriate place in the ranks. Here and there at intervals in the long procession were schools of boys dressed neatly in black or gray suits, and schools of girls dressed in white with white, flowing veils. Some of these boys and girls, we learned, were wards of the church, attending school in the convents; and they appeared intelligent and cheerful. Here and there were societies of men, who, as we were informed, belonged to the Temperance and other orders, and of women who did not appear to belong to any particular order, but were out displaying their zeal for the church. At the head of each column or order was borne a silken flag variously figured, each flag having inscribed upon it the motto of the order, mostly in French or Latin. At intervals they were chanting lustily the hymns of the occasion to time kept by some of the priests; and they sung in French or Latin. The sidewalks along the line of march and the avenues leading to it, as well as the windows and balconies, were crowded with spectators. When the canopy approached under which was borne the Corpus Christi, and accompanying which the Bishop and other clerical dignitaries were supposed to be, arrayed in their gorgeous robes of office, the Catholics on both sides of the line of march uncovered their heads, and knelt down on the sidewalk or on the side of the street, or wherever they happened to be, until the canopy had passed. This operation of uncovering and kneeling was repeated at every point of the way along which the procession moved. It seems, indeed, strange that such absurd and gross idolatry should be practised in British America, in the latter part of the 19th century. The practice of the Romish clergy, who, giving their whole attention to the subject of religion, must know better things, of imposing thus upon an ignorant and credulous populace, appears, to say the least, immoral.

The following extract is from a modern writer on Italy: "When Vesuvius thunders aloud, or when an earthquake threatens them with destruction, when the fiery streams vomited from the rousing mouth of the volcano roll on, carrying desolation over the plain below, when the air is darkened by clouds of smoke and showers of ashes, the Neapolitans will fall on their knees, fast, do penance, and follow the procession barefooted; but as soon as the roar has ceased, and the flame has disappeared, and the atmosphere has recovered its wonted serenity, they return to their wonted mode of life, they sink again to their former level, and the tinkling sounds of the tumberella call them again to the lascivious dance of the tarentella." As an evidence of the litigious character of the Neapolitans, the same author remarks: "That there is scarcely a landholder but has two or three cases pending before the courts; that a lawyer and a suit are indispensable appendages of property; and that some of the principal families have suits that have been carried on for a century; and for which a certain sum is yearly appropriated, although the business never advances; and at last the expenses swallow up the whole capital." The infinite number of churches," says another late writer, "is one of the most efficient causes of the decline of the religion of Rome, whose maxims and practices are diametrically opposite to those of the Gospel. The Gospel is the friend of the people, the consoler of the poor. The religion of Rome, on the contrary, considers all nations as great flocks, made to be shorn or eaten according to the good pleasure of the shepherd; for her the golden lever is the lever of Archimedes. The favors of the Church are only showered on those who pay; with money we may purchase the right to commit perjury and murder, and be the greatest villain at so much per crime, according to the famous tariff printed at Rome, entitled "Taxes of the Apostolic Chancery." In a conversation which Bonaparte had with his friends at St. Helena, on the subject of religion, as related by Las Casas, in his journal, the Emperor said, among many other things: "How is it possible that conviction can find its way to our hearts, when we hear the absurd language, and witness the acts of iniquity of the greatest number of those whose business it is to preach to us? I am surrounded with priests who preach incessantly that their reign is not of this world, and yet they lay hands on all they can get. The Pope is the head of that religion from heaven, and he thinks only of this world, etc. The Emperor ended the conversation by desiring my son to bring him a New Testament, and taking it from the beginning he read as far as the conclusion of the speech of Jesus on the mountain. He expressed himself with the highest admiration at the purity, the sublimity, the beauty of the morality it contained, and we all experienced the same feeling." Had Napoleon, in his youth, taken that which he now heard read as the rule of his life, and lived according to it, what an amount of human suffering and destruction, which he caused, might have been spared, and how much a happier man he would have lived and died himself! Such facts as these we have adduced may give some idea of what the state of morality is in all Catholic countries, and what may be the height of civilization to which they have attained.

Now, if we take a cursory glance at the Protestant branch of the Catholic Church, we shall observe a similar spirit in operation in it, as we have seen prevailed in the early Church under the Christian Roman emperors. The Church was at that time split up into a number of sects, each distinguished from the other by its peculiar tenets. Protestant Christians are also divided into a great number of sects, each distinguished from the other by its peculiar tenets and opinions as to mode of worship, Church government, etc. The differences between these sects which, in time past, were wide, are now becoming much narrower. All these sects profess to believe the orthodox Catholic creeds, such as the Apostles' Creed, the Nicene Creed, and, some of them, the Athanasian Creed; and the two orthodox sacraments of Baptism and the Lord's Supper; but their belief in these creeds, etc., are very general, and they all differ from each other in many particulars.

The Protestant Church has been distinguished to a considerable extent by the spirit of persecution which raged with such unmitigating violence in the Romish Church. The Reformation had scarcely been begun in Germany and England, when a series of persecutions were begun against dissenters from the doctrines of the reformers; and it is of late that these persecutions have ceased. Luther and Calvin did their part in this work in the continental countries of Europe and notwithstanding the unjust and cruel punishments which English Protestants endured at the hands of Popish priests and princes, a short time only elapsed after they had themselves risen to power before they began in their turn to harrass their dissenting brethren with vexations, and persecutions, and fines, and imprisonments, until many of them were compelled to seek a dwelling place in a distant land. And shortly after the English independents had established themselves in America, they, in turn, set on foot a persecution against the Quakers no less furious than that to which they had themselves been subjected in the country from which they had fled. They apprehended and imprisoned a number of those peaceably disposed and worthy persons, and seized upon the books they had brought out from England with them, and burned them. By a law which had been enacted against heretics in general, sentence of banishment was pronounced against them all; and another law punished with death all Quakers who should return into the jurisdiction after banishment; and it is a fact that four persons suffered death under this impolitic and unjust law.*

Nor did the reformed clergy in Scotland lose sight of that magisterial bearing, which was assumed by the Romish Clergy. Upon a representation in 1646 from the commission of the Church of Scotland, James Bell and Colin Campbell, bailiffs of Glasgow, were committed to prison by the Parliament, merely for having said that "kirkmen meddled too much in civil matters," † And even so late as the middle of the last century, when Whitefield, Wesley and other earnest and pious men began to address the ignorant villagers of England upon the important subject of religion "a multitude has rushed together, shouting and howling, raving and cursing," and accompanying their ferocious cries and yells with loathsome or dangerous missiles, dragging or driving the preacher from his humble stand, forcing him and those who wished to hear him to run for their lives, sometimes not without serious injury before they could escape. And these barbarous tumults have in many cases been well known to be instigated by persons, whose advantages of superior condition in life, or express vocation as instructors of the people, has been infamously lent in defence of the perpetrators, against shame or remorse or legal punishment for the outrage. And there would be no exaggeration in affirming that since Wesley and Whitefield began to conflict with the heathenism of that country, there have been in it hundreds of instances answering to this description. Yet the well-meaning and zealous men, who were thus set upon by a furious rabble of many hundreds, the foremost of whom acting in direct violence, and the rest venting their savage delight in a hideous blending of ribaldry, and execration, of jibing and cursing, were taxed with a canting hypocrisy or a fanatical madness, for speaking of the prevailing ignorance in terms suitable to the state of the case.

But we need not go back over half a century in order to find instances of religious intolerance among the Protestant communities and churches; our own times unhappily furnish examples of an intolerant and persecuting

* Morse's American Geography.

† Kaime's sketches.

spirit, though we are happy to be able to say that this spirit is fast disappearing among Protestants. About fifty years have elapsed since the methodist chapel in Barbadoes was thrown down, and demolished by the "mob-gentry," and with the connivance of the public authorities of that island; and Mr. Shrewsbury, a worthy missionary at that station, was obliged to flee for his life. Previous to this outrage he suffered insult, contumely, and reproach. He was abused as a villain, and hissed at on the streets, not by the mere rabble, but by the great vulgar, by merchants from their stores, and individuals in the garb of gentlemen. By such characters his chapel was surrounded and partly filled on Sunday, during the hours of worship. Their glass bottles had been previously prepared and filled with a mixture of oil and asafœtida, and all on a sudden they were thrown with great violence among the people, and one was aimed at the head of the preacher; and during the whole time of worship, stones were rattling against the chapel from every quarter. On the next sabbath an immense concourse of people assembled, breathings out theatenings and slaughter, and from twenty to thirty of the gentlemen mob planted themselves around the pulpit, apparently ready to perpetrate any mischief. Men wearing masks, and having swords and pistols, came galloping down the street, and presenting their pistols fired them at the door; and it was originally designed to have fire-crackers among the females, to set their clothes on fire. At length on an ensuing sabbath this execrable mob, consisting of nearly two hundred gentlemen and others, again assembled with saws and hammers, axes, crowbar[illegible] and every other instrument necessary to execute their infamous purpo[illegible], and in the course of a few hours, the lamps, benches, pews, pulpit, and even the walls, were completely demolished. They entered the dwelling-house of the preacher, broke the windows and doors, threw out the crockery-ware, chopped up the tables, chairs, and every article of furniture; tore the preacher's manuscripts and destroyed his library of more than three hundred volumes. All this was done under the light of the full moon, in the presence of an immense crowd of spectators, without the least attempt being made either by the civil or military authorities to check them, while the unfortunate preacher with his wife in an advanced state of pregnancy had to flee to a neighbouring island to save his life! Such is the civilized and humane conduct of gentlemen of the 19th Century, gentlemen who would no doubt consider it very unhandsome were they compared to the Vandals or Tartars or to the rude and barbarous savages of Caffraria or New-Zealand. How utterly abominable is the pride, hypocrisy, and deceit of the human heart exhibiting itself in such disgraceful and wicked proceedings! And such emissaries, often weak-minded and giddy-headed, in common parlance having no mind of their

Report of the Wesleyan Missionary Society for 1824, Debates in Parliament 1825.

own, are sometimes set on to their barbarous work, perhaps, by the sneering suggestion of others who are not so easy to be discovered, and who if they are suspected and questioned about it, will not only pretend their total ignorance of it, but express their sympathy with the sufferer, although they are themselves the real and prime causes of the whole barbarity. Several instances of this kind have come under our own observation, one of which we shall relate. In the college which we were attending, we had a worthy man for our president, a man, we had reason to believe, of a good christian temper, and of a sound missionary spirit. He was accustomed to teach certain branches of knowledge, and had a recitation room, as the professors, set apart for the purpose of teaching in. Into this recitation room, situated on the second story, and containing benches, chairs, fire apparatus, tables, books, etc., there was brought one night a full-grown cow; and what must one think was the surprise of the president on his coming next morning to meet his class, at finding such a tenant occupying his recitation room, which last, indeed, was in an exceedingly disordered and filthy state! Some of the giddy-brained students who were discovered to have done this disgraceful deed suffered such penalties as the president and faculty thought proper to impose; but any careful observer who was present and knew the circumstances of the president in relation to some other influentials, would at once perceive that those who performed the wrongful transaction were not the prime causes of it, but were incited to it by perhaps the sneering suggestion or remark of another, who, were he earnestly asked about it afterwards, would promptly disclaim all knowledge or intention on his part concerning it before it happened, and would most likely pretend the deepest sympathy with the sufferer. Such is the deceit of the human heart; and such are the devious ways of the old serpent. This worthy man was soon afterwards made a bishop, which office he holds now.

About the same time of that transaction which we have related as taking place in regard to the Methodist church at Barbadoes, the authorities of Demerara set on foot a persecution against Mr. Smith, a missionary from the London Society, under various pretexts; but his real crime in the eyes of his persecutors was his unwearied zeal in instructing the negroes in the knowledge of religion. He was condemned to death by a court-martial, in opposition to every principle of justice. He died in prison, was refused the privilege of Christian burial, and his friends were prohibited from erecting a stone to mark the spot where his body was laid. The whole details of this transaction present a scene of savage barbarity, scarcely to be surpassed in the history of Europe. The death of this missionary was that event which prepared for the overthrow of the slave system in the British West Indies. It called forth one of Lord Brougham's noblest speeches, and stirred the heart and conscience of the

English people. The blood of the martyrs is sometimes the seed of freedom as it is of the church; and the execution of John Brown, in Virginia, corresponded in its effects to the murder of this worthy missionary in the West Indies.*

In Switzerland, where formerly Protestantism had its stronghold, the demon of religious persecution has, even in the 19th century, raised its head. The council of state of the Pays de Vaud, at the instigation of the clergy, on January 15th, 1825, published a decree "prohibiting under the penalty of severe fines and imprisonments, all meetings for religious worship or instruction, other than those of the established church." And in the following May another decree was issued, which denounced "fines, imprisonment, or banishment, upon the most private kind of religious assembly, or even the admission of a single visitor to family worship." In pursuance of these disgraceful laws several ministers and private Christians of high character for piety and learning were banished from the Canton, some for one, and some for two years, cut off from all means of subsistence, unless possessed of independent fortunes, or able to procure it by labor, and some of them perhaps left to starve and perish in foreign lands. If they returned before the expiration of their sentence, death was the penalty to be inflicted. One poor man, a schoolmaster, in the principality of Neufchatel, was condemned to ten years' banishment. He was brought out from prison, tied with cords, and compelled to kneel in the snow in the public square to hear his sentence read. His crime was that of gathering together a few fellow-Christians in his own house, to whom the Lord's Supper was there administered by a clergyman.

Nor has England been free from the spirit of persecution and intolerance in the 19th century. At Kenneridge, in Dorsetshire, a worthy and excellent individual belonging to the Wesleyan denomination had attended on a green where twenty or thirty persons were accustomed to congregate on Sunday afternoons to listen to the truths he thought it important to declare. The English church clergyman of the parish approached with a retinue of servants and commanded him to desist. The preacher took no heed to the command and proceeded to read his text. The clergyman then commanded the tithing man to seize him, (which he had the power to do as a civil magistrate, for the clergymen of the church of England very commonly fill the office of justice of the peace as well as that of a priest). He was directed to be conveyed to Wareham jail; and to every question the preacher put as to the ground of his being arrested, the reverend and worthy clergyman only replied by brandishing his walking-stick. Instances have occurred in which clergymen of this establishment have refused to

* Report of the Wesleyan Missionary Society, for 1824. Debates in Parliament 1825.

* Cong. Magazine, June 1825.

bury the dead. At Childs Ercal, in Shropshire, the child of a poor man was refused interment, and the father was obliged to carry it six miles before he could inter it in a cemetery. At Catsfield, in Sussex, a similar infamous act was committed. At the moment the bell had tolled, when the earth was about to fall upon the coffin, and when the relations standing by wanted all the consolation which religion can afford, at this moment the clergyman appeared, but advanced only to give pain to the mourners, and to agonize their heart by saying: "Now that you have waited an hour until it suited me to come I will not inter your child! I did not know that you were dissenters; take your child somewhere else, take it where you please, but here it shall not lie in consecrated ground." Just as if all places on the surface of the earth were not equally consecrated; or, as if a cemetery or church-yard was a better and holier place to inter a dead body than any other place a person might choose. It is certain that a cemetery or church yard, in the common acceptation of the term, has no superior sanctity over any other spot of ground; its superiority in this respect is merely imaginary, delusive, and arises to the mind from the custom of mankind in all the ages of history being to bury their dead in certain places set apart for that purpose. In America, where many of the old superstitious notions have been given up, people very commonly, especially in New England, have each family their own burying ground on their own farm. This is as good a plan to follow as any other a person may choose with respect to the place of burial of the dead. This English family, however, to which we have just alluded, were not allowed to bury their child in the church-yard, and had to carry it eleven miles from the abode of its parents before they consigned it to its kindred dust in what they considered consecrated ground.

At Mevagissey, in Cornwall, the rector refused to allow the corpse of a dissenter to be brought within the church, and, therefore, read the burial service in the open air. At Wellingborough a clergyman, in opposition to a custom which had been practiced for sixty years, issued orders that no bell should toll when a dissenter expired. He boldly avowed "that he would never allow the passing bell to be tolled for a marriage when the parties were dissenters." In reference to this case an appeal was made to the bishop of Peterborough, who wrote a long letter on the subject, in which he defended the conduct of this Wellingborough rector. At Newport Pagnel two persons of decent appearance, teachers of Baptist societies, were collecting subscriptions for the erection of a new place of worship. After arriving at the residence of the parish clergyman they were taken before a clerical magistrate, who upon the evidence which the other clergyman offered, that they were rogues and vagrants, committed them to Aylesbury jail, where they were confined for three weeks, in common with the basest felons, among convicted thieves of the most abandoned character; nay, more, they were sentenced to the tread-mill, and kept at hard labor there, though during the whole time of their incarceration one of them was afflicted with spitting of blood. Their papers were seized upon, their money was taken from them, and by means of it the expence of sending them to prison was defrayed.

Since the time to which these instances refer the "Society for the Protection of Religious Liberty," has been formed, and has brought forth to public view many similar instances, some of them of a more barbarous nature. And were it not for the protection which this society affords to the victims of religious intolerance it is highly propable that vexation, persecutions, insults, fines and imprisonments on account of differences in religion would now be much more common than they are in England. Were such individuals as those to whom we have alluded permitted by the law to carry their intolerant spirit to its utmost extent, dissenters would have no security either for their lives or their property, and the fires of Smithfield might again be kindled to consume the bodies of all who refused to conform to the dogmas of a national church.

The main history of the Protestant churches since the reformation, in which there is much of a persecuting spirit displayed, we have purposely left untouched in this review. There are certain subjects we have to deal with in the latter part of this book, which will require these historical facts to which we now allude to illustrate them. By the time, therefore, the reader has advanced that far he will be able to learn much more as to the moral character of the reformed churches as represented in history. It would have given us pleasure in our review thus far to have been able to present before the eye of the reader a more cheerful picture of the moral character of the civilized nations, and of the Christian church; but facts are stubborn things, and there is no resisting the force of the evidence which they adduce. We intend, however, to relieve some of the dark shades of this picture by exhibiting some faint radiations of truth and benevolence, which appear amid the surrounding gloom. The dawn of a brighter day has appeared to gild our horizon. The Pope's temporal power has been taken from him, and his spiritual power and influence will continually henceforward wane, to be consumed and destroyed gradually until its end. Some of the Protestant establishments also are falling, that of the Irish church having completely given way. Substantial knowledge is being more generally diffused among all classes of the people; the shackles of despotism are bursting asunder; the darkness of superstition is gradually dispelling; the spirit of persecution is borne down by the force of truth and of common sense; and the rights of conscience are being more generally recognized. Philanthropic institutions of various descriptions have been established; missionary societies are extending their labors to almost every land; and now the far-off continents are to some extent coming under the influence of Christian civilization.

The light of science now shines with a greater lustre than at any previous period of which history informs us. The Telescope has opened up to us distant scenes of the universe, and has enabled us to calculate the distance, character, and motions of the moon and planets. The Microscope has introduced us to the invisible worlds of matter far beyond the ken of the unassisted eye. The electric Telegraph enables us to communicate momentarily with all parts of the earth. The Magnetic needle directs our course around the globe or to any point beyond the seas. The power of steam has been greatly developed to the use and convenience of mankind. The progress of invention has tended greatly to abridge human labor. Agriculture is practised more skilfully and advantageously than in former times. The arts, both useful and ornamental, are extensively cultivated. The use of the art of printing puts substantial knowledge within the reach of all, even the poorest. Literature and practical science are the order of the day in our schools and academies, and the youth of a dozen of years, whose time has been well employed in study, possesses more definite science at his command than the aged man of five centuries ago. But here the question arises: is it possible, judging from what we know of the past history of mankind, to bring the inhabitants of this world to a general observance of the laws of benevolence, which is the true index of high moral character and civilization? To such a question, we have answered frequently before that man has it in his power to cultivate the spirit of benevolence or of malevolence, either of which he chooses; but in this connection we answer it thus; that *whatever man has accomplished man may accomplish.* Amidst the darkness, depravity, and wickedness with which the earth has been generally enveloped individuals have occasionally arisen who have shone as lights in the moral world, and exhibited bright patterns of true christian temper and of active benevolence. The founders of the Christian faith appear to have belonged to this class. The Apostle Paul had his mind imbued with a large portion of the spirit of philanthropy. He voluntarily undertook a tour of benevolence to the nations, and notwithstanding the persecutions, the reproaches, the stripes and imprisonments which he encountered; and notwithstanding the perils in the waters, perils of robbers, perils by his own countrymen, perils in the city and perils in the wilderness to which he was subjected; and in the face of death itself, he prosecuted with a noble heroism, his labor of love, purely for the sake of promoting the best interests of mankind. All who at the same time engaged in the same benevolent undertaking sacrificed all private interest and selfish consideration in order to bring men to a belief of the doctrine which they had themselves espoused.

In modern times many individuals have arisen and distinguished themselves and reflected honor on their race by the benevolence which they displayed. The name of John Howard is familiar to every one who is at all acquainted with the annals of philanthropy. This excellent man devoted his time, his strength, his genius, his literary acquisitions, his fortune, and finally his life, to pursuits for the benefit of humanity and to the unwearied prosecution of active benevolence. He travelled over every country of Europe and into the adjacent regions of Asia, impelled by the spirit of true christian love in order to survey the mansions of sorrow and pain, and to devise schemes for the relief of human wretchedness wherever it existed. And in the execution of this scheme of benevolence the energies of his mind were so completely absorbed, that he never suffered himself for a moment to be diverted from his purpose even by the most attractive of those objects, namely, the pleasures of music, which formerly possessed all their most powerful influence upon his curiosity and taste. Also, Walter Venning, who has been denominated by Prince Galitzin the Second Howard, followed the course of his illustrious predecessor, and with the most fervent christian zeal devoted his short but very useful life to the alleviation of human misery, and to the promotion of the best interests of thousands of wretched individuals, who were all but lost. He withdrew from the ordinary routine of what is called genteel society in order that he might devote all the energies of his soul to benevolent occupations. He commenced his philanthropic career by cooperating in the organization of "the Society for the Improvement of Prison Discipline," which was founded in London in 1816; and he afterward visited the prisons in the cities of St. Petersbourg, Novgorod, Tver, Moscow, and other cities in Russia. The prisons, hospitals, workhouses, madhouses, houses of correction, and the abodes of misery of every description in St. Petersbourgh were visited by him day after day; and many a prisoner bowed down with affliction and iron was cheered, instructed, comforted, and served by his ministrations; for, it is said, that his philanthropy extended both to the bodies and souls of men. This truly benevolent person died in the city of St. Petersburgh in the year 1821, in the fortieth year of his age.

In our own day we have had a noble example of generosity and benevolence in George Peabody. An American by birth, having amassed a large fortune by the industries of trade and commerce in London, he liberally bestowed a goodly portion of it to provide shelter and comforts for the poor of that vast metropolis. In his native state he founded libraries for the instruction and enlightenment of the people, and his generous beneficence, and magnificent donations to worthy objects, ensure to him the respect of mankind in after ages. Men, who have any pecuniary legacy to bequeath to mankind, should, like George Peabody, always keep the *poor* and the *indigent* prominently in view. As the poet Homer, for the honor of whose birth-place, we are told by Cicero, several rival cities disputed, so this worthy man had the honor of his burial amicably disputed by two great nations, England and America.

Many other examples might be adduced from the history of our times, and illustrious characters now living, both men and women, to demonstrate that a noble and disinterested benevolence is a principle capable of being developed and exercised even in the present degenerate state of mankind. We find parents sometimes displaying a high degree of benevolence toward their children ; and sacrificing their ease and their personal interests in order to secure their health, their happiness, and their future good. We find bosom friends as David and Jonathan, and as Damon and Pythias, rejoicing in each other's welfare, and encountering difficulties and dangers in promoting the interests of the objects of their friendship. What then should hinder such dispositions from becoming universal ? What should hinder them from being cultivated and exercised by all rational beings ? Would not the universal exercise of such dispositions be highly desirable ? Would it not tend to banish war and discord from the world, and promote peace on the earth and good-will among men ? Why then are such dispositions so rarely to be met with ? Not because the universal exercise of them is a thing impossible, but because men, actuated by pride and selfishness, are unwilling to give full scope to the cultivation and exercise of the benevolent affections ; because they have never yet persisted in their endeavour to bring all these into full operation. If all the energies of the intellect, and all the treasures which have been expended in fostering malignant passions, and in promoting contentions and warfare, had been devoted to the great object of cultivating and exercising the principle of benevolence, and distributing happiness among men, the moral, yes, and natural, aspect of our globe would long ago have assumed a very different appearance from what it now presents to view.

We have examples before us not only of a few insulated individuals, but of societies where the principle of active benevolence to a greater or less degree pervades the whole mass. The people denominated Quakers have always been distinguished for their humane and peaceable dispositions, their probity and hospitality toward each other, their unostentatious liberality to indigent and suffering humanity, the modest cheerfulness of their manners, their opposition to war, and the active zeal they have displayed in promoting the moral welfare of mankind. We give the following extract from a daily paper of February 25th, 1872: "M. Drouyn de Lhuys, in his capacity as President of the French Société des Agriculteur, has written a letter which sets forth the help given to France by the English Quakers during the war. Those generous people have bestowed in the most unostentatious way aid to the extent of four millions of francs in the period named. The sum has been proved by regular accounts written by M. de Lhuys, kept with the exactitude of a commercial house. He expresses the gratitude of a Frenchman in manly and affectionate terms, not only for the help given, but for the delicate manner in which it has been bestowed. There is something fine and touching in these friends, the professed advocates of peace, thus giving out of their moderate possessions to repair the ravages of war." Thus the spirit of benevolence has to make repairs for the damage done by the outworkings of the spirit of malevolence ; and it is quite as important that men should do the justice to themselves and to mankind of restraining and eradicating the spirit of malevolence, that delights in war and every evil work, as it is that they and all others should cultivate and exercise the spirit of benevolence, which delights in all that is good. The Quakers are also distinguished for the simplicity and purity of the creed they profess. The Moravians are likewise distinguished for their affectionate intercourse with each other, the liberality of their dispositions, the peaceableness of their temper, the purity and simplicity of their lives, and their missionary efforts for converting the heathen to the truths of the Gospel. Would that the whole race of mankind were Quakers or Moravians (if they will not be more perfect), notwithstanding their peculiarities of opinion. With all their faults society would then present a more beautiful and alluring aspect than it has yet done ; peace and industry would be promoted; the fires of persecution would never be kindled; the sciences and the arts that tend to peace and order would be cultivated ; philanthropy would be exercised by the nations ; and the people would cultivate the spirit of benevolence toward each other, and learn war no more.

After our review of the moral character of mankind in its two aspects of bad and good ; and after having illustrated that man himself is the former of his own character and determines which of these it shall be ; we now think it proper, for the sake of digression, variety and information, to turn the attention of our readers to other things connected with our subject, *which tend to illustrate further the eternal existence of the earth, or of the order of nature and of man, in the main as now existing.*

First then we shall state, as we have done before, that there is no evidence except what is derived from contradictory and metaphorical and consequently from unreliable narratives, which goes to prove the contrary of the earth's eternal existence, although, notwithstanding all this, there are some who may not believe in this eternal existence. * But having before

* It is easily seen, however, that the question of the eternal existence of the earth and of the heavenly bodies in the forms which they have now can be only of secondary importance when it is remembered that the substance of these bodies certainly existed eternally.† If any one should undertake to say that these bodies assumed or were given their present forms and motions at some period of the past from their substance existing before in a nebular state, it would be well for such an one to say at what time that change took place, and how long their substance had existed in that supposed nebular state before it became into these globular forms, and in what state it existed before it became into the supposed nebular state. For if men allow themselves to launch out into the region of conjecture with respect to this subject there is no knowing where they will terminate their speculations and theories concerning it. That the earth and the heavenly bodies existed always in their present general form and aspect there is, as we have before stated, no evidnce to disprove.

† See page 27 at the bottom.

brought forward facts which tended to illustrate this, the eternal existence of man, and of all other animals, and of plants, will not be difficult for the readers to conceive ; we mean, that they who conceive the one will easily conceive the other, and admit the earth and all the order of nature to be an ever present thing ; and they who do not conceive the one will not conceive the other, nor admit the earth and all the order of nature to be an ever present thing.

Solomon was a wise man and uttered the truth when he said that there is no new thing under the sun. Paul or any other was a wise man also, who said: If a man sow not neither shall he reap, and whatsoever a man soweth that shall he also reap. It is a fact known to all common observers that all plants and animals bring forth after their own kind. The farmer does not expect to reap if he do not sow or plant, nor does he expect that a blade of rye will spring from a grain of wheat that he has sown, neither of barley or of buckwheat or any other than a blade of wheat; and he is never disappointed in this expectation. Nor does he expect that any of his domestic animals will bring forth other than young of their own species, unless he has crossed the species for the purpose of producing a hybrid, as, for example, a mule, the result of the crossing of the ass and horse species.

Of all the known species of plants--and there are reckoned as known, we believe, about ninety thousand species—there is not one that produces other than its own kind. Also, each of these species is distinguished by having varieties in it; and each of these varieties brings forth after its own kind. For instance the species oak, of the genus *quercus*, is distinguished by such varieties as the white oak, red oak, etc., as almost every one knows, and each of these varieties progagates after its own kind. The seed of the red oak will bring forth a red oak, that of the white oak a white oak, etc. Also, of the birch species there are several varieties, and each of these brings forth its own kind. And so it is with all the other species of plants and their varieties, unless, as some say happens, a different variety may arise within the same genus from the pollen of a plant of one variety falling upon and fertilizing the seed of a plant of another variety of the same genus, whence a new variety, a cross between these two varieties of the same genus or species, might arise.

Of all the known species of animals—and there are reckoned as known nearly as many as there are of plants, without reckoning the miscroscopic species—the general natural rule is that each species, as well as their several varieties, brings forth after its own kind. This they do permanently, unless, as we have said before, a hybrid is produced by the arbitrary government of man. Thus, in the animal kingdom propagations according to species and kind is the great rule ; hybridism the very rare exception. But it is an absolute fact, to which there is no known exception, that no plant or animal of any kind whatever can be produced unless the seed exists before from whence it is to spring. So, then, not only are all plants and animals propagated in succession from their own kinds, but neither plants nor animals of any kind could exist had not their seed preexisted to give them birth. And conversely the seeds could not exist had not the plants and animals existed to produce them. The seeds, therefore, of all the plants and animals in the earth must have always existed, and consequently the plants and animals themselves must have always existed and been propagated, were they not produced from non-existence at some past time in some way of which we have no experience.

Now propagation according to kind has taken place in all the periods of time of which we have historical records. These last go back in the case of Egypt and some other Eastern nations for a space of nearly 4000 years. This is the extent of time to which we have the written experience of mankind, (unless we receive the writings of the Hindoos and Chinese, which extend back for many thousand years before, and which are doubtless as authentic as the Egyptian records) and thus far may we profit from it. What has, then, existed and been taking place with such undeviating regularity for such a length of time, and what we see now existing and taking place, with no signs of its discontinuance, we may conclude is permanent, always existing, always taking place, since no evidence exists to the contrary.

But Geology, or the knowledge which man has obtained of the nature and construction of the earth's crust, may have something to teach us concerning the earth. This knowledge is indeed very limited, since geology has only been pursued for a short time, but it has nevertheless already done something, as did astronomy a good deal, to the removal of erroneous and superstitious notions. The latter of these, which is a definite science, does away with the old Hebrew idea of creation from every mind that has made it a study. Geology, which cannot be called a definite science, but only an accumulation of scraps and gleanings of knowledge derived from observation and examination of small parts of the earth's surface, has still so far effected as to show the falsity of the old idea of the earth and all visible things having been made to exist out of nothing in six literal days. Though the earth's centre is about four thousand miles from its surface yet geologists in their researches have not penetrated more than a mile or two of that distance, and this only in certain detached spots; while the great extent of the earth's surface, and its whole interior, remain still unexplored. From this it need not be inferred that scientific men must necessarily be altogether ignorant of the approximate density and consequently weight of which the bodies must be which go to make up the earth's interior and central regions; this knowledge they claim to come to, at least approximately, from a consideration of the earth's position in space, and of the force of gravity which it exerts on the moon and planets situated at different distances from it. About three fourths of the earth's surface are covered with water. Take a small artificial globe, such as they use in schools, and bringing the south pole under your eye and then viewing it all round you will see the great disproportion of the extent of the dry land to that of the water upon the earth's surface. The bottoms of the seas, lakes, and oceans then, as well as most of the dry parts of the surface of the earth remain unexplored by geologists. Hence it is seen how little information, comparatively speaking, geology affords us concerning the earth. But it gives us some information. It proves, as well as does the common experience of mankind, that parts of the earth which are now dry and subject to cultivation were at certain periods of the past a prey to the waves. We have seen a house in one of the western counties of New York State built of such limestone as is mainly made up of water shells, some of the shells larger than our fist, and these stones are from the farm on which the house is built. A great part of this section of country, especially the valley parts, present a like geological formation, indicating that at some time it was covered with water. There are large lakes in the vicinity, and one might suppose, with respect to the particular section of country to which we allude, that at some time in the past the waters of lake Ontario extended to a considerable distance south of its present southern boundary, but that the gradual enlargement of the St. Lawrence river by the constant flow of the water through it, by means of which a greater volume of water could pass through from the Great Lakes to the Atlantic, may have draimed it by degrees. There is, however no sufficient reason to believe that at any period of the past the waters at large covered a greater extent of the earth's surface than they do now, nor that more than comparatively small portions of land are at any time lost or set free by the water. People living near the sea shore have constant experience of the wearing effects of the action of the waves on the coasts. This is especially the case where the coast barrier is of a soft clayey character. When it is of hard and resisting substance, as rock, the wearing effect is not so noticeable during the lapse of two or three generations of men. But the effect on some coasts by the waters heaping up sand and other material, is that land is made. This is noticeably the case around some of the great lakes of North America; and some geologists go so far as to say that all the land between the Mohawk river and the Atlantic Ocean, comprising a large part of eastern New York and New England has been thus made, and by upheaval.

Also, at the mouths of rivers there is much land made by deposits from the waters. The delta of the Mississippi is of this character, the extent of which is at least 12,300 square miles, and this is computed by Sir Charles Lyell to have been 33,500 years in the course of formation. The Ganges performs even a greater work of depositing than this. In the four rainy months, at 500 miles from its mouth it was found to bear seawards 577 cubic feet of solid matter per second. Its annual discharge has been computed to be 6,368,077,440 cubic feet; an amount of water equal in weight to sixty great pyramids of Egypt, although the base of that immense pile covers eleven acres, and its apex is 500 feet above the level of the plain. Yet even this does not measure the depositions which are going on in the upper part of the Bay of Bengal; for it is considered the Brahmapootra contributes as much as the Ganges does to the sedimentary accumulation. From this we may form some conception of what great extents of land there are constantly being made by the depositions of all the rivers in the world which empty into the seas and oceans; for every river bears down to the ocean an amount of matter in proportion to the volume of water it discharges, and the nature of the country which it drains.

An admirable illustration of this subject is offered to us in the lake of Geneva. The river Rhone passes through this lake. It enters the lake at the upper end, its waters discolored by the mud; but on leaving the lake its waters are transparent blue, the mud having been deposited in the lake. As this has been going on for centuries we may expect to find some evidences of the work of the river. This is given us in the alluvial tract which stretches from the head of the lake for six or seven miles. It is a marshy plain, higher than the level of the water, and occupying what was once the bed of the lake. If this state of things continues the Rhone will eventually fill up the whole lake. The rate of the advance of the delta may be gathered from the fact that the Roman town Portus Valesia, which stood on the margin of the lake is now more than a mile and a half inland, the river having added to its delta this quantity in about eight centuries. By soundings it is found that the mud deposits reach some two miles from the river's mouth. On these alluvial tracts wild grasses are generally found growing, that is, species peculiar to the waters and to marshes, and these are often mixed with some of the cultivated grasses, the seeds and plants of which have been brought down and deposited by the waters of the river.

Examples of the loss of land by the waters, especially by the action of the waves on coasts, are of frequent occurrence on the coasts of Britain. Thus, on the coast of Yorkshire from Budlington to Spurm, a distance of 36 miles, it is computed that the waves eroded 2¼ yards annually, so that the sea has encroached two miles within the last fifteen centuries. Many old maps of Yorkshire, indicate that villages once stood where now the waves hold undisputed sway, and ports mentioned in past history are no longer to be found. The same destruction is taking place on the coasts of Norfolk and Suffolk. The sea-port towns are being driven back by the encroaching waters. The sites they occupied in past years now form their harbors. Between Cromer and Mundesley, according to the Ordnance survey of 1838, the cliff has receded at the rate of fourteen feet a year. On the same coast, as in Yorkshire, many villages are only historical remembrances. The church-tower of Eccles is still seen rising out of the sea-sand, but all other remnants of the village have long since succumbed to the action of the waves, or have been covered with sand-hills which are dispersed along that coast. Dunwich, on the coast of Suffolk, offers another remarkable instance of the conquests of the sea. What is now a small village was once a large and flourishing seaport; records of the town are preserved from Domesday book, from which we learn that the sea must have encroached on the land to the distance of several miles. Also, the Goodwin sands, which are from three to seven miles from the coast of Kent, nearly opposite to Ramsgate, tradition informs us were once the estates of the earl Godwin. England is, however, indebted to the sea for a recent gift of large tracts of land in Lincolnshire, and Cambridgeshire, and the 300 miles called the "Humber Warp." Other countries are far more indebted; Holland and Denmark are well-nigh wholly the products of the German ocean deposited in the most recent geological periods; and Tyre and Sidon, celebrated sea-ports of Phœnicia, mentioned in the Scriptures, are now several miles inland.

Changes corresponding to these are taking place on the coast of Italy, and to a greater or less extent on all other coasts. When any portion of land has been gained from the water man advances on it, bringing his plants and animals with him, and the water grasses being subdued these are propagated thereon. Or if for the course of ages there be no civilized men to occupy it, the seeds of vegetables from the old land become more or less scattered thereon, and the roots of vegetables, large and small, from the old land become gradually expanded thereon, so that if the soil be adapted to their growth these grow up, and in the course of ages all this new land may become covered with vegetables large and small, as the old land. The reader should remember the slowness with which these natural events take place, and in a low state of civilization man scarcely perceives them. The Irish and Danes, when they contemplate their peat-bogs of such great extent, and some of them we suppose from 100 to 150 feet deep, may well bethink themselves on the millions on millions of years during which these vegetable deposits were being made, and should glorify their great Creator, who has arranged and superintended this whole process.

Another subject which it is proper to mention in this connection is that of earthquakes. At different periods of time portions of the earth's surface have been elevated above the general level by the action of internal forces, igneous or aqueous, or both of these combined in the production of steam, and corresponding portions have been depressed, in some cases doubtless lost, by being submerged in water. Thus, the differences of level on the land surface of the earth have arisen either from the hills and mountain ranges having been pushed up by internal forces, or from the land on both sides of these having subsided. Elevation and depression have doubtless always been taking place on the earth's surface. The universal action of water is to level, and it is considered that should no other cause interfere with the degrading and filling up which is carried on by every rain-drop, river and ocean, the surface of the earth, after a requisite number of ages, would become level. This, however, can never be the case, for there exists a force in the earth which constantly opposes the action of water. Here, as in every domain of nature, is a finely adjusted balance, the aqueous agency on the one hand and the igneous agency on the other, the one wearing down, the other elevating; the one filling up and making the surface even, the other disrupting and throwing existing arrangement into disorder. The igneous action is exerted in three ways; in volcanoes, in earthquakes, and in the gradual upheaving and subsiding of portions of the earth's crust.

Many facts go to prove that in the earth's interior, and not far from its surface, there are vast accumulations of igneous matter. This sometimes finds vent in great quantities by means of volcanoes, of which there are known to be 225 active ones (or rather volcanoes which have been known to erupt within the last 150 years), besides a large number of inactive ones, on the earth's surface. These accumulations of fire, as we have intimated, are in detached places of the interior, and the water percolating through the fissures in the rocks finds its way into these fiery places, and thus a large amount of steam is generated, which, in its efforts to escape, sometimes finds vent by the mouths of volcanoes, and sometimes produces the disturbances of the earth's surface, which are called earthquakes, sometimes causing the destruction of large cities and flourishing districts, and the elevation of certain parts of the earth's surface into hills and mountain ranges, and the consequent depression of other corresponding parts. If the whole interior of the earth were one mass of molten matter, as some geologists are wont to suppose, then, according to the laws of hydrostatics, the pressure exerted at one point by the expanding steam must be felt by the whole liquid mass; for liquids transmit pressures equally in all directions; hence, the same force which throws into action one volcano must also cause all the neighboring volcanoes to erupt; and the same force which throws into disturbance one portion of the earth's surface, transmits an equal disturbing agency to every other part. This argument finds a remarkable illustration in one of the Sandwich islands. Mauna Loa is a volcano, frequently active; there is a crater near its summit, 10,000 feet above the ocean level; 6,000 feet upon one flank of this mountain is another crater, Kilauea. It often happens that while Loa is in action, the lava in Kilauea is molten, yet undisturbed. It appears an inevitable consequence, that if these craters both derive their lava from the same reservoir, the force which propels the molten matter to the higher crater must cause a jet of lava to be thrown from Kilauea to a similar height. That simultaneous disturbances would take place in each volcano, if their ducts led to the same reservoir, may be fairly inferred from the fact that we have numerous accounts of volcanic action occurring at the same moment at many distant points. For example, a violent earthquake visited Chili in 1835; at the same moment the shock was felt over a wide area; the two volcanoes, Vautales and Osorno, burst into action; and at Juan Fernandez, 720 miles distant, a submarine eruption took place. Thus, the commotion, in some deep-seated reservoir, affected a tract of country 900 miles long and 600 broad; and these examples show that some of the subterranean reservoirs are of greater extent than others; and also determines that the whole interior of the earth, reckoning at any distance from its surface, is not a mass of liquid fire.

The ordinary elevation and depression of the earth's surface takes place frequently, when by the fluctuations of the temperature of the earth's crust the rocks expand or contract, in the former case of which an elevation takes place in the surface immediately above the locality which experiences the expansion; in the latter case, especially when the contraction or cooling down takes place rapidly, fissures are made in the rocks, which admit the water to the igneous regions. When the shock takes place in the interior it is propagated on all sides from the centre of disturbance in a wave, which reaches the surface, and as it rolls wider and wider from its centre causes all the phenomena exhibited in an earthquake, gradually decreasing in its power until it becomes imperceptible. There may be earthquakes of which the igneous agency is the main cause; but it is a remarkable fact that all volcanoes, and ranges of volcanoes are in the neighborhood of seas and oceans.

It would be much beyond the limits of our space to chronicle the destructions which the eruptions of volcanoes have brought on human beings; but it may be permitted us to mention the effects of some remarkable earthquakes. The effects of some of these were felt over vast regions of the globe. One occurred at Lisbon in Portugal, on the 1st of November, 1755, the effects of which were felt over an area four times as large as Europe. The shock was preceded by no premonitory symptoms, but with a tremendous roar, the city reeled and fell. It seems from observations made on scientific principles that the centre of disturbance was some eighty miles from Lisbon, out at sea. The actual scene of the gaseous explosion must have been deep-seated, since its effects were felt over such a large area. The water rose suddenly twenty feet in the

West Indies. The great lakes of North America felt the movement. In Scotland, Loch Lomond rose on one beach more than two feet, the water not participating in the lurch of the land. The waves of disturbance extended to the very north of Europe. In six minutes, 60,000 people in Lisbon perished. Many had assembled on the wide expanse of the new marble quay out of the way of the falling houses, when suddenly the quay with its living throng sunk with many ships in the harbor, and not a body, nor the splinter of a wreck, was ever known to rise from the watery depths. We can only suppose that a fissure opened beneath the harbor, and, after engulfing the whole, suddenly closed in. In this earthquake a remarkable proof was offered of the fact that the earthquake wave is more readily propagated in some formations than in others. The lower part of the city which rested on blue clay was most severely shattered, while that part of the city which was built on limestone and basalt escaped. The wave movement passed along the earth's surface at the rate of twenty miles an hour; the sea wave which in such cases usually follows the land wave at a much slower pace, rolled about four miles in the same time. The sea wave is generally the cause of as much loss of life as the actual violence of the shock. This may be well understood from the fact that at Cadiz, the wave was sixty feet high. But the reason why the waters of Loch Lomond did not participate in any perceptible degree in the lurch which the land gave is that that lake is of so small an extent, and that the water wave travels so much slower than the land wave.

South America has for centuries been the scene of repeated earthquakes. A few years after Lima was built, in 1582 the city was ruined, and since then the catastrophe has been repeated some twenty times. In all the cities of that neighborhood the ecclesiastical year is full of anniversaries commemorating terrible overthrows or marvellous escapes. But none of these calamities seem comparable to that which has paralyzed that country some four years ago. On the 13th and 16th of August 1868, two earthquake shocks passed over Peru and Ecuador, ruining every town and city, and leaving between two and three hundred thousand people dead to putrify in the tropical sun. Arica, a sea-port town was completely covered with the wave. One who was present at the catastrophe, and who survived it, states, that upon the first shock, at a quarter past five in the afternoon, he with some others jumped upon a barge, when the great wave carried them on its crest, completely over the town, *above the spire of the church*, and landed them unharmed nearly a mile inland.

The chief geological effect of earthquakes is shown in the permanent alteration of the level of the land. In 1822, the coast of Chili was raised some two feet, while further inland the elevation was more than double this extent. In 1855, the coast of New Zealand, for ninety miles, gave evidence of a rise of nine feet. (For many other facts illustrative of the alteration of level in all parts of the world as a consequence of internal disturbances, the reader may consult Lyell's Principles of Geology, vol. II.)

But there is found to be a gradual alteration of level taking place on the earth's surface, not attended with convulsive movements, which is more important than those local variations. Observers find it difficult to establish these facts, because there is no standard which is not itself subject to alteration. Careful investigations, however, of the coast of Sweden has shown that most of the Scandinavian peninsula is rising at the rate of four feet a century. The coast is favorable for the observation; there are no tides in the Baltic, and the cliffs which line the coasts descend perpendicularly into the sea. Few other places present the same advantages for observation. The water level has been repeatedly marked, and the rise judged by its change. It has also been observed that the bed of the South Pacific Ocean is sinking in these ages. Some judge thus from the fact that the beds of the coral formation are found far below the depth of twenty fathoms, below which, it has been said, the coral insect could not exist from the pressure of the water being too great; just as if any man of sane mind could believe that an insect which exists under the pressure of twenty fathoms of water would be prevented from existing at five times that depth "by its pressure." There are doubtless portions of the bed of the Southern Ocean sinking to correspond with the elevations which are taking place in the Northern hemisphere, for, for every elevation there is a corresponding depression on the earth's surface.

One well known proof of the repeated oscillations of the earth's crust is that which is offered by the temple of Serapis near Puzzuoli in the Bay of Naples. The ruins of this temple consist of three pillars of marble, hewn out of solid blocks of more than forty feet high. The history of this remarkable temple appears to be as follows: From certain inscriptions discovered in the vicinity, we learn that in the year 105 B. C. a temple dedicated to Serapis existed on the shore. In 1828, the handsome mosaic pavement was discovered five feet beneath that from which the pillars rise. The existence of this pavement indicates that the land must have sunk, and the present floor have been raised above the level of the water. In the early part of the 3rd century, the temple was repaired and beautified by the Emperor Alexander Severus. At what time it was deserted, it is not known, but, in 1749, the following facts were brought to light by excavating: That when the sea broke in the salt water caused a hot spring which exists to throw down a dark calcareous deposit two feet thick. Above this a layer of volcanic tufa was found reposing, which must have been ejected by the neighboring volcano. This deposit is not regular, varying from five to nine feet in thickness. The eruption seems to have formed a barrier which kept out the waters of the sea, so that the hot spring continued to deposit its carbonate of lime, but without any marine admixture; thus about two feet more were added to the matter which embedded the bottom of the column. More volcanic tufa was now placed upon the lime deposits, either by a storm or another eruption, making a total deposit of eleven feet. All this time the land had been sinking. The sea now surrounded the pillars, which finally sunk nine feet more: thus half the height was above the water, and of that which was beneath the surface, eleven feet was embedded, and nine exposed to the water; in this space the pillars were perceptibly perforated by a bivalve "Lithodomus." Thus if we include the lower pavement, the land must have sunk 25 feet since the commencement of the Christian era. When the upheaval began, it has not been observed, but it was known to be in progress in 1530, and in 1838 the pavement was again above the sea level. The downward movement has again commenced, at the rate of about one inch annually. Here then we have evidence of a structure which has undergone a subsidence and an upheaval of at least 20 feet, and still stands to attest the quietness and regularity of the movement. Although this subject of the alteration of level of the earth's surface is a difficult one to prove, from the peculiar circumstances of the case, yet, we may safely infer that this oscillation is more general than is commonly supposed; and may fairly be brought to account for the depression and upheaval necessary for bringing the aqueous rocks to form the surface of continents. For the reader may remember that the rocks which underlie a great part of the dry land, as well as most of those found in the formation of lofty mountains furnish unmistakeable evidence of their having grown beneath the water. This too will partly account for the fact of by far the greatest part of the fossilized plants and animals which have been found being of aquatic origin. In no other part of the world, we believe has the subject of geology been more pursued than in the island of Britain, and as this island is so extremely small in proportion to the great extent of the globe, and as only small portions of it too have been geologically examined, it is the more surprising that such a great number of fossil animals and plants, and other interesting fossils, have been discovered there. We would add a list of the fossil plants and animals which have until recently been discovered in all parts of the globe to show the proportion which they bear in respect to kind to those now existing, but for the fact that these proportions are continually varying by means of the discovery of more fossils, and some new living species.

Geologists remark that the remains of man are mostly found in the alluvial deposits of rivers and lakes. These deposits contain also skeletons of land animals together with fresh water shells, intermixed with silt and vegetable drift carried down by the rivers. The reason they are found in such places rather than in others is, first, that man must have always occupied the regions of the land as a residence; and the remains of human beings found in such places are doubtless for the most part of those who have been drowned in the waters of the lakes, or in the rivers, and washed down with the debris which rivers usually carry to their mouths. We have ourself seen in an alluvial deposit in the State of New York, a fossilized man of such dimensions that, when living, he must have measured about eleven feet in height, and was made in proportion. We had the opportunity of closely examining this fossil and it appeared to have once been a noble specimen of human kind, and not to have belonged to any of the tribes now inhabiting this continent. Its antiquity, as indicated by its appearance, and the place in which it was found, must have been very great. Secondly, according to the evidence of geology and history, mankind has always been accustomed to dispose of his dead by burial and otherwise. But besides the remains of human beings which have been discovered, many indications of their existence are brought to light in the form of warlike instruments, etc. These are in the shape of knives, arrow and spear heads, hatchets and hammers, which indicate that the state of civilization of those using them was not high. The material and workmanship of these tools are considered by geologists to have marked the successive periods and the successive stages of civilization through which man has passed. But is is evident that in any period of the past, as at present, some tribes and nations may have been more civilized and ingenious than others, and that while one tribe used instruments of one material, and of good workmanship, another may have used instruments of another material and of better workmanship. There are found instruments of stone, of bronze (an alloy of tin and copper) and of iron; and the ages in which they are said to have been used are termed respectively the stone age, the bronze age, and the iron age. In the stone instruments there is a variety played indicating a less or a greater degree of ingenuity or tact in their making. Some of them are made of flint seemingly chipped into the required shape by hand. The regularity and proportion displayed in these arrow and spear heads are often remarkable. Although it may appear strange, it is said that the flint chips more easily, when chipped with another flint, than if an iron tool be used; so that we need not be surprised at the clever specimens of stone handicraft, preserved for us in these deposits, and formed by men who, like the North American Indian of the past, were not acquainted with the use of iron. Some of these flint instruments appear as if they had been subjected to a process of grinding, and consequently exhibit more skilful workmanship. An ancient people who fabricated these instruments lived in the Northern parts of France, and in the South of Britain. In the river gravels of Abbeville and Amiens in France, M. Boucher de Perthes found in 1847 many specimens of their handiwork. These beds of gravel vary in their depth to the present bottom of the valley from 20 to 200 feet. This depth indicates the amount of scooping work the river has done since these ancient people occupied its banks. These tools are usually bleached by long exposure to the air, or they are stained with the same yellow tinge which pervades the gravel bank, and sometimes crystalline incrustations of carbonate of lime appear upon their surface. Their edges are blunted either by wear or by the rolling action of the water, and they are usually found at depths of from fifteen to twenty feet from the surface. The fact that the Somme river has worn away more than 200 feet of valley since the people of this stone age inhabited its banks may impress us with some notion of the time which has elapsed since that very remote period; yet the position in which similar instruments are found in the South of England, carries our minds still farther back into the past. On the tops of the hills in South Hampshire, and in the North of the Isle of Wight, masses of gravel are found. These detached beds are believed to be remnants of a great deposit of drift resting upon the Eocene Tertiary Strata. In this gravel are blocks of sandstone, some twenty feet in circumference, and to account for their presence at some distance from their native beds geologists have recourse to the agency of the glaciers. It is in this gravel that numerous specimens of stone tools, precisely similar to those of the Somme valley have been found. If the theory of the glacier agency with respect to these rocks be true (and it does not seem altogether improbable when we consider that glaciers of great extent exist in the Alpine districts in the centre of Europe at present), then, when these ancient people inhabited Britain it was amid the ice and snow of the Artic regions, or, at least, in the proximity of glaciers and ice fields. And since the time of their existence the Southampton river, the Avon, and the Stour have begun their course and gradually worn for themselves their present valleys And probably the Isle of Wight was then part of the mainland; whether or not the strait of Dover then existed may be guessed or known. But not only have they passed away, but many of the animals then existing are now extinct. The bones of the mammoth, the woolly-haired rhinoceros, the reindeer and the Norwegian lemming all are associated with the flint instruments. These animals have all an Artic relation, and the two first have been known alive in historical times. The first of these is simply a large kind of Elephant, and the lemming is of the rat species. In the valley of the Somme the hippopotamus and the musk-ox are also found, indicating a somewhat more genial climate. The reason why the remains of men are not in general found associated with these instruments, is, as will appear more clearly from information hereafter to be given, that mankind has always been accustomed to bury their dead in detached places, or to burn them.

For a long time geologists refused to entertain the idea that mankind was co-existing with the mammoth; but now all doubt upon this subject too has been removed, for even in the scanty researches thus far more than 3000 flint instruments belonging to the ancient stone age have been discovered in Europe. Throughout the whole of Scandinavia (Sweden and Norway), although quantities of flint instruments are found none of them are of the rude stone type found in the South of England, and in France; but all are ground and better shaped. This may indicate that they were of a later age than the stone weapons, or of the same or even an earlier age, and made and used by a more ingenious and civilized race of men. The thought will probably strike one, was not Scandinavia in these early times covered with ice, and how could it then be inhabited? An equal and an equally forcible consideration is this—that Denmark was certainly inhabited by the men of the stone period; and if this, being in such close proximity to the Scandinavian Peninsula, was inhabited, why should not the latter have been? Doubtless the Scandinavian geologists have given considerable attention to this subject and understand it.

Along the coasts of the Danish islands are mounds from three to ten feet high, and some of them as many as 1000 feet long. These mounds are termed *kitchen middens*, being found to contain some shells of mollusks, etc., upon which the people lived. Being in close proximity to their dwellings it is natural they should contain many remnants of their mode of life; burnt bones of the animals they cooked, their stone knives, spears, etc. Sometimes bone and horn instruments are found in great numbers. The animals with which they were associated are still living in Europe, excepting the beaver. The dog alone, however, seems to have been domesticated by them. These facts, and fragments of rude pottery that are found, go to prove them to have been partially civilized.

These ancient people have reminiscences of their existence preserved to us in peat-bogs, and in Denmark successive stages of civilization are observed. In the lower beds of peat stone-weapons occur side by side with the roots of the Scotch pine, a tree which has never been known in Denmark in historical times. Higher up in the same bog bronze instruments are found; but here the pine has become extinct and the oak takes its place. Still nearer the surface iron instruments are found; but during the bronze period the oak growth waxed and waned, and next the beach tree which now flourishes in Denmark occupied the country. Let the long periods which it must take for successive generations of forest trees to wear themselves out tell the years which measure these ages of stone, and bronze, and iron.

An interesting and singular repository of these ancient relics has lately been discovered in Switzerland. It seems that it was the custom of the ancient inhabitants of the Swiss valleys to construct their villages on piles, driven into the bottom of the lakes, where the water was not more than fifteen feet deep. No fewer than one hundred and fifty of these lake villages, have been already discovered. Being surrounded with water the inhabitants were secure from the attacks of wild beasts, and in some measure from their human enemies. By dredging in the ooze great numbers of articles have been found. Some villages are characterized as of the stone age, others of the bronze, and others again give evidence of having been inhabited by people who used both the stone and bronze instruments. Among other things taken up from the villages characterized as of the stone age are charred corn, and bread. This proves that the people of that very ancient period cultivated corn. No corn has been discovered in the villages where the bronze instruments have been found, but the vessels occasionally bear the marks of the potter's wheel. Numerous animals were domesticated,and gold, amber, and glass were used for ornaments. From the size of the sword-handles and the bracelets it is concluded that the people denominated as of the stone age were smaller than the present inhabitants of Northern Europe.

With respect to the disposition made of the dead the evidence is as follows. During the age of the stone weapons the mode of burial seems to have been in rude coffins of undressed stone. The skull is remarkably round and small, and this type is now most nearly approached in the Laplander. It is suggested that he may be the descendent of the men of the stone age, his ancestors having followed the ice northward. During the age of the bronze weapons the fashion of burial changed ; or, perhaps, we may say with equal propriety that the men characterized as of the bronze weapons disposed of their dead differently. No human remains understood to have belonged to that period have been found ; they *burned their dead.* When the age of iron came they again resorted to sepulchral burial, and now the skull appears larger and longer. The floors of caves have proved the richest storehouses of human remains ; but owing to the fact that the cave may have been used as a burial place in comparatively recent times, it does not necessarily follow that human remains lying side by side with the bones of extinct animals belonged to human beings that lived contemporaneously with these animals. Out of the numerous fragments of skeletons which from time to time have been brought forth from such places Professor Duncan concludes that the lower jaw found in the cave of La Nautelle, the skull from the Engis cave, and the jaw of the Grotto des Fées are "the only examples of human bones which can bear criticism, and which can be referred to the mammoth age."

As we may have before intimated the stone, bronze, and iron instruments may have been used by the same nations and tribes for long successive ages, and may indicate the advances they made in civilization and art,or may have been used contemporaneously by different tribes and nations of different or the same degrees of civilization and art. The finding of the stone, bronze, and iron in successive strata, as in Denmark or in any other place where a sufficiently extensive search had been made, might appear to substantiate the first supposition ; but the finding of these different kinds of instruments in neighbouring villages or in the same village, would indicate that the second supposition may be equally true. The Augustan age in Europe, characterized by a certain kind of arms and arts, may have been characterized by very different kinds of arms and arts in China, which it undoubtedly was. Also, the ages of the bow and arrow in Europe and Asia were different from the modern age of artillery : and the tribes of Indians or other tribes who use the bow and arrow contemporaneously with the use of artillery by their white neighbours, may differ somewhat in point of civilization and art from the whites ; or there may be tribes on the earth who might be considered as equally advanced in many respects in regard to civilization with the whites who still use bows and arrows. And even neighbouring as well as distant tribes in prehistoric times may have differed in like manner, doubtless did. Each nation had then its own language, and differed from its neighbours in arts and characteristics even more than the nations differ now. We are to remember that the facts here adduced as to the discovery of human remains or of instruments indicating the existence of human beings in those very ancient times refer to Europe alone, and only to a small portion of that. But we have ocular evidence in the numerous tumuli of the Western States of the existence of men on the American continent in past ages, men who, as we have been informed by a man of sound judgment, who had inspected some of the remains, and handled some of the limbs, averaged 10 to 12 feet high (some of them much higher) and were made in proportion. This fact evidences as strong as anything can that different races of men have existed on this continent in past ages, and have passed away in succession ; men, some of whom were in point of size to the men of the present day either white, black, or red, as the huge mammoth or mastodon would be to the elephant. The whole continent of America has been peopled in some of the past ages by these gigantic races. We have mentioned in another place the huge fossil man we inspected in Western New York, which was casually happened upon by a man digging a well on his own farm. And we have been since told by a clergyman, who resides on the eastern side of lake Erie, that he had reason to believe that such huge fossils are not uncommon in the district in which he lives ; for that, when in Elgin county, in Canada, he handled a skull of one of these ancient giants, whose remains had been casually found in the neighbourhood, and that when through curiosity to find how his head compared with it in size he inserted his head into the cavity of the mammoth skull, there was still more than enough of room left on each side for him to insert his two hands between the skull and his ears.

The whole continent of America presents innumerable evidences of an extinct civilization. These are of various kinds, including mounds, tumuli, fortifications of large proportions, gardens, wells, artificial meadows, ruins of towns and cities once wealthy and populous, which all, with many other monuments are to be found scattered throughout the continent, especially from the 48th or 50th parallel on the north to about the same latitude on the South of the Equator. The valleys of the Mississippi and the Ohio abound in ancient mounds, tumuli, extensive fortifications, and traces of wells, salt mines, and artificial meadows which speak unmistakeably of a long period of time during which a numerous and powerful people of settled agricultural habits had made such considerable progress in civilization as to require large temples for their religious worship and extensive fortifications to protect them from their enemies. On the banks of the Blue river, the Black river and the St. Charles, near the river Gila, and upon an alluvial soil which reposes upon basaltic rocks, the remains of ancient colonies are very numerous. Rows and piles of stones show the plan of houses, though nearly covered up by the accumulated soil of ages. Here is seen a ruined circular stone wall about 250 yards in circumference with an entrance on the eastern side, and containing in its centre the ruins of a dwelling in which no traces of wood exist ; three quarters of a mile distant the soil is strewn with enormous remnants of spacious edifices which contained rooms fifteen feet square. In most of these, fragments of painted pottery have been found and traces of decaying cedar wood. These houses are surrounded by a rampart 300 yards in length. One writer observes in speaking of this locality : "Subterranean fires appear to have ruined all this country and converted it into a barren waste ; the country may also have been deserted in consequence of volcanic convulsions spreading death and misery among the inhabitants." Judging from the walls, houses, and remains of pottery met at every step all this region of country seems to have been very populous in past ages. In the Apache territory near the Rio Grande is a copper mine which shows distinct traces of ancient working A little to the East of this an ancient fort of a square shape is erected with a tower at each corner. The walls are four feet thick and in a state of some preservation. The banks of the Rio Verde abound in ruins of stone dwellings and fortifications which appear to have belonged to a more civilized people than the Aztecs. They are found in the most fertile valleys, where traces of former cultivation and of small canals for artificial irrigation are yet visible. The firmly built walls of these dwellings are twenty and thirty yards long to thirty or forty-five feet high, and from four feet thick at the base gradually taper to the top. The houses were four-storied, with small openings for doors, windows, and loopholes for defence against outside attacks. Excavations among these majestic ruins have yielded abundant fragments of beautiful pottery black, yellow, red, striped and scoloped and ornamented with brilliantly colored paintings. Of the ruins in New Mexico the most modern are the *pueblos* or stone dwellings; they comprised usually a main portion and two receding wings at right angles to the main part, from the extremities of which extended a circular wall enclosing a large yard or court. They had the appearance of an immense barracks, being of four stories high, each receding from the preceding one like a series of terraces rising one above another. The outside wall had no openings in the first or lower stories, and each story was reached from the court or yard by ladders which could be drawn up after the inmates, thus giving no opportunity for the enemy to enter. The minor details of these structures indicate much ingenuity and art. Some of them appear in the distance like splendid mosaic work, being constructed of stones of various colors. They are built of small flat slabs, in some cases of fine granite sandstone, a material never used in any of the modern monuments of Mexico; and the walls show no trace of cement, the intervals being neatly filled up with small colored pebbles incrusted in mortar made without lime, Remains of ancient towns are extremely numerous in the country of the Zunis, the Navagos, and Jemez. All these towns are so ancient that no Indian tradition makes any mention of them. Humboldt, speaking of these remains of the unknown past, in which may be included the ruins of populous cities possessed of much grandeur, the amazing signs of mechanical and architectural science which are manifest in the construction of the palaces of Tezcotzinco, the temple of Xochicalco, and the colossal stone calendar of Mexico, says; "Certain it is that they are the work of a great people, of an intelligent nation, whose civilization was far superior to that of the actual tribes." These ancients seem to have possessed a knowledge of astronony, as all their structures had either four entrances or four corners or towers answering to the four cardinal points. Among the basses Grandes are met numerous ruins, among which is a tumulus surrounded by an earthen wall 100 yards in circumference. A little from this is a large round terrace 100 yards by 70, supporting a pyramid 30 feet in height by 25 yards at its summit, commanding a view of a plain extending north, east and west, on the left bank of the Gila. The Pimas Indians have a legend concerning these ruins which runs thus; They pretend that these edifices were constructed by the son of the most beautiful woman that ever existed and who formerly lived in the neighbouring mountains. Her extreme beauty caused her to be beloved by a multitude of suitors; but she refused to marry; when they visited her they paid her tribute, and by means of this resource she provided for the people during times of famine without provisions ever failing. At length one day she fell asleep, and from a dew-drop descending and falling upon her bosom she conceived and gave birth to a son who built these houses and many others to the north and south-west. Among all these ruins are found beads and painted pottery, and perforated shells which antiquarians believe were used as coins or ornaments.

The valleys of the Ohio and Mississippi are rich in monuments of various kinds, dating from a period long anterior to the historical era. In Ohio alone, the number of ancient mounds, wells, etc., has been estimated at ten thousand. The American mounds have been divided by antiquarians, as follows: altars, tombs, temples, and tumuli of no determinate character. Out of one hundred examined, sixty had served as temples, twenty as tombs, and the rest were places of observation, or mounds, the uses of which could not be determined. Their plan and construction differ according to the situation. In the vicinity of the great lakes, and in the States of Wisconsin, Iowa, Michigan, and the western territories, they are made of earth, of conical form or in the shape of animals, birds and reptiles, or even in that of man; appearing like immense *Bassi Relievi* carved out on the soil by the hands of giants. In the interior of these monuments relics of art have been discovered belonging to a very ancient period, and consisting of personal ornaments, domestic utensils, and articles connected with religious worship, made of different metals and of *Pietra dura*, also polished stone and copper implements.

In the Ohio valley these earthworks are larger, more numerous, and of a more regular construction, in many instances surrounded by earthworks or strong walls; and give the best indication, from their number and style, of the greatness, or at least the multitude and superiority of the populations by which they were constructed. Advancing southward these antiquities are remarkable for the great regularity of their structure and their extraordinary size, and in these southern parts only have traces of brickwork been detected in their construction. In Florida and Texas these mounds are composed of several stories, somewhat resembling a Mexican *Teocallis* in their pyramidal form, dimensions, lofty passages, spacious terraces, and long avenues; they are often surrounded by smaller ones placed at regular intervals, some with paths winding around them from the base to the summit; others have gigantic steps, like slips in European fortifications.

Enclosures are rare in Florida, but those of a military character have been discovered in the Carolinas. Of the courts or amphitheatres that existed in the far South, the purpose seems to have been that of places for public amusement, as in the amphitheatres at Rome. The tetragonal terraces are apparently foundations for elevated fortifications, while the pyramidal hillocks are supposed to have served as observatories commanding a view of a wide extent of country. In Florida, frequent vestiges of extensive roads are met with, some running in a straight line for sixty to seventy-five miles. These highways were elevated above the surrounding plains, and appear to have led to the great centres of population, traces of which still exist. After traversing ruins of towns and villages they terminated at the foot of one of those artificial teocalli, or high dwellings of the chiefs. Few American curiosities are more striking to the imagination than these great roads, and the magnificent scale on which they were constructed brings to the mind the great roads made by the Roman government through the provinces of the empire. The elevated structures, or mounds of Florida, were usually square-shaped, sloping on one side to the road, or reached by a series of wide steps leading to the summit of the monument. The Indian population, whom Columbus found here, had no knowledge of the origin or uses of these structures, which were covered equally with the surrounding country by forests of gigantic growth. We might mention also the immense gardens, of unknown origin, found scattered over various parts of the American continent, whose size and state of preservation has produced, in the minds of observers, much astonishment. This perfect preservation is thought to be owing to the thick coats of prairie grass, which is so dense and abundant as to form a compact vegetable coating on the surface of the soil. This enables all their sinuosities to be easily traced, and has prevented their surface being overgrown with forest, as obtains in other ruins. They are square, or semi-circular, and are divided in parallel lines so as to form a series of ridges or beds, two or three yards in width, and are separated from each other by a number of very narrow paths. One of them is described by Domeneck, as above eight miles in extent. No light has been thrown upon the nature of the produce of those extensive fields laid out with so much regularity. The finest and best preserved have been found in Indiana, Michigan, the Western territories and Texas. Besides these gardens, artificial meadows, many of which were found situated on the borders of wood land or in the midst of forests, were also cultivated by the agricultural population which inhabited the western world previous to the tribes now existing. From the nature of the country, the configuration of the surface, as well as the agricultural implements of stone and brass found in those meadows, it is believed that in remote times these regions were covered with trees which must have been burned or torn up to make room for pasturage, etc., in the vicinity of human habitations. There are many traces which make it appear probable that the ancient inhabitants of the country worked the salt water springs in order to procure salt. These traces appear in Illinois, where, in a salt mine, there existed an excavation one hundred and thirty-five yards in circumference, in the middle of which a great pit had been dug at some unknown period. A conduit also existed by which it is supposed the water was drained off. In Ohio the salt mines give evidence of having been worked, the ancient remains of vases used in the evaporation of water having been found near the mines. In the salt-petre cave of Missouri hammers and axes similar to those found in the tumuli have been discovered. In the Lake Superior region are copper mines which bear unmistakeable traces of ancient mining. It appears that the ancients made use of tools of tempered copper, specimens of which have been found in the mines, as also evidences of the use of fire. The marks of such tools are traceable on the native copper.

Fortifications, of a singularly strategical character and of immense proportions, have been found existing in the vicinity of the Ohio and Mississippi rivers. With reference to these it has been said that, "of all the great works left by the ancient American nations, none are more extraordinary or more worthy of study than those colossal fortifications and vast entrenched camps protecting and surrounding spaces so very considerable that, of necessity, they must have been the work of a large population." The epoch at which these were constructed is, of course, quite unknown, but it is evident that they must have been coeval with the most ancient mounds or tumuli, since they are often placed within, or in the immediate neighborhood of, the fortifications, and in many cases form part of the general plan of defence.

These fortifications are found to consist sometimes of earthworks thrown up in the form of an extensive entrenched camp, or in the stone walls which have been thrown across peninsulas formed by the conflux of two rivers, and around the declivities of elevated terraces; while in all cases it is observable that a careful choice had been made of the most suitable position, of which every advantage has been taken to construct defensive fortifications on a surprisingly gigantic scale. On the delta formed between the Raccoon and Newark rivers in the county of Licking, Ohio, there exists an elevated table-land about 35 feet in height upon which are remains of military constructions of great extent. On the west side of the platform stood an octagonal fort enclosing an area of about forty acres, having stone walls of solid masonry about nine feet in height, and the same in width, at the base, each protected by a tumulus placed in the interior in front of the entrance. Two parallel walls lead to another circular fort at the south-west of the first, covering a space of 22 acres; further south is an elevated hillock or observatory which commands a view of the whole position, beneath which a secret passage leads to the opposite side of the river. A third fort of a circular form stands more to the right, enclosing about 62 acres; there was an interior ditch in this, out of which earth had been taken to assist in the formation of the wall, which ranged from 25 to 30 feet high. Two other parallel walls run towards the north, gradually converging to another fort of quadrangular form, enclosing an extent of about twenty acres. These four different forts are connected by rather low walls, and in the centre of the enclosed area is a shallow pond covering 150 to

200 acres, supposed to be artificial, and to have been required to afford water to the people and animals inhabiting the place; towers of observation placed at each of the salient points complete the works at this point. At Marietta, near the mouth of the Muskingum, some extraordinary ruins exist, among which are two square forts, the largest covering forty acres; these have earth walls from three to six feet high, and widest at the base; sixteen openings exist at regular intervals; at one side is a covered way formed by walls which are said to be 21 feet high, and 120 feet in length leading down to the river by a gentle slope. On the valley of the Paint Creek, near Chilicothe, is to be seen one of the most interesting of these fortifications; it is situated on a hill 300 feet high, and 130 acres in extent. The ascent is very steep and is accessible only on one side; a stone wall extends round this plateau of elevated ground. It is said that no engineer could have selected a more strategical position. On the Little Miami and its tributaries, and in Ohio several of these strongholds are said to have existed, in which the walls were disposed in a parallel manner. But enough has been said to show that the strongholds erected by these ancients were not of the meaner sort,—the earthworks seeming to be possessed of the greatest durability; for they have been protected by a growth of forest or thick grass, while the stone structures have tumbled in most cases to a mass of ruins only intelligible to the penetrating glance of the antiquarian. The Indians know nothing about the origin of these structures, nor about the people by whom they were erected; but they hold them in traditional veneration. The tumuli are massive and pyramidal in form and some contain a vault within which are laid the remains of the dead; these vaults are usually built of stones placed one above another, without any cement, sometimes of wood, or of both combined. The mounds are of various dimensions, from three to ninety feet in height, and from 100 to 700 feet in circumference at the base. In the top there exist altars of baked clay or stone in the shape of large basins, varying from 19 inches to 17 yards in length; but the average is from 2 to 3 yards. A number of these were examined by Messrs. Squire and Davis and were usually found to contain ashes and remains of calcined human bones, with sometimes a few ornaments; this leads to the belief that the ancient Americans sometimes burned their dead. In the larger burial mounds the vaulted chamber usually contains a raised pedestal or altar, upon which is laid the human remains. These skeletons are ordinarily covered with sheets of mica, and carefully placed around them are found ornaments and utensils of various descriptions. One was discovered in Utah in which a polished silver breast-plate lay upon the skeleton; at each side of his head lay what appeared to have been two tapers extending upwards, while between the feet was found an earthen vessel of remote antiquity. Some of the vaults have a stone pavement floor while others are vaulted and floored with

what appears to have been a species of brick or fire clay. In the Southern States, funeral urns have often been found within tumuli of this kind; also beds of charcoal, from which it is inferred that fire was used in their funeral rites. In these monuments also have been discovered ornaments of silver, brass, stone or bone, and ornamental beads made of shells; also pieces of silex, quartz, garnet, and obsidian, points of arrows, copper tools, marine shells, sculptures of human heads or of different animals, fragments of beautiful pottery, ornamanted with brilliantly colored paintings of butterflies, quadrupeds and other things, indicating a knowledge of art.

Very valuable discoveries of this kind have been made in New Granada, where arms, idols, and medals were found enclosed in tombs of people whose successors have disappeared for many centuries, and whose enormous wealth is reported by tradition. The archæologists of Panama declare these works of art to belong to very remote antiquity, and consider them to possess characteristics of both Chinese and Egyptian art.

Domenech describes enclosures made of earth of about 300 yards in circumference and having but one entrance, situated on low flats of circular, elliptical, or quadrangular form, but in all cases of regular shape. Aside from these there are a multitude of small circles about fifty yards in circumference, near which are grouped mounds that appear to have served as altars. The large circles extend over a surface of fifty acres, and are connected with rectangular enclosures by means of broad avenues, These walls are all made of earth. The religious feelings which actuated the authors of these immense structures, it is thought, can alone account for their erection. The Abbé Domenech, writes of them in these words: "If religion were out of the question it would be difficult to account for the object of works like those of Newark, which extend with their avenues over a space of more than four square miles, and to which only the great temples of Abury and Stonehenge in England, and Cornac in Britanny can be compared."

As to the probable age of these ruins we may observe that in the valleys of the Mississippi and Ohio, where the tumuli and ancient fortificacations are found in the greatest numbers, trees of enormous dimensions have grown upon them, the age of which form the surest data on which to form a judgment as to the period when these different structures were abandoned. In 1787, Dr. Cutler found trees of immense size in the ruins of Marietta. Many of those cut down were hollow, but one in which decay had only just commenced showed 463 concentric rings; and as naturalists have conceded a year's growth to each ring this tree must have existed more than that number of years. On the ground lay huge decayed trunks measuring six yards in circumference; he then concludes that as these were not the first trees to grow on these ruins, they must have been abandoned nine hundred or a thousand years ago. Sir Charles Lyel.

relates that on the same spot he, in company with Dr. Hildreth, in 1842, saw a tree, which when sawn asunder numbered eight hundred rings of annual growth. Gen. Harrison, President of the United States, in 1841, who was well skilled in wood-craft, remarked in a memoir upon this subject: "Several generations of trees must have lived and died before the mounds could have been overspread with that variety of species which they supported when the white man first beheld them, for the number and kind of trees were precisely the same as those which distinguished the surrounding forest." "We may be sure," he observes, "that no trees were allowed to grow so long as the earthen works were in use, and when they were forsaken the ground, like all newly cleared land in Ohio, would for a time be monopolised by one or two species of trees, as the white poplar, the hickory, the yellow locust, and the black and white walnut. When these had died out, one after another, they would, in many cases, be succeeded, (by virtue of the law which makes rotation in crops profitable in agriculture,) by other kinds, till at last, after a great number of centuries, several thousand years perhaps, that remarkable diversity of species characteristic of North America, and far exceeding what is seen in European forests, would be established." Taking this in connection with the opinion of a celebrated naturalist, who assumes that the oak is five hundred years in growing, remains five hundred years in *statu quo*, and is another five hundred years in decaying, we get some idea of the great antiquity of the American tumuli on which enormous oaks are found growing amid the remains of other oaks reduced to dust by extreme old age.

Hieroglyphic inscriptions have also been discovered from time to time in the States of Georgia, Kentucky, Minnesota, Ohio, Connecticut and Rhode Island, while some, remarkably well-preserved, have been found in the islands of Lake Erie. The red pipe-stone quarries of the meadow hillocks in the Western States conceal numbers, while others are met with in New Mexico. The most important and significant of these is that of Dighton rock. This rock is situated at the East of the mouth of the Taunton river in Manchuctka; the width of the rock is about forty-four feet, and the height in use about five feet; the surface is polished, either by water or by the hand of man. It was for a long time covered with moss, *detritus* and dirt, so that the inscription was not noticed until the middle of the last century, when it became a subject of much interest and scientific discussion. The characters entering into the composition of this inscription are decided to be hieroglyphic, kyriologic, and symbolical, and the strokes, roughly sculptured, appear to have been cut in the stone with a cylindrical instrument, the depth of the incision being about two lines. It has been attributed by M. Mathieu, a French writer to the Atlantides, about the year of the world 1902; and Messrs. Yates and

Moulton, in their History of New York, say it is of Phœnician origin. An inscription of much interest was also discovered in Grace Creek tumuli in Western Virginia. It was found buried with a skeleton in a mound containing two vaults; it is composed of twenty-two characters in three lines with a cross and a mask engraved on a dark hard stone of an elliptic shape, about two and a half inches long, two inches wide, and about five lines thick.

Learned men who have examined this inscription most carefully, neither agree as to its origin nor as to the nature of its characters, of which four, it was thought, had a resemblance to the Etruscan signs, four to the Thugga (African), five to the ancient Runic in Scandinavia, six to the Touarick, seven to the old characters found in Ireland, ten to the Phœnician, and fifteen to the Celtiberian, several resembling more than one kind of character. The divided state of opinion as to the relic only proves the uncertainty of its meaning, and causes one writer to ask the questions concerning it: Is it a sign, a motto, an ornament, or an historical remembrance.

There is another circumstance which is worthy of mention and is thought to be of great historical significance among the evidences of past civilization which are found to exist on this continent, namely, the marks of "fountain worship." The ancient peoples of Mexico and Peru have left traces, not only of the Phallic worship and its accompaniments, but also of that ancient material worship that believed the spiritual essences of things to be manifested in the expressions of life around them. Deity was perceived everywhere, and in everything, and thus they worshipped the sun, the moon, (which they supposed controlled the weather,) the stars, the earth, (which they called their mother, the sun being their father,) the rivers and fountains. The Zunis, above all, not using artificial means to irrigate their fields, and whose crops, therefore, depended entirely upon the rain that fell, believe to this day if they neglect to make their annual offerings to the spirit of the fountains their harvests will be destroyed by drought. Thus, in Mexico, Ireland, Scotland, as in ancient Carthage, Persia, Chaldœa, India, China, and Arabia, holy wells are held in great reverence and veneration by the inhabitants, who repair to them every year to make their offerings to the spirit of the springs. In the country of the Zuni one of these is still found; it is seven or eight yards in circumference, and surrounded by a low circular wall. Once a year the water is withdrawn, when offerings of varnished pottery are placed upon the wall, there to remain until they fall by accident or time; hence there are to be seen here specimens of pottery of great antiquity. A tradition obtains among them that any one attempting to steal one of these offerings would be punished by instantaneous destruction. The worship of wells was practised in the East from times of the greatest antiquity, not only by the worshippers of Baal, by the Scythians and their descendants, but also by the Chinese, Hindoos, Moors, Persians, Arabians, Egyptians, Jews, and Celts of Ireland and Scotland, where these objects of the profound veneration of the Celtic people were usually situated in the most picturesque spots, on the slopes of hills and venerable oaks, amidst rocks covered with heaths, in retreats difficult of access, and, above all, in the vicinity of an ancient oak or upright unhewn stone, and in dark and mysterious solitudes, where the breezes and the brooks murmur incessantly, and where the voice of man finds a faithful echo always ready to make nature resound with the songs and praises inspired by the piety of the people. In England, it is said, the Druids practised this worship, and under the reigns of Canute and Edgar edicts were promulgated against those who venerated these secred wells ; while in the Scandinavian manuscripts it is related that in the tenth century, a schism arose among the Americans, some of whom were accused of despising the sacred well of Vagarscriebat. That a worship so ancient and so general in the Eastern hemisphere as that of the fountains and wells should have been found to exist in the Western Hemisphere, may appear to be a mark of no small significance. In those times, there were people who believed that spirits presided over these fountains and rivers; that these spirits were invisible, and hovered around them, and received with pleasure the offerings made to them by mankind either as thanksgiving or propitiation.

Certain idols, shells, pottery and ancient mummies, have been found in the mounds and caves of Tenessee, which are thought by some writers to point to an Asiatic origin. In reference to these remains, the Abbé Domenech writes: "A knowledge of conchology is by no means unimportant in the study of the origin of the first inhabitants of North America, since it appears that they employed large marine shells, for their personal use, and for their sacrifices." The tumuli found in the valleys of the great rivers and the ruins of ancient fortifications contain a great number of these shells, which have formed the subject of long discussions among ethnographers, who are not ageed as to the locality of their origin. The most curious perhaps of the idols which have been found in these ruins have been found in the state of Tenessee. One of these was found enclosed in a small shell of the species *Cassis Flammea* which is of tropical origin, the others are without shells and either seated on their heels or kneeling, the hands being placed upon the thighs or abdomen. They are naked and represent different sexes ; the largest are about four inches in length ; they are cut in stone common to the country. One of the professors of the University of Tenessee expressed the opinion that all these idols were representations of the ancient Phallic worship and were similar to those exposed in the temples of Eleusis.

The existence of American mummies, swathed in the veritable manner of the ancient Egyptian mummies, excited considerable surprise and comment at the time of their discovery. They happened to be discovered only in the neighborhood of large rivers, where vessels could easily approach; they evidently belong to a race anterior to the red Indian; and from their discovery, some writers agree that the ancient inhabitants of the continent were of Egyptian origin, or at least came from the shores of the Mediterranean, while Dr. Mitchell endeavored to prove that the ancient inhabitants of America were of Malay origin, and resembled the natives of the islands of the Polynesia and Australasia. He founded this opinion on the resemblance of the cloth in which these mummies were enveloped to that brought from the Sandwich and Figi Islands, which is similarly made of fine cord doubled and twisted by hand; and again on the fact that feather mantles are applied to a similar use by the islanders of the Southern Ocean. It may, however, appear strange to men of sober reflection that our modern ethnographers are not content to allow the ancient inhabitants of this continent to have had an American origin without wearying themselves with investigating an origin for them on other parts of the earth's surface.

The mummies were found in great numbers in the mammoth cave near Louisville in Kentucky. This cave contains a large quantity of nitre and the preservation of these mummies is attributed to its presence. Domenech describes one of these, that was found nine feet below the surface of the soil; it was placed between two large stones and covered by a flat slab, the knees were drawn up to the chest, the arms crossed, and the hands folded the one over the other at the height of the chin. The hands, nails, ears, hair, teeth, and all the features were in a state of perfect preservation. The skin resembled leather of a yellowish color, and no traces of an opening in the body could be detected. Though this mummy was of a person six feet in height, it was so dried up that it did not weigh more than fourteen pounds. This body was not surrounded either by bandages or by any bituminous or aromatic substance, but was wrapped in four coverings. The first or interior one was made of fine cord doubled and twisted in a peculiar manner, and of large feathers interwoven with great art; the second wrapping was of the same stuff, but without feathers; the third consisted of a deer skin without hair; and the fourth and external covering of another deer skin, but with hair. The bodies of a man and woman found in a saltpetre cave in Warren County, Tenessee, are also described by the same writer; these were wrapped in deer skins, and in a cloth made of the fibres of the bark of trees and ornamented with feathers; while in the hand of the female was a fan composed of turkey's feathers, and made to open and shut at pleasure. These relics of past ages have greatly occupied the attention of American antiquarians, but the race to which they belong, evidently anterior to the Indian, is not decided.

Naturalists have expressed the opinion that the horse is not a native of the American continent; according to Linnæus, it is a native of Europe and the East, while Goldsmith makes it to be a native of Africa; and yet, when the European first set foot upon this continent, vast herds of these animals in a wild state were found roaming at large over the immense prairies of the West. It has been suggested that these may be the descendents of the domesticated animals, once used by the ancient agricultural population who were the former cultivators of the soil. There are also herds of sheep in the north of Mexico appearently quite wild. Of these are two varieties, one called the "Rocky Mountain Sheep," found inhabiting the elevated regions between the 48°th and 60°th parallels of north latitude, and near the head waters of the Columbia, the country at the sources of the Marais, the Saskatchewan and Arthabaska rivers, but less numerous on the eastern than on the western slope of the Rocky Mountains; and a second, bearing the name of the American Argali or Ovis Pygargus, believed by some to be identical with the Ovis Ammon of Central Asia, Siberia and Kamschatka. The wild *bison*, of which the domestic ox is a variety, are also found in large herds, and these, together with immense flocks of wild *turkeys* luxuriate at perfect liberty upon the rich pastures of the great prairies of the West.

The *turkey* was supposed by some to be a native of Peru, South America, by others to be a native of the East Indies, or Japan, or probably some of the islands of the Indian Ocean, whence it was brought to America by the ancient Malayan maratime adventurers. We see, however, no good reason why naturalists should seek an origin outside of America for any tribe of animals found on this continent, when the modern white men first set foot on it; still not attempting to deny that some of these tribes might have had an origin, if we may speak of an origin in some other quarter of the globe, for it cannot be said that there was no intercourse of men between these continents in the ages preceding the discovery of America by the modern Europeans, which undoubtedly there was.

Tropical plants and varieties of grasses common to other countries are found growing in the Western sections of the continent; among these are the maize and garden bean.

From the various relics which have been mentioned, and others to which we need not here refer, we gather that a great and powerful people, advanced in arts and agriculture, and acquainted with the use of metals, held sway over this continent prior to the red Indians. Ruins of ancient *pueblos*, remarkable for their construction and immense size, some of which were erected on the opposite sides of rivers, and connected by bridges, are scattered over the country, south of the great prairies of the West. The configuration of the surface, the existence of river beds where the water has long since ceased to flow, whose banks, once gay with a tropical verdure, plants, flowers and trees, have now given place to deserts of sand, presenting everywhere a picture of desolation; so that Domenech and others, who have explored these regions and written upon them, believe that, at some indefinite period of the past, this whole territory was densely populated by a settled agricultural people, but who, by some great geological change, perhaps volcanic, taking place in the country, changing the soil from a rich and fertile country, well watered, into a dry, barren, sandy desert, were compelled to seek a settlement elsewhere.

Domenech thinks that the great centres of this ancient civilization were near the great lakes in Ohio, and in Mexico, and Peru, whither the natives repaired to have commercial interchange with each other. This he deduces from the discovery of mica sheets from the Alleghanies, shells from the Gulf of Mexico and Florida, and obsidian from the mountains of Mexico, and copper instruments, with specimens of ore, from Lake Superior, which are found buried, together with ornaments of silver, brass, stone and bronze, in the ancient mounds of Ohio, and whose origin and history seems as impenetrable as the night of ages. In the history of the ancient American races are recognised in order by antiquarians the age of rough stone implements, the age of polished stone implements, and the age of copper tools. The ages of brass and iron instruments and tools are later, and that in which we live.

Since there exists such multitudinous relics of past civilization on this continent, it becomes a matter of interest to enquire whether, among the ancient traditions of America, or the records and mythologies of the Old World, any traces can be discovered of an acquaintance with this continent by the people of the other hemisphere. Inquirers of the greatest care and intelligence believe that communication between the two continents did exist at a very remote period. Evidences of this they discover in the ruins to which we have referred, and in the traditions of ancient America, as well as in the traditions and myths of classical antiquity. The antiquities of Mexico and Central America reveal religious devices, symbols, and ideas almost identical with those found in all countries of the Old World where communities called Cushite formerly existed. They exhibit evidences of the worship of the heavenly bodies, with its usual orphic and phallic accompaniments. Humboldt, when visiting America, observed these remains of past civilization, and was convinced that communication between the two continents formerly existed. The Abbé Domenech, who traversed the desert wilds of America and Mexico, also produced two volumes as the results of his discoveries, which abounded with evidences of an extinct civilization. Humboldt found evidences of it in the religious symbols, the hieroglyphics, the architecture, and the social customs, made manifest among the ruins, which he felt sure came from across the seas, and in his view the date of this communication was older than the present division of Asia into Chinese, Mongols, Tartars and Hindoos.*

The high state of agriculture, mechanical art, commerce, the profusion of gold and copper, and the religious views and domestic manners which were found to exist among the long since extinct Aztec and Zezcucon peoples found in possession of the Eastern Shores of Mexico by the rapacious Spaniards, are indicative of a long period of peaceful possession and prosperity in that country, during which time they had succeeded in surrounding themselves with every imaginable kind of luxury; and there are traces of a superior civilization even beyond the Aztecs. They possessed a system of numerals, and divided their year into 18 months of 20 days each, five complementary days being added, as by the Egyptians, to make up the full number of 365 days. They were also devoted to astrology, and their knowledge of astronomy is truly astonishing. They used the sun-dial to mark the day, which was divided into 16 parts, commencing at sunrise. An immense circular block of carved stone, disinhumed in the great square of Mexico, in 1790, has supplied the means of establishing some interesting facts in regard to ancient Mexican science. This colossal fragment, on which the calendar is engraved, shows that they had the means of determining the hours of the day with precision, the periods of the solstices and the equinoxes, and of the transit of the sun across the meridian of Mexico. It is hardly possible that a nation so far advanced as the Aztecs in mathematical science should not have made considerable progress in the mechanical arts. A degree of refinement is, indeed, shown by intellectual progress of any kind, requiring as it does a certain cultivation of both useful and elegant art. Agriculture was in the same advanced state in Mexico as were the other arts of social life. Their chief productions consisted of beans, Indian corn or maize, the cacao, from which chocolate is derived, the vanilla, used for flavoring their food and drink. The gigantic stalks of the great staple Indian corn afforded them a saccharine matter which supplied the natives with sugar little inferior to that of the cane itself; but the most wonderful production of their soil was the great Mexican aloe, or Maquey tree, whose clustering pyramids of flowers, towering above their dark coronals of leaves, were seen sprinkled over many broad acres of the table-land. Its bruised leaves afforded a paste, from which they manufactured paper; its juice was fermented into an intoxicating beverage called *pulque*, of which they were excessively fond; with its leaves the more humble dwellings were thatched; thread, of which coarse stuffs were manufactured, and strong cords, were made

* See, "Researches concerning the institutions and monuments of the ancient people of America."

from its tough and twisted fibres; pins and needles were made from the thorns on the extremity of its leaves; and the root, when subjected to a process of cooking, was converted into a palatable and nutritious food; it furnished, in short, meat, drink, clothing and writing material to the Aztecs. A large variety of plants, many of them of great medicinal virtue, have been introduced into Europe from these regions. The Mexican flowers also are of the most variegated and gaudy colors, and now form the greatest attraction of European greenhouses. They were well acquainted with the mineral as well as the vegetable treasures of their country. They drew silver, lead, and tin from the mines of Tasco; also copper from the mountains of Zacotollan, taken not only from the crude masses on the surface, but also from veins wrought in the solid rock into which they opened extensive galleries. The gold which they found on the surface and gleaned from the beds of rivers they cast into bars, in which state, or in the form of dust, it made part of the regular tribute. Iron existed in the soil, but they knew nothing of its uses. They found a substitute in an alloy of tin and copper, and with tools made of this bronze they could cut not only metals, but it is said, with the aid of siliceous dust, the hardest substances, as basalt, porphyry, amethysts and emeralds. They fashioned these last, which were found very large, into many curious and fantastic forms. They also cast vessels of gold and silver, carving them with their metallic chisels in a very delicate manner. Some of the silver vases were so large that a man could not encircle them with his arms. They imitated with great nicety the figures of animals; and, what was extraordinary, could mix the metals in such a manner that the feathers of a bird or the scale of a fish should be alternately of gold and silver. They used another metal, made of obsidian, a dark transparent mineral, exceedingly hard, found in abundance in their mountains, which they manufactured into knives, razors, and serrated swords. It was said to take a keen edge, although it soon became blunted; and with it they wrought the various stones and alabasters used in the construction of their public works, and principal buildings. These ancient Mexicans made utensils of earthenware for their ordinary purposes of domestic life. They made cups and vases of lacquered or painted wood, impervious to wet and gaudily colored. Their dyes were obtained from both mineral and vegetable substances. Among these was the rich cochineal, the modern rival of the far famed Tyrian purple; with this they gave a brilliant color to the webs which were manufactured of every degree of fineness from the cotton plant, which grew in abundance in the southern parts of the country. They also employed the art of interweaving with these the delicate hair of rabbits and other animals, which made a cloth of great warmth, as well as beauty, and of a kind altogether peculiar to themselves; on this they often laid a rich embroidery of birds, flowers, or other fanciful devices.

But the art in which they most delighted was the plumage or feather work; and with this they could produce all the effect of a beautiful mosaic. The gorgeous plumage of the tropical birds, especially of the parrot tribe, afforded them every variety of color; and the fine down of the humming-bird, which revelled in swarms among the honeysuckle bowers of Mexico, supplied them with soft aerial tints, which gave an exquisite finish to the picture. The feathers, pasted on a fine cotton web, were wrought into dresses for the wealthy, hangings for apartments, and ornaments for the temples. The profusion in which gold existed in Mexico and Peru, and the estimation in which it was held by these ancients, was best seen in the manner in which it was used in the liberal decoration of their temples, "which," one writer says, "shone resplendent by reason of the abundance in which it was used," and for the adornment and magnificence of their princes. Their palaces, gardens, fountains, and temples exceeded those of every other portion of the country, a detailed account of which is given by Prescott in his reference to the golden age of Tezcuco. Translations into the English and Spanish languages have been made of ancient manuscripts found in Mexico by the Spaniards at the time of their conquest of that country: one especially contains the advice of an Aztec mother to her daughter on the occasion of her marriage, inculcating the precepts of monogamy, conjugal fidelity, the idea of a Supreme Being, to whom all are responsible, and who sees all our actions. This document also contains an admonition to the bride to persevere in the practice of those graces and virtues which had distinguished her ancestors; advice in fact altogether equal to what might be expected of a Christian mother at the present day. The Abbé Brasseur de Bourbourg shows that the symbols of phallic worship were described by Spanish writers at the time of their conquest; that they were frequent in the countries of Central America, abounding in Colhuacan, a city on the gulf of California, and at Panuco (the former was at one time a flourishing city, the capital of an important kingdom); here phallic institutions had existed from time immemorial. In the temples at Panuco phallic symbols abounded, and also on the public monuments. These, with the serpent devices, the sun-worship, the remarkable knowledge of astronomy accompanying them, shows a system of religion of which the Abbé says: "Asia appears to have been its cradle, as that of the social institutions which it consecrated."

It is said that the traditions of the inhabitants of Mexico and Central America uniformly assert that the ancient American civilization came originally from the east "across the ocean." The Abbé de Bourbourg, speaking of the earliest civilization of the inhabitants of these countries, says: the native traditions generally attribute it to "bearded white men, who came across the ocean from the east." The history of Sahagun also states that, according to the traditions of the people of Yucatan, "the original civilizers came in ships from the east." Montezuma, it is said, related a similar tradition to the Spaniards. There were in Central America three classes of ancient inhabitants, first, the Chichimecs, who seem to have been the uncivilized aborigines of the country; the Colhuas, who were the first civilizers and who were "the bearded white men" who came in the early times across the Atlantic, and who built Palenque and other cities, originated the oldest and finest monuments of the ancient civilization, and established the great kingdom of Kibalba celebrated in tradition and history; it comprised Guatemala, Chiapas, Yucatan, and probably other countries. The third class of inhabitants mentioned are the Toltecs, a powerful race whom Humboldt, strangely enough, supposed to have derive their origin from the Huns, and who came much later as peaceable immigrants, but, uniting with the uncivilized Chichimecs, caused a civil war and acquired the ascendancy over the land.

Desiri Charmay, in speaking of the ruins of the ancient city of Mitla, points out the most ancient architecture, paintings, mosaics and artistic designs as being in the highest style, showing marvellous workmanship; while the later additions are in a much lower style, and seem to be the work of a people less advanced in culture and skill than the original founders of the city. The most remarkable and finest monuments found in those countries are believed to belong to the remains of the ancient kingdom of Kibalba. Other traditions point to an existing acquaintance with the country among the Chinese and Malays. The Abbé de Bourbourg relates that there was a constant tradition among the people who dwelt upon the Pacific Coast that people from distant countries across the Pacific formerly came to trade at the ports of Coatulco and Pechugui, which belonged to the Kingdom of Tehuantepec. Again, the traditions of Peru tell of people who came to that country by sea and landed on the Pacific Coast, thought probably to be the Malays of the great Malayan maratime empire that flourished in ancient days.

If we now turn to the ancient traditions, mythology, and records of the Eastern world, we shall find much that points directly to an acquaintance with the "Atlantic, or continent beyond the sea," which either appears to refer to America or to be utterly meaningless, which latter opinion does not seem to be entertained by any antiquarians of the present day. In ancient mythology there is reference to a great continent beyond the Cronian Sea, meaning the Atlantic; and it was in the Atlantadis of Homer and Horace, beyond the western waters, that the ancient poets placed their Elysian fields.

Theopompus, a learned historian and celebrated orator who lived in the days of Alexander the Great, relates, in his work entitled "Thaumasia," a very ancient dialogue which took place between Midas, King of Phrygia, and Silenus, in which the latter is made to say: "There is a continent beyond the sea, the dimensions of which are immense, almost without limit, greater than Asia, Europe and Lybia, (Africa) together, and so fertile that animals of a prodigious size are to be seen there, as likewise a race of men calling themselves Meropes, whose stature is much greater than that of ordinary men, and who attain to an extreme old age; that a great many large towns and cities were to be found on that continent, one of which contained above a million of inhabitants, and having different laws and customs from those of the people of Asia, Africa, and Europe; and, finally, that gold and silver were found very common over all the surface of that vast continent. Another writer relates that these Meropes were so persuaded that there existed no continent but their own that out of curiosity alone some of them crossed the ocean and visited the hyperboreans. Another ancient writer, Diodorus of Sicily, in his fifth book, chapter 11, has an important passage concerning this continent, which is historical, in which he affirms that some Phœnicians were cast upon the shores of an exceedingly fertile island situated opposite to Africa. The passage referred to reads as follows: Over against Africa lies a very great island in the vast ocean, many days' sail from Lybia westward. The soil is very fruitful, it is diversified with mountains and pleasant vales, and the towns are adorned with stately buildings. Its shores are indented with countless navigable rivers; its fields are well cultivated and dotted with delicious gardens and with plants and trees of every sort; finally he describes it as being the most beautiful country known, with inhabitants who live in spacious dwellings, possessing abundance of every kind. In regard to this the Abbé Domenech says: The recital made by Diodorus exactly corresponds with that of the first Spaniards who landed in Mexico.

It is related of one Hanno, who lived before the foundation of Rome, that he made a voyage beyond the Pillars of Hercules (the straits of Gibraltar) and visited a strange coast, which he reached by keeping due west, after traversing the ocean for thirty days. The best authors suppose this coast to have been that of one of the West India islands, or of the mainland of America. Homer, Solon, and Horace speak of the Atlantides as being islands situated at a distance of ten thousand stadia (a stadium is 606¾ English feet) west of Europe and Africa. Aristotle speaks of an island placed beyond the Straits of Hercules, in these words: It is said that the Carthaginians have discovered beyond the Pillars of Hercules a very fertile island, but which is without inhabitants, yet full of forests, navigable rivers, and abounding in fruit; it is estimated many days voyage from the mainland." Plutarch also has a passage quoted by Humboldt, in which mention is made in unmistakeable terms of a great transatlantic continent, and of a mysterious stranger who came from that distant country to Carthage, about 300 B. C., where he lived many years. According to Cabrera the first Carthaginian emigration to this Western continent took place during the first Punic war. According to Sandoval a succession of emigrations came from Ceylon, Java, and from Southern India to America, many centuries before Christopher Columbus. In support of this statement figures representing the god Boudha of Java, seated on a Siva's head, were found at Uxmal, in Yucatan. It is well established that a knowledge of the American continent existed in China and Japan long before the time of Columbus. M. de Guigies, relying upon the chronicles preserved in the Chinese work, Pran Y tien, attributes the Peruvian civilization to emigrations proceeding from China, from Japan, and the East Indies; recent investigations, it is thought, confirm this opinion. M. Paravey, in the year 1844, proved that the province of Fu-Sang, described in the Chinese annals, was nothing less than Mexico, known to them in the fifth century; and the Abbé de Bourbourg says, in his introduction to the *Popol-Vuh*: "It has been known to scholars nearly a century that the Chinese were acquainted with the American continent in the fifth century of our era; their ships visited it; they called it Fu-Sang, and said it was situated at the distance of 20,000 li (about 7000 miles) from Ta-Han.

J. Hanly, the Chinese interpreter at San Francisco, has lately written an essay upon this subject, in which he makes the following statements, drawn from Chinese historians and geographers: Fourteen hundred years ago even America had been discovered by the Chinese, and described by them. They stated that land to be about 20,000 Chinese miles distant from China. About 500 years after the birth of Christ Buddhist priests repaired thither and brought back the news that they had met with Buddhist idols and religious writings in the country already. Their descriptions in many respects resemble those of the Spaniards a thousand years after. They called the country "Fu-Sang," after a tree which grew there, the Maquey tree, whose leaves resemble those of the bamboo, whose bark the natives made clothes and paper out of, and whose fruit they ate. These particulars correspond remarkably with those given by the historian Prescott about the Maquey tree in Mexico. The accounts given by the Chinese and Spaniards, although a thousand years apart, agree in stating that the natives did not possess any iron, but only copper; that they made all their tools for working in stone and metals out of copper and tin; and that they, in comparison with the nations of Europe and Asia, thought but little of the worth of silver and gold. The religious customs and forms of worship presented the same characteristics to the Chinese fourteen hundred years ago. There is, moreover, said to be a remarkable resemblance between the religion of the Aztecs and the Buddhism of the Chinese, as well as between the manners and customs of the Aztecs and those of the people of China. It is, however, remarkable, and may be thought confirmatory of the idea of emigration from China to America, at some remote period, that at the time that America was discovered by the

Spaniards the Indian tribes on the coast of the Pacific opposite to China for the most part enjoyed a state of culture of ancient growth, while the inhabitants of the Atlantic coast were found in a state of original barbarism. The stone arrow-heads, lance-heads, hatchets and tomahawks found in Europe, India, Japan, and America, are so similar to each other that it is often impossible to distinguish them by their form. It is remarkable that everywhere except in America these weapons are believed by the common people to be thunder-bolts. They are called elf-bolts in Scotland: and Pliny speaks of them as *Ceraunia;* while in China and Japan the same origin is ascribed to them.

M. Leon de Rosny has ascertained that Fu-Sang is the topic of a curious notice in the great Japanese Encyclopedia, which enjoys the curious name of the "Wa-kan-san-tai-dron-ye." In that work it is said to be situated east of Japan, beyond the ocean, at the distance of about 20,000 Chinese miles from Ta-nan konek. Great stress is laid upon these records of the Chinese and Japanese, as they are peoples that do not deal in myths, but in actual facts and historical events.

Let us now turn our attention to the Atlantic coasts, and enquire into the early communication with this continent by Europeans, prior to Columbus. Following the chronological order of events as they seem to have transpired here we first refer to the emigration of the Ires, or people from Ireland, who came to this continent by way of Iceland at rather uncertain epochs. The opinion of learned men, familiar with the antiquities of the Western world, is that, as in the most ancient records of Iceland the first inhabitants of that island are called "men come from the west by the sea," so we may conclude that Iceland was not colonized by people coming direct from Europe, but by Ires who had returned from America who at an early period had been transplanted and, who returned from Virginia and the coast of Carolina (called Great Ireland) to settle in the island of Papar and the south-eastern coast of Iceland. In the ancient documents preserved in Iceland accounts are given of Christian Papas, or fathers who returned from Great Ireland on the West (America) to Iceland, to instruct the Icelanders in the principles of the Christian religion, about the year 800 A. D. Accounts are also given of persons who, having been cast away in ships, landed upon a western coast called "huitra manna land" or the land of the white men. These stories are considered as authentic, and as an important proof in favor of the prevailing opinion that at a very early period of the Christian era Irish colonies existed on the coast of the Carolinas and farther south. The Abbé Brasseur de Bourbourg in a note to his translation of the Popol-Vuh, says on this matter there is an abundance of legends and traditions concerning the passage of the Irish into America, and their habitual communication with that continent many centuries before Columbus was heard of.

An Irish saint named Vigile, who lived in the eighth century, was accused by Pope Zachary of having taught heresies on the subject of the antipodes. He at first wrote to the Pope in reply to the charge, but afterwards went to Rome to justify himself; and there he proved to the Pope that the Irish had long been accustomed to communicate with a transatlantic world. These facts are said to be preserved in the records of the Vatican. It is now an historical fact also that the northmen sailing from Iceland not only discovered America in the tenth century, but also established colonies on the coast of New England, and preserved a communication with these colonies for two centuries. In 877, Gunbiorn, the Icelandish navigator, first saw the mountain sea-board of Greenland. It appears from the Scandinavian manuscript, in which are to be found the accounts of the Normans' first voyages to America, that in 983 the celebrated Ari Marsson, while sailing southward, was cast by a storm upon the coast of this continent, which he called *Irland it Mikla*, or Great Ireland. In 986 Eric, surnamed the Red, established on these shores the first colony, composed of emigrants from Iceland. Afterwards, in 1121, a bishopric was instituted here called Garda, which existed for upwards of 300 years. In the year 1000, Lief, the eldest son of Eric the Red, sailed with thirty-five companions in seach of new discoveries, when he discovered Newfoundland, and called it Litla Helluland; re-embarking he arrived in the country situated between Newfoundland and Canada, which he called Markland (now Labrador); pursuing his voyage farther south, he landed on an agreeable coast, where he found an abundance of vines, which he called Vinland (now New England); here he made a settlement, which flourished for a length of time, and was visited in 1121 by the first bishop of Greenland, Eric Upn, of Irish origin, for the purpose of confirming the colonists of Vinland in the doctrines of Christianity. In the year 1002 another expedition, under Thorwald, visited this coast and landed at Cape Cod, near Boston, where the leader was killed in an encounter with the Esquimaux In the year 1006, Thorstein embarked on a similar expedition, but was unsuccessful. Thorfinn, the most celebrated of the first explorers of America, landed in the year 1007 on the island called *Martha's Vineyard*, on the New England coast, and spent two winters in the bay of Mount Hope, close to Secon t. From this time to the middle of the fourteenth century, very little can be ascertained concerning the Scandinavian colonies in America. In the twelfth century, Norwegian colonies existed in Greenland. In 1170 the Welsh prince Madog was quite certain of the existence of America, for, it is said, he sailed away westward, going south of Ireland, to find a land of refuge from the civil war which was raging among his countrymen. The Welsh annals inform us that he found the land he sought, and having made preparations for a settlement, he returned to Wales, secured a larger company, that filled ten ships, and then sailed away again and never returned. With reference to this Welsh colony, we may state that in 1660, the Rev. Morgan Jones, a Welsh clergyman, seeking to go by land from South Carolina to Roanoke, was captured by the Tuscarora Indians. He declares that his life was spared because he spoke Welsh, which some of the Indians understood; that he was able to converse with them in Welsh; and that he remained with them four months preaching to them in Welsh. Dr. Williams, in his work on the "Story of Prince Madog's emigration" published in 1791, explained Mr. Jones's statement by assuming that the Welsh colony, becoming weakened, had become incorporated with those Indians; and it is well known that in early colonial times the Tuscaroras were sometimes called "White Indians." It is known that the northmen had colonies in New England long before prince Madog's colony sailed for the Western continent; and one able writer says on this subject: "It is not so well known, but is nevertheless quite true, that they were preceded in Iceland by the Irish, and in voyages to America by the Irish and Basques; the latter, he says, were adventurous fishermen, who were accustomed to visit the north east coast of America from time immemorial" Thus it appears that sufficient evidence is afforded by ancient European records to warrant us in believing that America was not unknown to the ancients, and was comparatively well known to Europeans, in the early part of the Christian era, centuries before Columbus was heard of or the classical nations thought of changing their patristic geography.

The period of time which must have elapsed since the abandonment of the ancient monuments of America, of which we have spoken above, sufficient to allow of successive forests of so ancient a character to have lived and died upon them, taken together with other evidences of antiquity, lead us to suppose that the people by whom they were constructed lived and flourished in times perhaps long anterior to our historic ages; and this being the case we are told that those nations claim an antiquity which to Europeans appears almost fabulous. The Biblical chronologies extant in the present day appear to have been made out to show that the earth itself is scarce 6000 years old but it should be remembered that the scriptural writings furnish no data whereon to found any other than an uncertain and speculative chronology. When we look into the book of nature, which proclaims in such eloquent terms the wisdom and design and the progressive operations of the Creator, and which cannot lie, we find it tells us of events of such magnitude as to require prodigiously long periods of time for their accomplishment, making its moments appear eternities. What if in it we read that there are fossilliferous rocks which have been slowly raised ten thousand feet above the level of the sea, and that so late in the world's history as since the beginning of the tertiary period? What if it informs us that the peninsula of Florida, which is coraliferous, upon which are found monuments of ancient races, abandoned scores of centuries ago, has not required less than 135,000 years in the process of its formation? What if it tells us in most unmistakeable language that the coal deposits of the earth, which once in their history were immense dense forests of gigantic fern trees and grasses, must have required a period of 240,000 years as the minimum time for their accumulation; assuming that it is impossible to suppose that they were formed faster than at the rate of one tenth of an inch in a year; and this unfolds to us but a fragment of geological time. Or if we discover from it that the great chasm, seven miles in length, through which the Niagara river flows from Goat Island to Queenston Heights, required a period of over 30,000 years for its excavation; or that in certain alluvial beds numerous specimens of the mastodon giganteus have been found on the shores of Lake Ontario, one at a great depth in Burlington Heights, Hamilton, and one in the old river bed on Goat Island; and that these individuals must have lived and flourished (says Sir Charles Lyell in his "Age of Deposits in North America,") previous to the gradual excavation of that deep long chasm; for this ravine is not only postglacial but also posterior in date to the mastodon-bearing beds. Or, again, if the depression of the fern forests which now form the coal beds of Nova Scotia took place at the rate of four feet in a century, there was required a period of 375,000 years for their completion to their present depth. Or, as a forest can scarce produce more than two or three feet of vegetable soil in a thousand years, the dirt beds are the work of hundreds of centuries. Or if it tells us that the delta of the Mississippi could only have been formed in many tens of thousands of years (estimated by Sir Charles Lyell at 100,000): and that four successive cyprus forests lay buried in its depths and yet that it is only as a work of yesterday compared to the inland terraces of the Mississippi river; that skeletons have been disinhumed in this same delta to which Dr. Dowler assigns an antiquity of 40,000 years at least. Or, if, as Sir Charles Lyell says, it be admitted that the human remains discovered at Natchez, in connection with those of the Mastodon and Megalonyx, were found in their primitive bed, then a race of human beings must have occupied that country more than a thousand centuries ago: and if a thousand centuries, we may say, why not tens of thousands of centuries; yea, a beginningless succession of centuries; for who will put a beginning to the human race other than it has now? To many who with difficulty shake off their patristic chronology such statements appear wonderful, and yet they are the deductions the most learned and profound geologists have drawn from their perusals of the book of nature. Who then will say that the poet was not partly right who penned that remarkable line: "Thou canst not find one spot whereon no city stood."

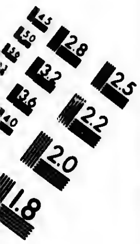
Before this continent was discovered by Columbus, Europeans generally did not know that it existed, with its races of men, its many languages, and its great natural wonders; but since that time, the progress of discovery has been rapid, and each continent and island that has been discovered has exhibited its peculiar human inhabitants with their language, its flora and fauna. And while the Europeans and Asiatics, in their vain imagination, were setting up theory after theory as to the existence and nature of the Deity,—yea, and adding one Deity to another in their assumed hierarchy of heaven; while they were expounding their doctrines of a literal creation of the earth in six literal days, of redemption, transubstantiation, total depravity, or predestination; while they were magnifying themselves in their own estimation by the invention of such systems, and the inculcation of such dogmas, they were all but totally ignorant of the earth on which they lived; much more of the Deity, in the immensity of his nature, whom they pretended to know. Alexander and the Romans both made great mistakes when they sat down under the impression that they had conquered the world. There remained vast continents on the earth which they had never seen, never dreamed of: and there remained even in their own hemisphere a far greater extent of land than that which they had conquered, and which they had never explored. There remained the vast continent of Africa, with its numerous tribes and languages; and equally vast Eastern and Northern Asia and Northern Europe. The Hindoos and the Chinese have literature which goes back for tens of thousands of years; but our European system-makers would place the beginning of the existence of the earth and of man at less than six thousand years ago. The ancient Pelasgians, inhabitants of Eastern Europe, including Greece and Italy, called themselves Autochthons, that is, "offsprings of the earth." This seems to have been their traditional belief of their origin. It was not, however, literally true, for no human being ever sprung from the earth as such. Nor did any real human being ever live that was not produced by his own kind, male and female.

Mr. Darwin, in his work on "the Descent of Man, and Selection in relation to Sex," makes the following statement as to the origin and descent of man: "The most ancient progenitors in the kingdom of the vertebrata, at which we are able to obtain an obscure glance, apparently consisted of a group of marine animals, resembling the larvæ of existing *Ascidians.* These animals probably gave rise to a group of fishes; these to the Samiada; the Samiada then branched off into the two great stems, the new world and the old world monkeys; and from the latter at a remote period, man, the wonder and glory of the universe, proceeded. Thus, we have given to man a pedigree of prodigious length, but not, it may be said, of noble quality." This is the theory which Mr. Darwin has propounded. In it we have five successive stages set forth in the descent of man from an insignificant salt-water animal to his present state. The first stage consists in a group of marine animals *resembling the larvæ of* *existing Ascidians*; (Greek ἀσκός, a leather bottle or wine skin, having two necks), called Ascidians from the resemblance which these little salt-water animals bear to a two-necked jar or bottle. But according to the statement the progenitors of man only *resembled* the larvæ or spawn of these bottle-shaped animals. The second stage was *probably* a group of fishes; the third that of the Samiada; the fourth that of the new world and old world monkeys; and the fifth his present stage as represented in mankind. The difficulty with us in this case is to conceive how any man, supposing him of sane mind, could expound such a gross absurdity; how he could possibly conceive of the human race ever being derived from the larvæ of the lowest species of salt-water animals; how he could conceive of little animals, which, if they resembled the larvæ of Ascidians, must have been invertebrate, being changed into fishes, vertebrate animals, a thing utterly impossible; how he could conceive of fishes being transmuted into Samiada, and these into monkeys, land animals; and of monkeys being transmuted into men!! Are men openly to degrade the Deity by representing him as having existed at any time, having no higher being to represent him in the earth than the larvæ of the lowest sea animals? Or are they going to deny that word of truth, which represents the Logos, the son, or man in whom the reason (and speech) is exhibited, as co-existing eternally with the Deity.* But this theory Mr. Darwin bases mainly upon geological discovery. He should bear in mind that the insignificant scratchings which geologists have done on exceedingly small spots of the earth's surface, amongst, for the most part, rocks of aquatic origin, are not by any means sufficient to base a theory upon which goes to assert absolute impossibilities with respect to any thing connected with the earth or to man. What do men know about the tens of thousands of genera and species of aquatic plants and animals which may now live on the beds of the mighty oceans of the earth? What do they know, but that most of the fossilized aquatic animals which geologists have discovered are now represented by living species in the oceans and seas, salt water and fresh? Some species which existed in time past may have entirely passed away, and their place may be supplied by the multiplication of individuals in remaining species. But the discoveries of geology thus far do not afford any sufficient reason to believe that most of the species of plants and animals which existed in times past are not now represented in living species. These species may be modified in size, but they are of the same structure. Man of the past, of whatever size, and we know that his size has varied in different ages, is represented by man of the present. And so, we think, men will find with respect to most of the other species of animals, as well as of plants, if they only take time to

* See Gospel of John, chapter I.

make sufficient research, of if they ever *can* do it. By the time that even the vast continents of South and North America, Australia, and all the Islands of the Pacific and Indian Oceans, as well as Asia, Africa, and Europe, have been thoroughly explored by naturalists and geologists, then men will be better able to determine with respect to the land species of both plants and animals of the present and the past. It cannot be said with respect to geological discovery, as it is said with respect to the classes of things that what is true of one member of the class is true of the class in general. The geological discovery of Britain or France or of any other part of Europe may not be at all a fair representation of the geological discovery which may be made in Tartary, China, Central Africa, Brazil, or Utah. Geologists know very well how that alteration is continually taking place in the earth's surface by elevation and depression; how that their researches hitherto have been among rocks chiefly of aquatic origin; how that many parts that were once dry land, inhabited by man and land animals, are now submerged far beneath the surface of the seas and oceans; and how that they could not answer a question, even approximately, with respect to the relations of past and present species until they would have explored not only all the dry land, but even the beds of the seas and oceans, a thing they cannot accomplish. Even in places on the land surface where fossil remains existed during long ages of the past there may remain no traces of any now, from the fact that they have disappeared by decomposition or some chemical process. But to say that one species of animals or of plants has ever been changed into another entirely different species is saying a thing has been done which has never been done, and which is utterly impossible to take place. All the species of plants and animals have always and permanently sprung from their own seeds. The rose bush never sprung from the seed of the tamarack, the apple tree from the seed of the plum, the bean from the seed of wheat; nor did any one species of plants or animals ever spring from other than seeds of their own kind. Cross breeds of animals, such as mules, always exhibit characteristics unmistakeably different from either of the species that entered into their production; and it is by the appearance and characteristics that the different species are determined. With respect to Mr. Darwin's theory, we have but to add to what we have already said, that strange indeed is the course taken by some speculative minds! The great mass of mankind remain yet unenlightened; and when an individual arises who has become possessed of information which he wishes to impart to the rest, his object should be to instruct and enlighten them in the truth, and not to propound erroneous theories which will tend only to confuse the people's minds and render the truth more difficult to be attained.

Man stands at the head of the animal creation, and has ever occupied that place. He has ever in general propagated with his own species. This is illustrated by the fact that in all countries which have been discovered no order of animals exists as indicating a cross species between man and the lower orders of animals, The different species of apes, monkeys, baboons, etc., are distinct from man and appear to have always been so. They differ from him not only in their appearance and habits, but in their bodily conformation also. Twenty-four alterations of structure at least, would be required for the transmutation of the body of a gorilla into that of a man, all these in the physical organization alone. And the difference in the mental capacity is still greater; for while the average capacity of the Anglo-Saxon skull, which perhaps may be taken as nearly the average capacity of all human skulls, is 96 cubic inches; that of the gorilla is only 34½; that of the Chimpanzee 27½; and that of the Orang 26 cubic inches. These are the highest of the ape tribes; they come nearest to man in the scale of being; and yet, what a gulf separates those orders from mankind! But what eminently distinguishes man from all other orders of animals, is the capacity of mind which he possesses, the power of reasoning, which indeed gives rise to the power of speech; and without which speech, properly so called, could not exist. Some have ventured to enquire why the apes do not speak; (for it may be remembered that no animal but man exercises the faculty of speech,) as, say they, the organ of speech of the apes resembles that of man. Such enquirers do not consider that organs of speech must act according to the mind which employs them. Hence while man uses a glottis or vocal chords, which act in accordance with his reason, or logos, to form a language, the apes can but employ the same organs to produce a bark or a yell. Human beings in all parts of the world, however unenlightened they may be, know, as it were instinctively, the relation in which they stand to the lower orders of animals; and even in the regions of Africa, far away from the civilization and unacquainted with the ideas and habits of the white races, they preserve their place, and regard the apes with superstitious horror! Even in the earliest periods of our race of which geology thus far furnishes us any information we find its members displaying a certain ingenuity and tact in the making of tomahawks, arrows, etc., and for all we know to the contrary, they may have displayed great ingenuity in the construction of innumerable other things, every trace of which has ages since passed away. There was doubtless in all ages a difference of degree existing in respect to civilization, as there is now, among the different tribes of mankind. And even in the earliest geological times, we find them exercising the care of burying their dead or of burning them, which will, in the main, account for the fossil remains of man not being found strewed as broadcast as those of the lower land animals. Man has always exercised a care over the dead of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his own species which none of the lower orders of animals were capable of exercising. This of itself is enough to show that he always possessed and exercised the power of reason, and speech. * Would that he had always used this faculty aright! Well and happy would it thus have been for him! Even the Quadrumana, or Ape-tribe, which comes nearest to man in the scale of being, do not evince to us that they have any conception of care for their dead. All the care which they exhibit and which they have in common with all others animals, even the lowest, is for their young, and to supply their own physical wants. All the Indian tribes of North and South America, even in their most wild and savage state, have always, since the white men have become acquainted with them, given evidence of deep affection and care for their dead; and some of these tribes are accustomed to come periodically, bringing offerings and tears to their tombs! And every human being, possessing the ordinary mental faculties of a human being, of whatever nation or language, you may meet with, will, if you find him in circumstances favorable for the intercommunication of ideas, give unmistakable evidence of his possessing reason, and of his having some thoughts as to right and wrong much as you have yourself. How long ere human beings exercise such kindness toward each other as their kindred relation calls for? How long before all men will cultivate and exercise only the principle of benevolence, to be good and to do good? When that

* The consideration of the great development of language among the civilized nations, ancient as well as modern, would go far to show man's true position in the scale of creation. This is especially so in the case of the Greek language, which is constructed with such mathematical precision, and which has been cultivated after that manner in such an early age. Also, in the Latin, which approaches the Greek in the beauty and the complexity of its construction, though not in the smoothness of its sound, man's mental superiority over the lower animals is no less apparent. Even in the contsruction of these two languages we see a very remarkable degree of skill displayed, and in their use during the historic ages, a wonderful development of reasoning power. But because the language of a nation does not display a great number of words, this is not a sufficient indication that it is not ingeniously constructed. Succinctness of expression gives power to language. The languages of all the Indian tribes of America, South and North, including the Esquimaux, though differing much from each other as to root and sound, are all constructed upon the polysinthetic principle; that is, root is so added on to root, that quite a number of ideas may be expressed by one complex word. And these people do not give much attention to the niceties and the mathematical complexities of mood, and tense, and case. For instance, one of the tribes, the Algonquins, are said by a missionary, who has been amongst them, to have espressed the following number of ideas by one word, "nadholineen;" "Come and fetch us across the river in a canoe." The Greek language, both as to its alphabet and construction, must have been in use in very early times. This is evident from the perfection it displayed, as compared with other ancient languages, even so early as the age of Homer, the 12th century B. C. It then had its several dialects of the Doric, Ionic, Æolic, and Attic, which all after yielded in perfection to the perfected Attic. The Latin also, which, as the Attic, was the perfected product of many Italian dialects, must have had a very early origin as to its characters and construction, since that we meet with the construction of mood, and tense, and case, even in the earliest authors of this language, as in the Greek. The characters and constructions of these two languages are old, and the thought of their authors is old, and indicative of true human feeling.

time has come, they will know what we say to be true, and each one will realize for one's self the application of the name which has long ago been given of the Eternal Father.

A contemplation of other scenes and objects of Nature intended to further enlighten us and to exalt our conceptions and ideas concerning the Deity.

All the works of nature speak of their author in silent but emphatic language, and declare his wonderful perfections. But, although there is no speech nor language in which the voice of Deity is not heard, yet how gross and inadequate are the conceptions generally entertained of that Being in whom we live and move, and by whose power all events in nature are directed and controlled. The benevolence of the Deity is seen not only in the sunshine and the shower, but in the ample provision which is made on the earth for the wants of man and all other animals. Some fifty years ago it had been ascertained that more than 60,000 species of animals inhabited the air, the earth, and the waters; and it was supposed that many more thousand species existed, which had not, up to that time, come within the observation of the naturalist. Since then, naturalists may, by their discoveries, have added largely to the number of known species, and they may still go on discovering, and be able only to make near approaches to the real number existing in the earth and in connection with it, a number which it does not seem they will ever be able definitely to learn. On the earth's surface there is not a patch of ground or a portion of water, a single shrub, tree, herb or plant, nor a single leaf of a tree or flower, but what teems with animated or sensitive beings. What countless millions even of visible animals have their dwellings in caves, in the clefts of rocks, in the bark of trees, in ditches and fences, in marshes, in the forests, the mountains and the valleys. What innumerable shoals of fishes, of various sizes and appearances, inhabit the ocean and sport in the seas and rivers. What millions on millions of birds and flying insects, in endless variety, wing their flight through the atmosphere above and around us! Besides these there are innumerable multitudes of animated beings, invisible to the unassisted eye, and dispersed through every region of the earth, air, and seas. In a small stagnant pool which, in summer, appears sheeted over with a green scum, there are more microscopic animalcules than would outnumber all the human inhabitants of the earth. How immensely great then must be the collective number of these creatures throughout all the regions of the earth and atmosphere! It utterly surpasses the limits of our conceptions. Now, it is a fact that, from the elephant to the mite, from the whale to the clam, and from the ostrich to the gnat or the microscopic animalcule, no animal can subsist without nourishment. The species, too, require various kinds of food; some live on grass, some on shrubs, some on flowers, and some on trees; some feed only on the roots of vegetables, some on the stalks or stems, some on the leaves, some on the fruit, some on the seed, some on the whole plant; and some, as we have shown before, from Linnæus, with respect to quadrupeds, prefer one species of grass or vegetables, some another. Yet such is the boundless munificence of the Creator, that all these countless myriads of sentient beings are amply provided for in nature. The eyes of all these sentient beings look unto the Creator, and he openeth His hand, and satisfieth the desire of every living being. The world is so arranged that every place affords the proper food for all the living creatures with which it is inhabited. They are furnished with every organ and apparatus for the gathering, preparing, and digesting of their food, and are endowed with admirable sagacity in finding out and providing their nourishment, and enabling them to distinguish between what is salutary and what is pernicious. In the exercise of these faculties, and in all their motions, they appear to enjoy a happiness suitable to their nature. The young of all animals in the exercise of their incipient faculties, the fishes sporting in the water, the birds skimming through the air or warbling in the thickets, the gamesome cattle browsing in the pastures, the wild beasts bounding through the forests, the insects gliding through the air and crawling along the ground, and even the earth-worms wriggling in the dust, all proclaim, by the vivacity of their movements and their various tones and gesticulations, that they are not without enjoyment in the exercise of their powers. In this boundless scene of animate existence we see a striking illustration of the truth of the statements, "Jehovah is good to all," the earth is full of His riches," and "His tender mercies are over all His works." Although such displays of adaptation in animate creatures to their circumstances, and in the arrangements for their wants and enjoyments, are obvious evidences of benevolence in the Deity to a reflecting mind, yet they are almost entirely overlooked by the bulk of mankind, owing to their ignorance of the facts of natural history, and the inconsiderateness with which they are accustomed to view the objects of the visible creation. Hence they are incapable of appreciating the beneficence of the character of the Deity, and the wealth of his munificence, and unable to feel those emotions of admiration which an enlightened contemplation of the scenes of nature are calculated to inspire.

Infinity of ideas and conceptions in the mind of the Creator.

As the conceptions existing in the mind of an artificer are known by the work he produces, or the operations he performs, so the ideas which have eternally * existed in the Creator's mind may be known from the objects

* That this infinity of ideas always existed in the Creator's, mind is necessarily certain from the fact of the infinite and eternal omnipresence of the Creator, which necessitates that these ideas could not arise to him from any other source than from himself. The

He creates, the events He brings about, and the operations He is incessantly conducting. The production of a single object is an exhibition of the idea existing in the creative mind of which it is a copy. The production of a second or third object exactly resembling the first would only exhibit the same idea a second or a third time without disclosing anything new concerning the producer; and, consequently, our conceptions of his intelligence would not be enlarged though millions of such objects were presented to our view, just as a hundred pairs of spectacles or a hundred microscopes of exactly the same pattern, constructed by the same artist, give us no higher idea of his skill and ingenuity than the construction of one. But every variety in the objects and arrangements of nature exhibits a new discovery of the contrivances, the intelligence, and the multiplicity of ideas of the Creator; and these varieties, as the Creator, are infinite.

It is proper here to state that the objects which man produces are all imitations of objects already existing in nature, and that man cannot have any *true* conceptions but what are of existing things. The word idea means literally an image or picture of anything; and as everybody knows there cannot be a true image or picture unless there exists a thing of which the image or picture is a representation; so neither can there be a true idea conceived in the mind unless a thing exists in the universe of which it is a representation. This will at once satisfy any thinking mind that a real world exists external to one's self in opposition to any false theory which will represent the world as consisting merely of our conceptions.

We remember once being in company with some rural friends, when bishop Berkeley's theory was mentioned, a theory which pretends to demonstrate that no external world exists, and that when one sees with his

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Creator alone is eternal; all created things have a beginning and an end in time and space It cannot be said that the idea or ideas implied in the created thing arose to the Creator from the thing created any more than a picture can exist without an original existing of which it is a copy. All created things are merely copies of ideas pre-existing in the creator's mind. This general idea of created things refers to all the objects created on or in the earth, on or in any of the heavenly bodies, or in any part of space. That the earth considered as a globe made up of solid, liquid and aeriform substances, has a limit in every direction in space cannot be doubted; and thus it is beyond all doubt with each of the heavenly bodies, for the earth and each of them perform motions and revolutions in space around each other; but it cannot he said with any exhibition of evidence that any of them has had a beginning or will have an end in time. It is in accordance with our experience and knowledge that all things created in the animal and vegetable world have a beginning and an end in time and space; and also in the mineral world, even in the bowels of the earth, we find change taking place, one form or species of matter frequently taking the place of another in mineral existences, and to the extent that this change takes place in the mineral department of existence, to this extent there is mineral creation. Indeed the whole earth may be said to be continually in a state of change, and so it may be said to be an object of creation. But while all these creative changes which we speak of take place it is contrary to our experience, nor is there any valid evidence to prove, whatever individual reason may have to say concerning it, that the earth or any one of the heavenly bodies as to its form and substance, ever existed otherwise than it exists now.

eyes any object, for example a tree, he does not see the tree but only a picture of it on his retina. This illustration of the theory being made, one of the company expressed himself as follows: "Well, I guess, if he bumped his head against it, he would find out whether it was a tree or only an idea." Even so the readers may always feel assured that a world exists external to themselves in which they as creatures live and move. And each human being has his own ideas of and concerning the world. This external world you realize in every man and every object you behold. The martyr at the stake, or on the cross, realizes it in those who are cruelly depriving him of life. The convicted person in the court or on the scaffold realizes it by all he sees around him. And both opposing parties in the terrible bayonet charge realize mutually this great fact. Let no one by sophistry or plausible talk impose upon you to such a degree as to cause you to believe that a shadow can exist without a substance; or that true ideas can exist in the mind without the real things existing of which they are the pictures,* even so the Deity is everywhere present, a great reality; You can appreciate his presence and character in all the objects and operations of nature; nor can sophistry or plausible words, spun out to any extent, make the Deity other than that great and omnipresent reality the Deity is. You should ever remember that your duty is to be good and to do good before him, worshipping him who is invisible alone in spirit and in truth.

The young (yea, and the old) should always remember, that while studying, either from books or from nature, it is very important to acquire full and distinct ideas in their minds of the subjects of their study; for as true ideas cannot exist without the real things existing, of which they are but the pictures or shadows; even so a proper and well connected discourse on any subject cannot be produced unless the distinct ideas exist in the mind before, of which the discourse is but a representation. Ideas are representations of things, and words are representations of ideas; and words spoken inconsiderately, and at random, which are not the representations of true and well defined ideas, are as chaff blown away by the wind; they produce no proper effect, and are better left unspoken. The young and old should endeavour to have full, and true, and well-defined ideas of things, and having these they will acquire, with comparative ease, words to express them. First have full and accurate ideas on any subject, and a sufficiency of words to express those ideas will naturally and easily follow.

Now in the universe, we find all things constructed and arranged on the plan of boundless variety. In the animal kingdom, as we have already remarked, there had been ascertained some fifty years ago,

* Ideas which do not represent real things are fictitious, creations of the imagination.

sixty thousand different species of animate beings. These were enumerated as follows: Six hundred species of mammalia, or animals that suckle their young, most of which are quadrupeds; four thousand species of birds; three thousand species of fishes; seven hundred species of reptiles, and forty-four thousand species of insects; about three thousand species of shell-fish; and besides these there were perhaps one hundred thousand species of animalcules invisible to the naked eye, which the microscope had brought to view, and new species daily discovering in consequence of the zeal and industry of the lovers of Natural History. We cannot set any definite limits to the number of animate beings existing in the earth, which has never yet been thoroughly explored, and never can be.

We may next consider that the organized structure of each species consists of an immense number of parts, and that all the species are endlessly diversified, differing from each other in their forms, organs, members, faculties, and motions. They are of all shapes and sizes, from the microscopic animalculum, ten thousand times less than a mite, to the elephant and the whale. They are different in regard to the construction of their sensitive organs. In regard to the eye, some have that organ placed in front so as to look directly forward, as in man. The human eye is so constructed by means of muscular bands attached to it as to be able to move up or down, to the right side or to the left, without the head being moved. This, you see, is a very convenient arrangement indicating benevolent design in the Creator. Other animals, as birds, deer, hares, and conies, have this organ so placed toward the side of the head as to take in nearly a whole hemisphere. This is a convenient arrangement for them, as it enables them to see their pursuers behind them, without turning the head. Some have this organ fixed and others moveable; some have two globes or balls, as man and quadrupeds; some have four, as snails, which are fixed in their horns; some have eight, set like a locket of diamonds, as spiders; some have several hundreds, as flies and beetles; and others have over twenty thousand, as the dragon-fly, and several species of butterflies.*

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* The eyes of beetles, silk-worms, flies, and several other kinds of insects are among the most admirable productions of the Creator. On the head of a fly are two large protuberances, corresponding to the two eyes in other animals, one on each side; these constitute its organs of vision. The whole surface of these protuberances is covered with a multitude of small hemispheres, placed with the greatest regularity in rows, crossing each other in a kind of lattice work. These little hemispheres have each a minute, transparent, convex lens in the middle, each of which has a distinct branch of the optic nerve ministering to it; so that the different lenses may be considered as so many distinct eyes; Mr. Leeuwenhoek counted 6236 in the two eyes of a silk-worm, when in its fly state; 3180 in each eye of a beetle; and 8000 in the two eyes of the common fly. Mr. Hooke reckoned 14,000 in the eyes of a drone-fly; and in one of the eyes of a dragon-fly there have been reckoned 13,500 of these

In regard to the ear, some have it large, erect and open, as in man and the hare, so as to hear the least noise and avoid danger; in some it is covered to keep out noxious bodies; and in others, as the mole, it is lodged deep and backward in the head, fenced and guarded from external injuries. With regard to their clothing, some have their body covered with hair, as quadrupeds; some with feathers, as birds; some with scales, as fishes; some with shells, as the tortoise; some only with skin, as some serpents and eels; some with stout and firm armor, as the rhinoceros and crocodile; and others with prickles, as the hedgehog and porcupine; all nicely adapted to the nature of the animal, and the element in which it lives. These coverings too are adorned with diversified beauties, as appears in the plumage of birds, the feathers of the peacock, the scales of fishes, the hair of quadrupeds, and the variegated polish and coloring of the tropical shell-fish, beauties which, in respect of symmetry, polish, texture, variety and exquisite coloring, defeat every attempt of human art to imitate or to copy.

In regard to respiration, some breathe through the mouth by means of lungs, as men and quadrupeds; some by means of gills, as fishes; and some, during the early part of their life, as the frog, breathe by means of gills, and in a more advanced stage of it they acquire lungs and breathe by means of them; and some breathe by organs placed in other parts of their bodies, as insects. In regard to the circulation of the blood, some have

es, and consequently in both eyes 27,000, every one of which is capable of forming a distinct image of any object, in the same manner as a common convex glass; so that there are 27,000 images formed on the retina of this little animal. Mr. Leeuwenhoek, having prepared the eye of a fly for that purpose, placed it a little farther from his microscope than when he would examine an object, so as to have a proper focal distance between it and the lens of his microscope; and then looked through both, in the manner of a telescope, at the steeple of a church, which was 299 feet high, and 750 feet distant, and could plainly see through every little lens the whole steeple, inverted, though not larger than the point of a fine needle; and then directing it to a neigbouring house saw through many of the little hemispheres, not only the front of the house, but also the doors and windows, and could discover distinctly whether the doors were open or shut; Such an exquisite piece of mechanism transcends all human comprehension.

The eyes of a fly are very large when compared with the size of the head. If one of these compound eyes be examined under a glass with a linear magnifying power of 100 the organ will be found to consist of many thousand tubes, each fixed in a six-sided case. Every one of these eyelets appears to be a perfect simple eye, resembling in all essentials that of a man. Dr. Hooke gave the number of eyelets in each eye at 7,000, and Dr. Carpenter estimates them at 4000. Thus at the lowest computation, a common house-fly possesses 8000 separate organs of vision.

The eyes of all insects are compound. The eye of a butterfly contains in reality about 17,000 eyelets giving to this gaudy insect, 34,000 in all. Each eyelet is a perfect organ in itself, hexagonal, or six-sided, in shape, so that the whole collection resembles the cells in a large honeycomb. Some of these insects have also two simple eyes on the top of the head, so that we must confess ourselves to be altogether inferior in the matter of eyes to the gaudy butterfly. It must not be supposed that when a butterfly looks upon a female of his own species he sees 34,000 fluttering beauties before him. As the two human eyes do not double objects so the numerous lenses of the butterfly may combine to form but one image.

but one ventricle in the heart, some two, and others three. In some animals, as man, the heart propels the blood to the remotest part of the system; in some it throws it only into the respiratory organs; in others the blood is carried from the respiratory organs, by means of the veins, to another heart, and this second heart distributes the blood by the channels of its arteries to the several parts. In many insects a number of hearts are placed at intervals along the circulating course, and each renews the impulse of the former, so that a continual circulation is kept up.

In regard to the bodily movements, some are endowed with quick motions, others slow; some walk on two legs, as fowls; some on four, as dogs; some on eight, as caterpillars; some on a hundred, as scolopendra; some on fifteen hundred and twenty feet, as one species of starfish; and some on two thousand feet, as certain species of echinus. (It is mentioned by Lyonet that these echini have 1300 horns, which they protrude and draw in at pleasure). Some glide along with a sinuous motion on scales, as snakes and serpents; some skim through the air, one species on two wings, another on four; and some convey themselves in speed and safety by means of their webs, as spiders; while others glide with agility through the waters by the instrumentality of their tails and fins. Some animals are distinguished for having an internal bony skelet on, as man, beasts, birds, and fishes, thence called vertebrate; some for having an external bony skeleton jointed at intervals as the lobster and insects, and thence called articulate; some for living in horny houses, as shell-fish, turtles, and land snails, and thence called crustaceous, and molluscous. Some live fixed like plants at the bottom of the sea, as the hydra. This animal, for example, produces young not only from eggs in the ordinary way, but also by putting forth buds from its sides, which while attached to the parent develop mouths and arms, and then become separated; and having become fixed in their turn they live for themselves. The animals called crinoids grow like plants in the seas of the Tropics. The sponge also is a plant animal which lives fixed at the bottom of the sea. These sponge-plant animals, are of various forms, some of them corresponding to our moorland moss-tufts; some to the most elegant types of flower form, and some resembling in miniature the great candelebra-formed berus of the Gila regions. Most people have seen and used the sponge sold in our stores, which is merely part of the skeleton of those plant-animals. The great coral islands of the Pacific Ocean are merely aggregations of animal developments. The coral is the solid parts of the animal, composed of carbonate of lime, and corresponds, as does the sponge, to the bony skeleton in higher animals. Corals are of different forms, sometimes having the form of trees and shrubs, and sometimes a round form, as the br ain-stone. You have, therefore, in these plant-animals, which are developed in great variety and to vast extent in the seas and oceans, the connecting link between the animal and vegetable, and mineral kingdoms.

But it would require volumes to enumerate and explain all the varieties and peculiarities which distinguish the different species of animated beings. Besides the varieties which distinguish the species from each other, there are not, perhaps, of all the hundreds of millions of individuals which compose any one species, two individuals exactly alike in every point of view in which they may be contemplated. As an example of the numerous parts and functions which enter into the construction of an animal frame, we may state that in the human body there are about 254 bones, each of them having about forty different intentions or adaptations; and 446 muscles, each having ten several intentions, so that the system of bones and muscles alone comprises about 14,620 varieties or different scopes and intentions. But, besides the bones and muscles, there are hundreds of tendons and ligaments for the purpose of connecting them together; hundreds of nerves ramified over the whole body to convey sensation to all its parts. The nerves have their centres in the brain and spinal marrow, whence ramifications proceed to all parts of the body. Nerve is derived from the Latin, and means cord; and the nerves, though infinitely fine cords, may, for the sake of illustration, be compared to telegraph-wires, which communicate their messages *instantly* to their centres, and thence to all parts of the system. The human being has five senses, sight, hearing, touch or feeling, taste, and smell; each of these has its peculiar set of nerves; and not only that, but the nerves are so closely reticulated over the whole body that you cannot prick it in any place with the point of the finest needle without affecting numbers of them. The senses, then, are the channels through which the sensitive or animate being communicates with the external world; by which the rational being knows that it exists, and that he exists. There are thousands of arteries to convey the blood to the remotest extremities of the system, and thousands of veins to bring it again to the heart; thousands of lacteal and lymphatic vessels to absorb nutriment from the food; thousands of glands to secrete humours from the blood, and of emunctories to throw them off from the system; and besides many other parts of this variegated system with which we are unacquainted, there are more than sixteen hundred millions of membranous cells, or vesicles, connected with the lungs; more than two hundred thousand millions of pores in the skin, through which the perspiration is incessantly flowing; and above a thousand millions of scales which, according to Leeuwenhoek, Baker, and others, compose the cuticle or outer covering of the body. We have also to take into account the compound organs of life, the numerous parts of which they consist, and the diversified functions they perform; such as the brain, with its infinite number of fibres and numerous functions; the heart, with its ventricles and auricles; the stomach, with its muscular coats and juices; the liver, with its lobes and glands; the spleen, with its infinity of cells and membranes; the pancreas, with its juice and numerous glands; the kidneys, with their fine capillary tubes; the intestines, with all their windings and convolutions; the organs of sense, with their multifarious connections; the messentery, gall bladder, the uretus, the pylorus, the duodenum, the blood, the bile, the lymph, the saliva, the chyle, the hair, the nails, and the numerous other parts and substances, every one of which has diversified functions to perform.

We may also take into consideration the number of ideas included in the connection and arrangement of all these parts, and of the manner in which the yare compacted into one system of small dimensions, so as to allow free scope for all the intended functions. If then, for the sake of illustration, we were to suppose, in addition to the 14,620 adaptations of the bones and muscles, as stated above, that there are 10,000 veins, great and small; 10,000 arteries, 10,000 nerves, 1,000 ligaments, 4,000 lacteals and lymphatics, 100,000 glands, 1,600,000,000 vesicles in the lungs, 1,000,000,000 scales, and 200,000,000,000 pores, the amount would be 202,600,149,460 different parts and adaptations in the human body; and if all the other species were supposed to consist of a similar number of parts, though differently organised, this number multiplied by 300,000, the supposed number of species, the product would amount to 60,780,044,838,000,000, or above sixty thousand billions, the number of distinct ideas, conceptions or contrivances, in relation to the animal world, a number of which we can have no adequate conception, and to our minds seems to approximate to infinity; but the calculation is merely a rude approximation, and may serve to convey some idea of the endless multiplicity of conceptions which pervade the Eternal mind.

That many other tribes of animate beings have an organization no less complicated and diversified than that of man, will appear from the following statement of M. Lyonet. This celebrated naturalist wrote a treatise upon a single insect, the cossus caterpillar, which lives on the leaves of the willow, in which he has shown from the anatomy of that animal, that its structure is almost as complicated as that of the human body, and many of the parts which enter into its organization even more numerous. He has found it necessary to employ twenty figures to explain the structure of the head, which contains 228 different muscles. There are 1647 muscles in the body, and 2066 in the intestinal tube, making in all 3941 muscles, or nearly nine times the number of muscles in the human body. There are 94 principal nerves, which divide into innumerable ramifications. There are two large tracheal arteries, one at the right and the other at the left side of the insect, each of them communicating with the air by means of nine spiracula. Round each spiraculum the trachea pushes forth a great number of branches, which are again divided into smaller ones, and these subdivided and spread through the whole body of the caterpillar; they are naturally of a silver color, and make a beautiful appearance. The principal tracheal vessels divide into 1326 different branches. All this complication of delicate mechanism, with numerous other parts and organs, are compressed into a body only two inches in length.

If we direct our attention to the vegetable kingdom, we may contemplate a scene no less variegated and astonishing than what appears in the animal world. There have already been discovered about ninety thousand species of plants, specimens of the greater part of which have been preserved in the museum of Natural History at Paris. But it is said by naturalists that the actual number in the earth and waters cannot be reckoned at less than four or five hundred thousand species; indeed the truth is that as in the animal kingdom, they can put no definite limits to the number, for a great part of the earth they can never explore.

The observer who takes a survey of the various members of the vegetable kingdom becomes cognisant of at least one prominent distinction between them. He soon perceives that while certain vegetables have flowers, others have none; or, perhaps, more correctly speaking, if the second division really possess flowers they are imperceptible. This distinction was first taken as a basis of classification by Linnæus, the Swedish naturalist; and to this extent the classification adopted by that great philosopher was strictly natural; beyond this his classification was artificial. Now taking advantage of this distinction, Linnæus termed the evident-flowering plants *phœnogamous*, from a Greek word signifying *to appear*; and he designated the non-flowering or more correctly speaking, the non-evident-flowering plants *Cryptogamic*, from a Greek word signifying *concealed*. In making this division of plants into flowering and non-flowering, one must greatly expand his common notions of a flower, and not restrict the appellation to those pretty floral ornaments, which become objects of attraction, and of which bouquets are made. On the contrary he must admit to the right of being regarded as a flower any floral part, however small, even though a microscope should prove necessary for its discovery. Thus, in common language we do not usually speak of the oak, the ash, the beech, the elm, etc., as being flower-bearing trees; but they are, nevertheless, and consequently belong to the first grand division of flowering, or phœnogamous, plants. The reader may remember as a rule, to which there are no exceptions, that every member of the vegetable world which bears a fruit, and consequently seeds, belongs to the phœnogamous division. By following the indications of this rule, we restrict the cryptogamic, or non-flowering plants, to the seemingly narrow limits of ferns, mushrooms, mosses, and a few others, all of which are devoid of seeds, properly so called, but are furnished with a substitute for seeds termed *sporules* or *spores*. Sporules, then, the reader may remember are, so to speak, the seeds of flowerless and, therefore, seedless plants. We have before spoken of the vegetable kingdom as being divided into the two great branches of exogenous and endogenous plants. We may here state, however, that these two branches are included within the one great division of flowering plants, and have nothing to do with the non-flowering division, which is itself confined to narrow limits of the lowest species of plants.

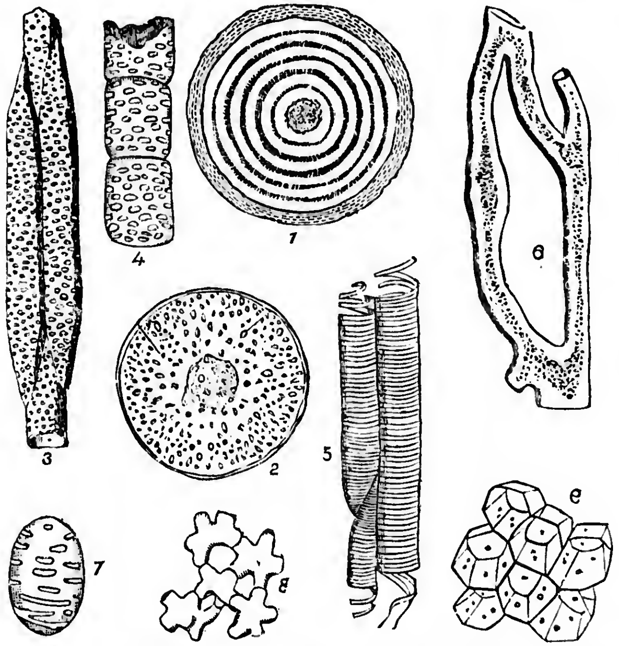
All plants, most probably, certainly all flowering plants, possess sexes. The flower and its appendages are the reproductive organs of the plants. Without flowers there could be no fruit; without fruit there could be no seed; and without seed, properly so called, by far the greater number of vegetables could not be multiplied. Both sexes, the male organ called stamen, upon which the pollen or fecundating dust is produced, and the female organ called pistil, in which the fertilizing takes place, are usually contained in the same plant, in the same flower of the plant. Occasionally, however, the two sexes are on different flowers of the same plant, and sometimes on different plants. We may, therefore, properly say that the greater number of flowers contain both sexes; but occasionally, on some plants, the sexes have flowers, each sex to itself; and occasionally again the males monopolise all the flowers on one plant, and the females all the flowers on another. When the two sexes reside in two sets of flowers on the same plant, then such a plant is said to be *monœcious*, signifying "one house;" the plant, we suppose, being regarded as a house, and the flowers as chambers in the same, in which the ladies and gentlemen dwell. When, however, the males all reside in the flowers of one plant, and the females in the flowers of another, then such plants are said to be *diœcious*, or "two-housed," the reason of which is obvious. The seeds or eggs of the plants are fertilized by the pollen, a yellowish powder, from the stamen, falling on the top of the pistil, causing it to expand, and finding its way into the ovary, or seed-case, situated at the bottom of the pistil; and so the seeds are fertilized and prepared to produce when placed in proper circumstances. See figures on pages 201, 202, 203.

The function of seeds in the flowerless plants is, as we have said, performed by spores or sporules, from σπόρος, the Greek word for scattered seeds. This class of plants is very small when compared with the flowering; and the spores are prepared for the most part in little receptacles called sporanges or theca; from whence when ripe they are scattered about by the winds; the old plants dying, new ones spring up from the spores to replace them. The best known species of this cryptogamic division, are the mosses, lichens, ferns, and fungi. The fungi are said by naturalists to be a mass of reproductive matter in themselves. In these non-flowering species may be recognized the lowest in the scale of plants; just as we have seen sponges, corals etc., to be the lowest in the scale of animals. Do not the fungi, sponges, etc., of the two kingdoms bear some resemblance to each other?

If the reader wishes to know what the sporules are like let him take the well-ripe leaf of a fern, (which is not properly a leaf, but a frond); let him turn the under surface of the frond uppermost, and he will see thereon many rows of dark stripes. These are termed *Sporidia*, and they contain the spores or sporules of the plant; which latter may be obtained by opening the sporidia. These sporules, when viewed with the naked eye, look almost like dust; when examined under a microscope, however, their outline is easily recognized. The difference between a sporidium or sporule and a real seed may be thus explained: a seed has only one part, the embryo or germ, from which the young plant can spring; whereas a sporule does not refuse to sprout from any side which may present itself to the necessary conditions of earth and moisture. Thus we see the resemblance of these minute seeds to the sponge, which is said to be a vast mass of reproductive matter. Although the sporules are thus easily discernible in the fern tribe, yet they are not found so easily in other members of the cryptogamic division; in various members of which not only does their position vary, but their presence is undiscoverable by any means we possess.

Now the members of the vegetable kingdom are of all sizes, from the invisible forests, which are seen by the aid of the microscope in a piece of moldiness, to the cocoa of Malabar, fifty feet in circumference, or the great dragon tree of Teneriffe, which is of such dimensions that ten full grown men joining hand to hand are scarcely sufficient to encircle its base. Each of them, great and small, is furnished with a complicated system of vessels for the circulation of its juices, the secretion of its odors, and other important functions, analogous to those in animals. Almost every vegetable consists of a root or an assemblage of roots, each of which is terminated by a number of rootlets or little tufts called spongioles, which absorb the nourishment from the soil; a tuber or bulb, a trunk or stem, branches, leaves, skin, bark, sap-vessels, or system of arteries and veins, glandules for perspiration; flowers made up of sepals, petals, stanima, pistils, farina, ovary or seed-case, seed, fruit, spores or sporules and various other parts; and these are different in their construction and appearance in the different species.

Some increase, or grow, as all exogenous plants, by external depositions of their woody matter, and are distinguished, if cut in horizontal section of the trunk, by concentric rings increasing in dimensions from the centre to the outside. See, for illustration, a horizontal section of the trunk of the oak or elm. Others, as all endogenous plants, grow by internal depositions of their woody matter, and are distinguished, if cut in horizontal section of their trunk, by the absence of pith and concentric rings; and by the tissue, of which the stem is made up, appearing as long strings of woody fibre, and extending upwards. See, for illustration of this kind,



1. Horizontal Section of an Exogen. 2. Horizontal Section of an Endogen. 3. Dotted Vessels of the Clematis. 4. Dotted Vessels of the Melon. 5. Spiral Vessels of the Melons. 6. Lactiferous Vessels of the Celandine. 7. Ovoid Cell. 8. Stelliform Cells. 9. Angular Cells.

the horizontal section of the palm tree of tropical climates, the sugar cane, the bamboo, and all the grasses.

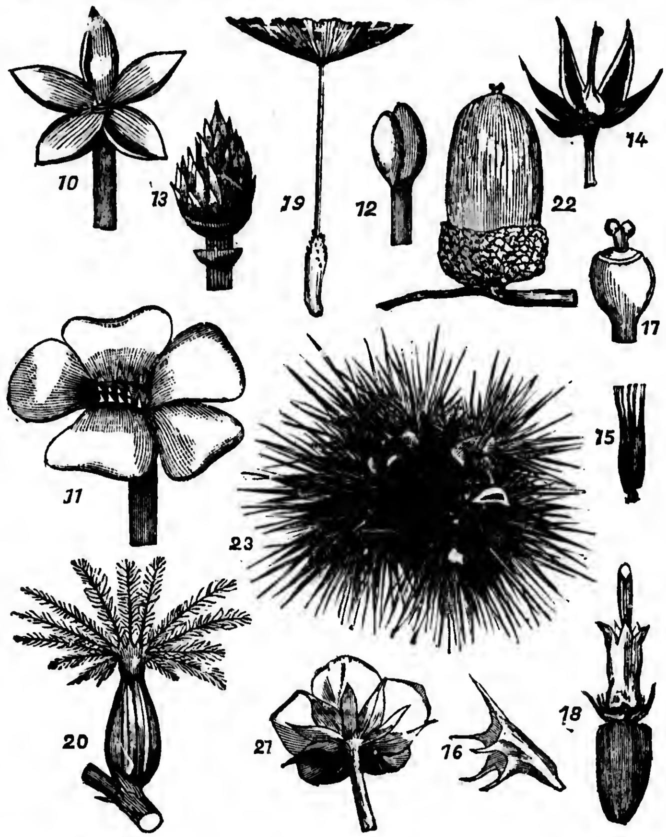
Some vegetables, as the oak, are distinguished for their strength and hardness; others, as the elm and fir, are tall and slender; some are tall, and tapering upwards to a point, as the cedar; while others never attain to any considerable height, as the thorn-shrub; some have a rough and uneven bark, while others, as the birch, the maple and the poplar, are smooth and fine; some are so slight and delicate, that the least wind may bend them; while others can resist the violence of the strongest blasts; some acquire their full growth in a few years; while others, as the dragon-tree, grow to a prodigious size, and stand the blasts of many centuries; some have their branches close to the trunk; while others, as the banyan tree, shoot them out so as to cover five acres of land, and shelter a thousand men; some have leaves scarcely an inch in length and breadth, while others, as the tallipot of Ceylon, have leaves so large that one of them, it is said, will shelter fifteen or twenty men from the rain; or as some of the water lilies of Central America, whose leaves, being fifteen or eighteen feet in diameter, a man may float on in safety, and whose flowers and ovary are proportionally large. Some drop their leaves in Autumn, and remain for months like blighted trunks; while others, as the hemlock, the pine, and the holly, retain their verdure during the winter.

The variety in the vegetable kingdom as to flowers is apparent even to the most careless observer. Each species of flower differs from another in the form and hues which it exhibits. The carnation differs from the rose, the rose from the tulip, the tulip from the primrose, the auricula from the lily, the lily from the daffodil, the narcissus from the ranunculus, and the butter-cup from the daisy ; while at the same time each narcissus, ranunculus, rose or daisy, has its own particular character and beauty ; something peculiar to itself, and which distinguishes it from the others. In a bed of ranunculuses or tulips for example, we shall scarcely find two individuals that have precisely the same aspect, or present the same assemblage of colors. Some flowers are of stately appearance and seem to reign over their fellows in the same parterre ; others are lowly, and creep along the ground ; some exhibit the most dazzling colors ; others of less imposing appearance blush almost unseen ; some perfume the air with the most delightful fragrance, while others emit an unpleasant odor, and only please the sight with their beautiful tints. And not only do flowers differ in their forms and colors, but there is a great diversity in their perfumes also. The smell of southernwood differs from that of thyme, that of balm from that of peppermint, and that of the primrose from that of the daisy ; which indicates a variety in their internal structure and in the juices which circulate within them.

As to the flower it is made up of different parts, as the calyx or under whorl, which is itself made up of several parts, called sepals ; and the corolla or upper whorl, which is also made up of severals parts, called petals. The calyx and corolla taken together comprise what is called the perianth, or that which surrounds and protects the reproductive parts of the flower. It may be called a beautiful painted house, in which the gentlemen and ladies of the flower live.* Thus, in the concave space enclosed by the perianth are found the reproductive parts of the plant; the stamens and pistils, or carpels, either or both. At the bottom of the pistil, or carpel, which means the same thing, is situated the ovary, or seed-case ; the point in which it terminates above is called the stigma, and the middle part of it, the style. Upon the stigma of the pistil falls the pollen from the stamen, which causes the ovary to expand, the fruit to ripen, and the seed to grow. Thus, while the roots, with their spongioles, are called the nutritive, the

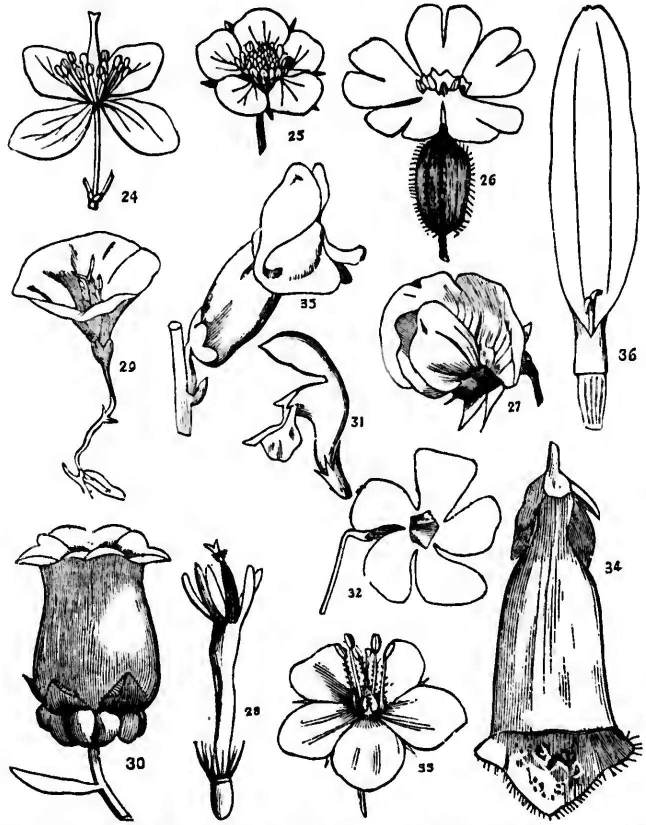
* See page 197.

flower and its appendages are called the reproductive parts of the vegetable. See annexed figures; also figures on pages 202 and 203.



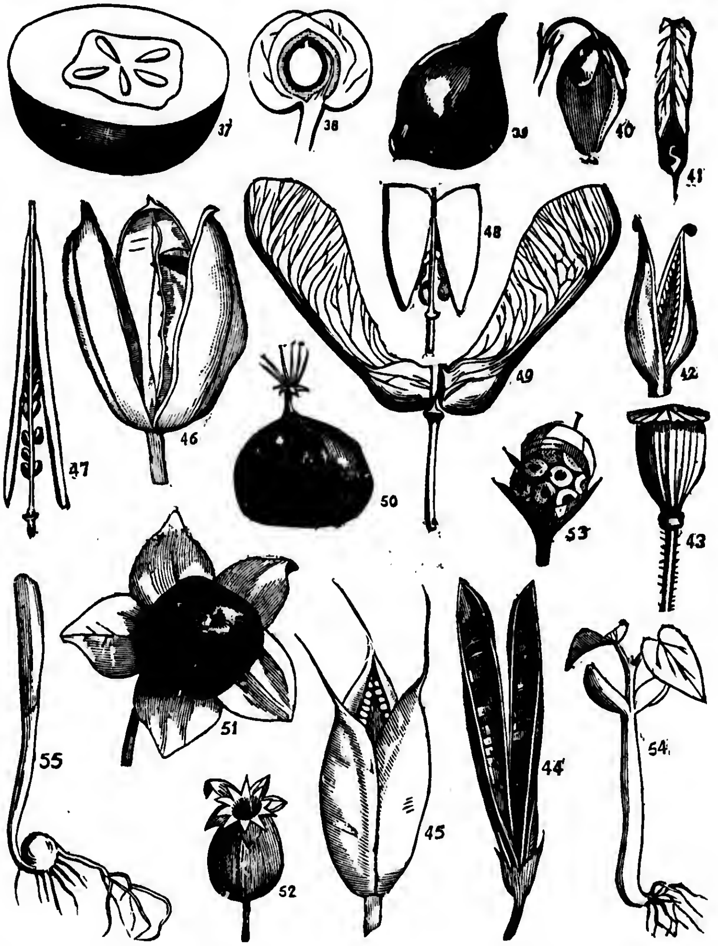
10. Calyx of Ranunculus. 11. Corolla of Ranunculus. 12. Stamen of Ranunculus. 13. Carpels of Ranunculus. 14. Quinquepartite Calyx of the Pimpernel. 15. Quinquefid Calyx of the Gentian. 16. Irregular Calyx of the Dead Nettle. 17. Calyx of the Madder. 18. Adherent Calyx of the Sunflower. 19. Calyx of the Dandelion. 20. Calyx of the Centranthus. 21. Calycule of the Strawberry. 22. Acorn and Cup. 23. Involucrum of the Chestnut.

The leaves of all vegetables, like the lungs and skin of the human body, are diversified with a multitude of extremely fine vessels, and an astonishing number of pores. The leaf itself consists of two flattened expansions of the epidermis, or the outer covering, called the cuticle, of the tree, the one above and the other below, enclosing between them nerves and veins, vascular and cellular tissue. The word vascular means consisting of, or containing, vessels ; and cellular means consisting of cells. By vascular tissue is meant those little pipes and tubes which run through vegetables, just like arteries and veins through animal bodies, and which serve the purpose of conveying juices from one part of the plant to another. In plants, those pipes or tubes are so exceedingly small, that their tubular character is only recognized by the aid of a microscope or powerful lens, but their presence may be recognized in general by the naked eye. Cellu-



24. Cruciform Corolla of the Celandine. 25. Rosaceous Corolla of the Strawberry. 26. Caryophyl-ate Corolla of the Lychnis. 27. Papillionaceous Corolla of the Pea. 28. Tubular Corolla of the Corn Centaury. 29. Infundibuliform Corolla of the Bindweed. 30. Campanulate Corolla of the Campanula. 31. Labiate Corolla of the Dead Nettle. 32. Hypocrateriform Corolla of the Periwinkle. 33. Rotate Corolla of the Pimpernel. 34. Anomalous Corolla of the Foxglove. 35. Personate Corolla of the Snapdragon. 36. Ligulate Corolla of the Chrysanthemum.

lar tissue is, as its name indicates, an assemblage of little cells, the natural form of which is spheroidal or oval; but more frequently this form is modified from various causes, usually the mutual pressure of the cells against each other. Thus, the pith of trees, a portion of which is made up of cellular tissue, if examined under the microscope, will be found to be composed of cells, having the form of honeycomb cells, that is, hexagonal. Occasionally the cells assume a stellate or starlike form, which may be seen in a section of the common bean, if examined under the microscope. Usually those vegetable cells are so very small that a microscope or a powerful lens is necessary for observing them. In certain vegetables, however, they



37. Pome. 38. Drupe. 39. Achænium of the Ranunculus. 40. Caryopsis of the Buckwheat. 41. Follicle of the Columbine. 42. Capsule of the Gentian. 43. Capsule of the Corn Poppy. 44. Legume of the Lotus. 45. Capsule of the Colchicum. 46. Capsule of the Iris. 47. Siliqua of the Celandine. 48. Silicule of the Mustard Plant. 49. Samara of the Maple. 50. Nut of the Chestnut. 51. Berry of the Deadly Nightshade. 52. Capsule of the Lychnis. 53. Pyxis of the Pimpernel. 54. Germination of the Bean. 55. Germination of Indian Corn.

are of such dimensions as to admit being readily seen by the naked eye. For example, if the fruit of an orange be cut or pulled asunder, the cells will be readily apparent. And not only do the cells of this cellular tissue admit of being altered in form, but occasionally they give rise to parts in the vegetable organization, which would not be suspected to consist of cells. The cuticle, or outer skin, of vegetables is nothing more than a layer of cells, firmly adherent; and the pith of exogenous plants, for example, the substance which makes up the densest part of the centre of the oak is nothing more nor less than closely compressed cellular tissue. In a former illustration we have stated that the air contained in an apple can be expanded into forty-eight times the bulk of the apple; and this is because the inside of the apple is made up of little cells, each of which is filled with closely-compressed air. We have also intimated that leaves perform for vegetables the same functions in a manner as the lungs do for man and land animals, and the gills for fishes. But how is this performed? We have shown that the leaves, as well as the skin, are full of cells, and tubes, and pores, just as the lungs and the skin of an animal are; but, they make use of that very kind of air which man and the animals refuse; they inhale carbonic acid, so much of which is generated on the surface of the earth by combustion, as well as otherwise, and in animal bodies; they retain the carbon, which the animals refuse, and reject the oxygen, which the animals retain, and which supports their life. Carbonic acid is in itself poisonous to animals, but is thus the support and nourishment of vegetables; and the latter, by using it, perform the part of purifying the air. Hence it is seen how one part of nature is adapted to the other; how each element returns to its proper place, and all things to equilibrium. In a kind of box-tree, called Palm of Ceres, it has been observed that there are above 172,000 pores on *one side* of the leaf. The whole earth is covered with vegetable life in such profusion as astonishes the contemplative mind. Not only the fertile plains, but the rugged mountains, the *most barren spots*, and even the caverns of the ocean, are diversified with plants of various kinds; and from the torrid to the frigid zone every soil and every climate has plants and flowers peculiar to itself. To attempt to estimate their number and variety whould be like attempting to dive into the depths of infinity; and, therefore, we shall have to content ourself with merely giving this interesting part of nature a passing notice, so far at least as to show its analogy and relation to the animal kingdom. Yet every diversity in the species of plants, every variety in the form of individuals, and even every difference in the shade and combination of colors in flowers of the same species, exhibits a distinct conception which ever existed in the Eternal mind.

Linnæus adopted the following pithy designation for minerals, vegetables and animals. "Minerals," he said, "grow; plants grow and live; but animals grow, live, and feel." An expression which indeed, if insufficient, is not unjust. We may say more distinctively, however, that animals are those living beings which derive their nutriment from an internal cavity, the stomach; and vegetables are those living beings which derive their nutriment from without.

If we should take a survey of the mineral kingdom we should also behold a striking expression of the manifold wisdom and the power of Deity. It is true we cannot penetrate into the bowels of the earth so as to ascertain the substances which exist and the processes which are going on near its central regions. But within a short distance of its surface we find such an astonishing variety of mineral substances as clearly shows that its internal parts are constructed on the same plan of variety as characterizes the animal and vegetable kingdoms. In the classes of *earthy*, *saline*, *inflammable*, and *metallic fossils*, under which mineralogists have arranged the substances of the mineral kingdom, are contained an immense number of genera and species. Under the *earthy* class of fossils are comprehended diamonds, chrysolites, menillites, garnets, zeolites, corundums, agates, jaspers, opals, pearl-stones, tripoli, clay-slate, basalt, lava, chalk, limestone, ceylanite, strontium, barytes, celestine, and various other substances. The *saline* class comprehends such substances as the following; natron or natural soda, rock-salt, nitre, alum, sal-amoniac, epsom-salts, etc. The class of *inflammable* substances comprehends sulphur, carbon, bitumen, coal, amber, charcoal, naphtha, petroleum, asphalt, caoutchouc, mineral-tar, etc. The *metallic* class comprehends iridium, platina, gold, mercury, silver, iron, lead, tin, bismuth, zinc, antimony, cobalt, nickel, manganese, magnesium, molybdenum, arsenic, scheele, menachanite, uran, silvan, chromium, tungsten, uranium, titanium, tellurium, sodium, potassium, etc. All these mineral substances are distinguished by many species and varieties. There are reckoned eight genera of earthy fossils. One of these genera, the flint, contains thirty-four species; and these species are distinguished by numerous varieties, such as chrysoberyls, topazes, agates, beryls, quartz, emery, diamond, spar, etc. Another genus, the clay, contains thirty-two species, such as opal, pitch-stone, felspar, black-chalk, mica, horn-blende, etc. And another genus, the calc, contains twenty species, as limestone, chalk, slate, spar, fluor, marle, boracite, loam, etc. There are ten species of silver, five of mercury, seventeen of copper, fourteen of iron, ten of lead, six of antimony, three of bismuth, etc. All these mineral bodies present differences as to figure, transparency, hardness, lustre, ductility, malleability, texture, structure, sound, smell, taste, weight, and their magnetical and electrical properties; and they exhibit almost every variety of color. As to structure, a body may be brittle, sectile, or separating in layers, malleable, flexible and elastic. A mineral can only effect the taste which is soluble in the saliva, and is saline, alkaline, or astringent. Dependent upon light are five characteristics of minerals, color, lustre, diphaneity, refraction, and fluorescence. Color is either metallic or non-metallic. Metallic lustre is that peculiar lustre which distinguishes the metals, although it does not belong exclusively to them; for graphite, which is carbon, and the scales of iodine both possess metallic lustre. Minerals whose colour is non-metallic may be found of every hue, from the black onyx to the colorless diamond. The colors which distinguish all other objects are non-metallic. The degrees of lustre are five ; splendent, shining, glistening, glimmering, dull, which expresses the absence of lustre. The degrees of diaphaneity are five ; transparent, semi-transparent, translucent, translucent on the edges, opaque, when no light passes through, etc. Some of these substances are soft and pulverable, and serve as a bed for the nourishment of vegetables, as black earth, chalk, clay and marl. Some are solid, as iron and silver ; and some are fluid, as mercury, sodium, and potassium. Some are brittle, as antimony and bismuth ; and some are malleable, as gold and zinc ; some are subject to the attraction of the magnet ; others are conductors of electricity ; some are easily fusible by heat ; others will resist the strongest heat of our common fires. Some are extremely ductile, as platina, which has been drawn out into wires less than the two-thousandth part of an inch in diameter ; and gold, the parts of which are so fine and expansible, that an ounce of it is sufficient to gild a silver wire more than 1300 miles long.

To have the opportunity of acquiring the most ample and impressive idea of the mineral kingdom, one should visit an extensive mineralogical museum, where he will have ocular evidence of the great beauty and the endless variety which this department of nature exhibits. Here it may also be remarked that not only the external aspect of minerals, but also the interior configuration of many of them presents innumerable beauties and varieties. A rough, dark-looking pebble, which to an incurious eye appears only like a fragment of common rock, when cut asunder and polished, presents an assemblage of the finest veins and most brilliant colors. Marble workers have daily experience of this in the rough blocks of California and other marble, as well as of granite and other stone, which they reduce to such smoothness and beauty by their art. If one goes into a lapidary's shop which is furnished on an extensive scale, and takes a leisurely survey of his jaspers, topazes, cornelians, agates, garnets, and other stones, he cannot fail to be struck with admiration, not only at the exquisite polish and the delicate wavings which their surfaces present, but at the variety of coloring and design exhibited, even by individuals of the same species ; the latent beauties and diversities of which require the aid of the microscope to discern, and are beyond the efforts of the most delicate pencil fully to imitate.

And not only in the objects which are visible to the naked eye is the characteristic of variety to be seen, but also in those which can only be discerned by the aid of the microscope. In the scales of fishes, for example, we perceive an infinite number of diversified specimens of the most curious productions. Some of these are of an extended form, some round, some triangular, some square, in short of all imaginable varieties of shapes. Some are furnished with sharp prickles, as in the perch and sole; some have smooth edges, as in the tench and cod fish; and even in the same fish there is a considerable variety; for the scales taken from the belly, the back, the sides, the head, and other parts, are all different from each other. In the scale of a haddock we perceive one piece of delicate mechanism; in the scale of a perch another; and in the scale of a sole beauties different from both. We find some of them ornamented with a prodigious number of concentric flutings, too near each other, and too delicate to be easily enumerated. These flutings are frequently traversed by others diverging from the centre of the scale, and proceeding from thence in a straight line to the circumference. On every fish there are many thousands of these varigated pieces of mechanism.

The hairs on the bodies of all animals are found by the microscope to be composed of a number of extremely minute tubes, each of which has a round bulbous root, by which it absorbs its proper nourishment from the adjacent humours; and these are all different in different animals. Hairs taken from the head, the eyebrows, the beard, the nostrils, the hand, and other parts of the body, are unlike each other, both in the construction of the roots, and the hairs themselves, and appear as varied as plants of the same genus but of different species.

The parts of which the feathers of birds are composed present a beautiful diversity of the most exquisite workmanship. There is scarcely a feather but contains a million of distinct parts, every one of themof regular shape. In a small fibre of a goose quill more than 1200 downy branches, or small leaves, have been counted on each side; and each appeared divided into sixteen or eighteen different joints. A very small part of the feather of a pea-cock, one-thirtieth of an inch in length, appears no less beautiful, when viewed through the microscope, than the whole feather does to the naked eye, exhibiting a multitude of bright, shining parts, reflecting first one color and then another, in the most vivid manner.

The wings of all kinds of insects too present an astonishing variety, and no less captivating to the mind than pleasing to the eye. They appear strengthened and distended by the finest bones, and covered with the thinnest membranes. Some of them are adorned with neat and beautiful feathers, and many of them provided with the most symmetrical articulations and foldings for the wings when they are to be withdrawn and folded up in their cases. The thin membranes of the wings appear beautifully divaricated with thousands of little points like silver studs. The wings of some flies are filmy, as the dragon-fly; others have them stuck over with short bristles, as the flesh-fly; some have rows of feathers along their ridges, and borders round their edges, as in the gnats; some have hairs, and others hooks, placed with the greatest regularity and order. In the wings of moths und butterflies there are millions of small feathers of different shapes, diversified with the greatest variety of bright and lively colors, each of them so small as to be altogether invisible to the naked eye. The leaves of all plants and flowers, when examined by the microscope, are found to be full of innumerable ramifications, corresponding to the closely interwoven network of veins on the surface of the human body, whose office is to convey the perspirable juices to the pores, and to consist of the barenchymous, and ligneous fibres, interwoven in a curious and admirable manner. The smallest leaf, even one which is little more than visible to the naked eye, is found to be thus divaricated, and the variegations are different in the leaves of different vegetables. The way in which the leaves are veined is also another means, beside that of the horizontal sectional aspect of the trunk or stem, of determining the class of flowering vegetable to which their plants belong. If the veins run parallel to each other on the leaf, the plant belongs to the *endogenous* class; if they are reticulated, or, interlacing each other in all directions, it belongs to the *exogenous*. Thus, referring to the leaf of the iris, you find that it is of an endogenous, or within-growing, plant; and you know by the same kind of examination that the melon is an exogenous, or without-growing, plant.

A transverse section of a plant not more than *one fourth of an inch* in diameter, when viewed through a powerful microscope, displays such beauties as cannot be conceived without ocular inspection. The number of pores of all sizes, amounting to hundreds of thousands, which are the vessels of the plant cut asunder, the beautiful curves they assume, and the radial and circular configurations they present in endogenous plants are truly astonishing; and not only the two great classes but every distinct species of plants exhibit a different configuration. There have been counted in a small section of a plant, of the size above stated, 5000 radial lines, each containing about 250 pores, great and small, which amount to one million two hundred and fifty thousand of these variegated apertures.

Even the particles of sand on the sea-shore, and on the river's banks, differ as to the size, form, and color of their grains; some being transparent, others opaque: some having rough, and others smooth surfaces; some are spherical or oval, and some pyramidal, conical, prismatical, or polyhedral. Mr. Hooke happening to view some grains of white sand through his microscope, hit incidentally upon one of the grains which was exactly shaped and wreathed like a shell, though it was no larger than *the point of a pin*. "It resembled", says he, "the shell of a small water-snail, and had twelve wreathings, all growing proportionately one less than another toward the middle or centre of the shell, where there was a very small, round, white spot." This gives evidence of the existence of shell-fish, which are invisible to the naked eye; and therefore smaller than a mite.

The variety of forms in which animal life appears, which the microscope enables us to explore, is indeed wonderful. Microscopic animals are so different from those of the larger kind, that scarcely any similarity seems to exist between them ; and from a limited knowledge of them, one would be almost tempted to suppose that they live in accordance with laws directly opposite to those which preserve man and all other animals in existence. When we begin our explorations in this region of animate nature, we feel as if we were entering upon the confines of a new world, and surveying a new race of sentient existence. The number of these creatures exceeds all human calculation or conception. Many hundreds of species, all differing in their forms, habits, and motions, have already been distinguished and described ; but we know that by far the greater part of the system of the earth is unexplored, and doubtless forever hid from the view of man. They are of all shapes and forms. Some of them appear like minute atoms ; some like spheres or spheroids ; some like hand-bells ; some like wheels turning on an axis ; some like double-headed monsters ; some like cylinders ; some have worm-like appearances ; some have horns ; some resemble eels ; some are like long hairs, 150 times as long as they are broad ; some like spires and cupolas ; some like fishes ; and some like animated vegetables. Some of them are almost visible to the naked eye ; and some so small that the breadth of a human hair would cover fifty or a hundred of them ; and others are so minute that millions on millions of them might be contained within the space of a square inch. In every pond and ditch, and in every puddle ; in the infusions of pepper, straw, grass, oats, hay, and other vegetables ; in paste and vinegar, and in water found in oysters ; on almost every plant, and flower ; and in the rivers, seas, and oceans, these creatures are found in such numbers and variety, as altogether exceed our conceptions. A class of these animals, called Medusæ, has been found, so numerous as to discolor the ocean itself. Captain Scoresby found the number in the olive green sea to be immense. A cubic inch contained sixty-four; and consequently a cubic mile would contain 23,888,000,000,000,000, or nearly 24 thousand billions ; so that if one person could count a million in seven days, it would have required that 80,000 persons should have begun 6,000 years ago, in order to have completed the enumeration at the present time. Yet, all the minute animals to which we now allude, are furnished with numerous organs of life, as well as the larger kinds. Some of their internal movements are distinctly perceived ; their motions are evidently *voluntary*, and some of them appear to be possessed of a considerable degree of sagacity, and to be fond of each others' society. It may in short be unhesitatingly affirmed that the beauties and varieties which exist in those regions of the earth which are invisible to the unassisted eye are far more numerous than what appear to a common observer in the visible domain of nature. How far this scene of creating power and intelligence may extend beyond the range of our microscopic instruments it is impossible for us to determine ; for the more perfect our glasses are, and the higher the magnifying power we apply, the more numerous and diversified are the objects which they discover to our view. And as the most perfect telescope is, and will ever be, insufficient to convey our view to the boundaries of the great universe, so we may justly conclude that the most powerful microscope that has been, or ever will be, constructed, will be altogether insufficient to guide our view to the utmost limits of the descending scale of creation.

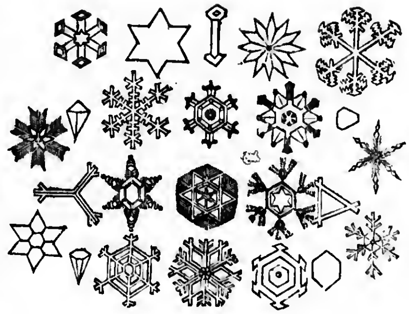
But the knowledge we already possess of these invisible and inexplorable regions gives us an amazing conception of the wisdom and intelligence of the Creator, of the immensity of His nature, and of the infinity of ideas which during all time existed in His all-comprehensive mind. What an immense space in the scale of animal life intervenes between an animal which appears only the size of a visible point, when magnified 500,000 times, and a whale a hundred feet long, and twenty broad! The proportion of bulk between one of these beings and the other is nearly 34,560,000,000,000,000,000 to 1, or over thirty-four trillions and a half to one. Yet all the intermediate space is filled up with animated beings of every form and order.

A similar variety obtains in the vegetable kingdom. It has been calculated that some plants which grow on rose leaves and other shrubs are so small that it would require more than a thousand of them to equal in bulk a single plant of moss; and if we compare a stem of moss, which is generally not above one-sixtieth of an inch, with some of the large trees in Brazil and California, of twenty feet diameter, we shall find the bulk of the one to exceed that of the other, no less than 2,985,984,000,000, which, multiplied by 1,000, will produce 2,985,984,000,000,000, or nearly three thousand billions of times, which the large tree exceeds the rose-leaf plant in size. Yet this immense interval is filled up with plants and trees of every form and size. With good reason then may we repeat the language of the Psalmist, with reference to the Deity: "How manifold are thy works, O Lord! In wisdom hast thou made them all. Marvellous things doeth He, which we cannot comprehend."

On Crystallization.

The subject of crystallization is one which is also of great interest, and in which there is great variety of forms of matter displayed. When a mineral from any cause has been deprived of its cohesion, and its particles separated, if the particles are permitted to associate themselves again to form a solid, in such a way that they can follow their own inclination, the solid will indicate its being constructed according to certain laws; that is to say, the force of cohesion operating in the new formation does not act equally in all directions, but in the great majority of cases sets itself to construct regular geometrical solids, called crystals. For illustration, if any ordinary salt, common salt, or salt-petre, or alum, be added to boiling water until the water will dissolve no more, and a bunch of threads be suspended in this solution, and allowed to stand all night, in the morning the string will be found covered all over with crystals. If common salt be used the crystals will be cubes; if alum they will be four-sided pyramids, placed base to base. The larger the quantity of solution, and the more slowly it cools, the larger will be the crystals; muddy solutions also increase their size. The presence of a substance which does not crystallize with the salts may modify the shape of the crystals; thus, if in the solution of common salt urea be present, the crystals will no longer be cubes, but, like those of alum, octahedra.

The peculiarities of crystallization are many. We might almost say that crystals in their formation exhibit signs of instinct. If a damaged crystal be suspended in a saturated solution of the salt which composes it the salt out of the solution will begin to repair the damage, so that in a little while the general contour of the crystal will be restored. If in a solution there be small and large crystals, and the solution by an alteration of temperature be made alternately saturated and non-saturated, it will be found that the small crystals become entirely dissolved, while the large crystals grow. Crystals may also be obtained from a vapor condensing. Sulphur, arsenic, and iodine, afford examples of this, or from a liquid cooling. If, for example, six or eight pounds of sulphur of bismuth be melted and allowed to cool, if, when a crust has been formed on it, the crust be removed, and the yet liquid substance be poured out, the cavity of the vessel will be found lined with crystals; and often when a metal has been molten, and in its cooled state exhibits no signs of crystallization, yet the existence of the phenomenon may be shown if a weak solvent be applied to remove those particles which mask the formation. If a sheet of tin, while hot, be washed over with a weak solution of hydrochloric acid, the crystals which make the tin *moirée metallique* (or crystallized tin plate), and which previously existed, will appear. A bar of nickel, placed in dilute nitric acid, becomes covered with tetrahedra, because the acid dissolves the intervening uncrystallized metal. But, perhaps, the tendency of particles to arrange themselves in some order of polarity is most strikingly illustrated in solids which are undergoing processes which move their particles. For example the axle, or the tire of the wheel, of a railway carriage, by constant vibration occasions the particles of which it is composed to take positions according to the polarity of their kind, and the consequence is that many axles or trees, when broken after years of service, exhibit throughout their mass crystals of iron.



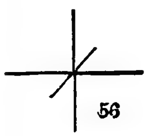
Very few persons out of the great mass of mankind are aware that when they are walking on snow they are treading beneath their feet the most beautiful crystals. Snow is all composed of crystals in which, though a great diversity of figure is apparent, yet all the angles are equal, being those of an equilateral triangle, sixty degrees; and it is the angles which are the constants in crystallography; these never vary; but the faces of the same form of crystal are always equally inclined. When a flake of snow is examined by a magnifying glass, the whole of it will appear to be composed of fine shining specula, diverging like rays from a centre. Many of the snow crystals are of a regular figure, for the most part stars of six points, and are as perfect and transparent *ice* as any we see on a pond or river. Their forms present an almost endless variety, are often very regular and beautiful, and reflect with exceeding splendor the rays of the sun. This is the reason why snow appears white, the light being reflected from every angle and face of the infinite number of crystals. The crystals of snow vary from one-third to one thirty-fourth of an inch in diameter, in the natural size. Ice, as we have had occasion to remark before, is crystallized water, just as snow is crystallized water from vapor in the air. See annexed figure.

A very slight acquaintance with crystals will assure the observer that those of the same mineral have a close relationship to each other, whenever the same forms are studied. The law of symmetry is one of the principles upon which creation is carried on. It is observable in every organic structure that about a certain plane or certain planes the structure is built up. For example, a plane passing down through the centre of the human frame would divide the body into two similar halves. So with crystals they are all arranged symmetrically about *imaginary* lines; and according to the *arrangement* of these axes of symmetry crystals are divided into six classes or systems.

1st. The *Monometric*, *Regular*, *Tessular*, or *Cubic*, *System* has three axes of symmetry, all equal, and all at right angles to each other. About these axial lines the crystal is symmetrically built up, so that when heated it expands equally in all directions, and transmits light without refracting the rays. The primary figures of this system may be found by causing planes to pass perpendicularly through the extremities of the axis. This will produce the cube. The other prominent figure of the system, the *octahedron*, is formed by causing eight planes to pass through the three extremities of the axes. The reader will easily conceive of two tetrahedral, or four-sided, pyramids, being joined to each other base to base, which is the form of this octahedron. By combining these two primary figures in various proportions a series of crystals may be produced. It is proper here to remark that this combination we speak of is only imaginary, for all the forms of crystals are natural, and that by this imaginary combining and modifying the prominent forms of each system a series of crystals appear for each system, which are called *secondary* crystalline forms, which only means that they are forms which are scarce in the system as compared with the primary or prominent forms. The following are the forms of this system and the minerals which crystallize into it :

The tetrahedron, in which form grey copper crystallizes.

The Cube (Primary) in which form	....	Flour Spar Galena Rock-Salt Iron Pyrites	Crystallize.
The Octahedron (Primary) "	....	Alum Spinell	Crystallize.
The Cube Octahedron "	....	Galena (ore of Lead)	"
The Rhombic Dodecahedron "	....	Garnet	"
The six-faced Tetrahedron "	....	Diamond	"
The six-faced Octahedron "	....	Garnet	"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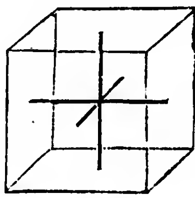
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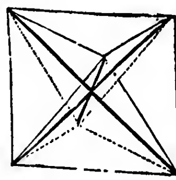
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Figures 56, 57, 58 represent the primary.

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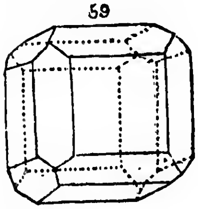

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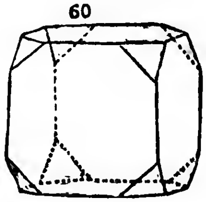

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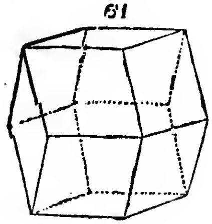

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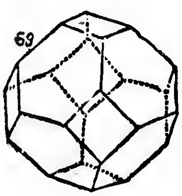

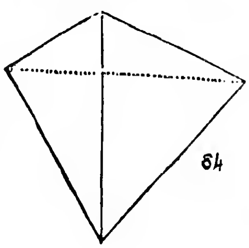
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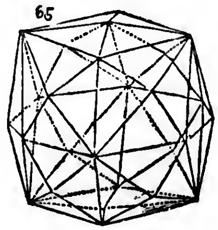
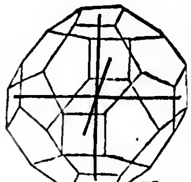


Figures 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, the secondary forms of this system. See also figures on proceeding page.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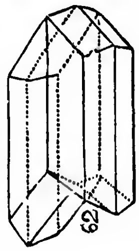
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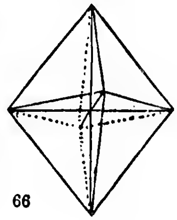
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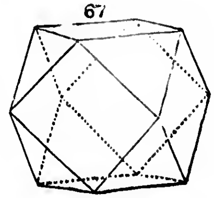
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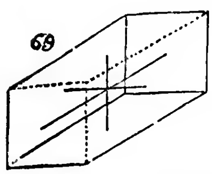
2nd class : The *Dimetric, Right Square ; Prismatic*, or *Pyramidal system* has also three axes all at right angles to each other ; but one axis is longer than the other two. The prism and the double-pyramidal octahedron are the usual primary forms of this system, and it has also its secondary forms. The following minerals are known to crystallize into this system : Ti. stone, ferrocyanide of Potassium, cyanide of Mercury,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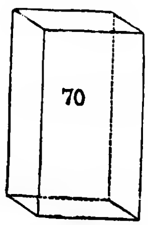
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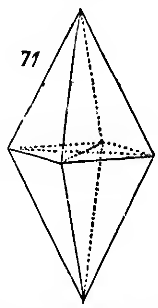
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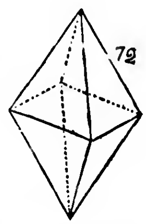
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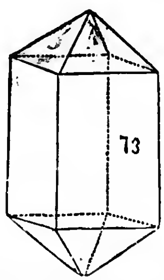
rutile, anatase, and idocrase. Figures 69, 70, 71, 72 represent the primary :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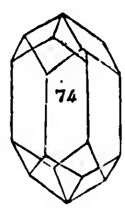
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mary : and 73, 74 the secondary forms of this system.

3rd Class. The *Trimetric, Right Rectangular*, or *Prismatic system*. This system has three axes all at right angles, but all unequal. The primary forms in this system are the rectangular prism, and the octahedron. It has also its secondary forms. Nitre, aragonite, topaz, sulphate of

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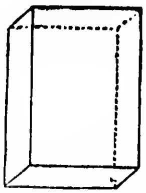
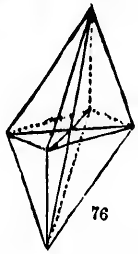


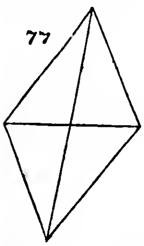


76

baryta, sulphur, and stilbite crystallize in this system. Figures 75, 76, represent the principal forms of this system.

4th Class: The *Monoclinic*, or *Oblique system*. The axes of this system are unequal in length, like the last; but two of them intersect each other, not at right angles. The effect of this is that the base of the prism or octahedron, which are the principal forms of this system, is a parallelogram of unequal sides. Green vitriol, sulphate of soda, phosphate of soda, sulphur, crystallized from its melted state, and borax, crystallize in

77



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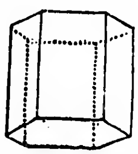

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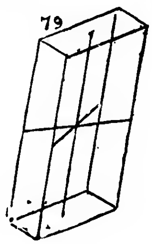

this system. Figures 77, 78, 79 will give the idea of this system.

5th Class: The *Triclinic*, *Doubly Oblique*, or *Anorthic system*. This system has also three unequal axes, but none of them intersect at right angles. The prism and the octahedron are the primary forms, but these

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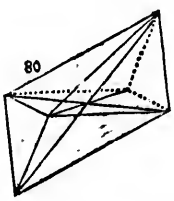

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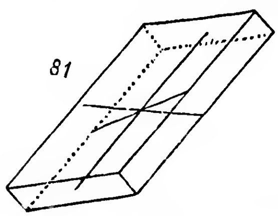
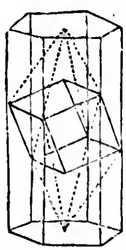


are necessarily different in form from the preceding; and there are secondary forms. But few minerals appear to crystallize, in this system. The most common are blue vitriol (sulphate of copper), labradorite, anorthite, and aximite. Figures 80 and 81 show the octahedron and the prism of this system.

6th Class ; The *Hexagonal*, and *Rhombohedral System*. The crystals of this system have four axes, three of them in the same plane, and intersecting at angles of sixty degrees, and all equal; the fourth perpendicular to these, and varying in length. By the supposed joining of the extremities of these axes a hexagon is formed, which is the base of a prism (therefore six-sided,) and of a hexagonal dodecahedron. These primary forms appear in snow crystals, beryl, tourmaline, and nitrate of soda, and the very common quartz crystals, which almost every one has seen, are generally six-sided prisms, terminated by six-sided pyramids. This system is also called the Rhombohedral, from the fact that the rhomb, so admirably shown in calc-spar, is the hemihedral form of the hexagonal dodecahedron; that is, if the alternate faces of the double, six-sided pyramid be supposed

84



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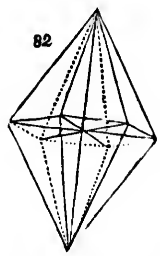

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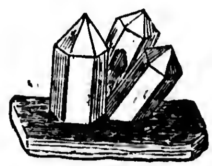

produced, they will form a six-sided solid, which appears in figure 84. Figures 82, 83, represent the principal forms of this system.

Almost all minerals crystallize into some one of these systems. For example, gold, silver, copper, and platina are found to crystallize in the first or monometric system. A sublime display of crystallization is seen in some places on the earth's surface. A visit to the island of Staffa, in Scotland, and to the Giant's Causeway, in Ireland, would be amply repaid to one who liked to inspect and contemplate such sublime natural wonders.

In order that some of the words which we have found it necessary to use in this short description of crystallization may be understood by all our readers, we may explain that monometric signifies having one measurement, or equal measurement, the monometric system being distinguished by equality of axes. Dimetric signifies having two measurements, crystals in this system having one longer axis and two shorter ones, which latter two are of the same length. Trimetric signifies having three measurements, the crystals of this system having three axes, all of which differ in length. Monoclinic signifies having one sloping axis, crystals of this system having one axis, which is not rectangular to the other two. Triclinic signifies having three axes at oblique angles to one another. Hexagonal signifies six-sided, or six-angled. Dodecahedral signifies having twelve sides. Rhombohedral signifies having its sides in the form of a rhombus, from a figure whose four sides are equal, but its angles are not right angles.

ON LIGHT.

But all this scene of beauty and all these natural wonders we have been contemplating need the agency of light to make them apparent. Light, as we have before remarked, is essential not only to the existence and growth of plants and animals, but also to the phenomena of colors. It is a manifestation of a substance which is universally present, but needs to be in certain conditions of chemical action in order that the light be made manifest. It radiates from a luminous object in straight lines in all directions, and all objects are seen by its reflection from their surfaces. The *reflection* of the rays of light is that property by which, after striking the surfaces of bodies, they are driven back or repelled. It is, therefore, in consequence of this property that all the objects around us, and all the diversified landscapes on our globe are rendered visible. When light impinges or strikes upon a surface,—say, for illustration, a polished surface, rather more than half of it is thrown back or reflected in a direction similar to that of its approach; that is to say, if it fall perpendicularly upon a surface it will be *perpendicularly reflected*; but, if it fall obliquely, it will be reflected *with the same obliquity*. Hence the following fundamental law, regarding the reflection of light has been deduced both from experiment and mathematical demonstration, namely, that *the angle of reflection is, in all cases, exactly equal to the angle of incidence.* * Thus if a ray of solar light be admitted into a dark room through a hole in the window-shutter, the ray will pass straight through to the opposite wall, and by its reflection from the wall throw a certain amount of light round the whole room. Thus the whole room is to a certain degree lighted, although not with the direct rays of the sun. Also, if the window be not situated directly opposite to the sun, the ray of light which enters must itself be a ray of light reflected from the atmosphere, or from some outside objects. This last ray, however, when admitted, passes through as a direct ray to

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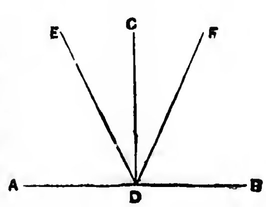
* Let A B, represent a plane mirror, and C D, a line, or ray of light, perpendicular to it. Let E D, be the incident ray, from any object; then D F, will be the reflected ray, thrown back in the direction D F; and it will make with the perpendicular C D, the same angle which the incident ray E D does with the same perpendicular; that is, the angle F D C, is equal to the angle E D C, in all cases of obliquity; the perpendicular ray being, of course, perpendicularly reflected. The way we see our faces and our persons in a looking-glass, is illustrated by figure 87.



the opposite wall, and is again reflected. Thus it is seen that there is no end to the reflections of light, and the atmosphere during the day is one great illuminated ocean, from the fact that the solar image is reflected and refracted from every portion of it. You see your own image in a looking-glass, moreover, by the rays of light from your body being reflected; and by placing two plane mirrors in certain positions in relation to each other and to a luminous object, you can multiply the number of images of an object indefinitely. In the case too of your image being reflected from a looking-glass, the angle of reflection is equal to that of incidence; for your image seems to form the same angle with the glass behind it, as you do before it; and if you change your position it changes also, and maintains the same angle as you do in relation to the glass.

While light, when proceeding from a luminous body, without being reflected from any opaque substance, or inflected by passing near one, is invariably found to proceed in straight lines, without the least deviation, yet, if it pass obliquely from one medium to another, it always deviates from its original course, and takes a new one. This change of direction, or bending of the rays of light, is what is termed *refraction*, from the Latin word *frangere*, to break or to bend. The angle of refraction depends upon the obliquity of the rays falling upon the refracting surface, being

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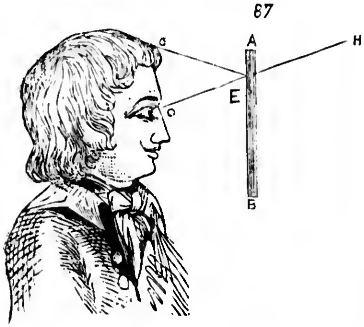
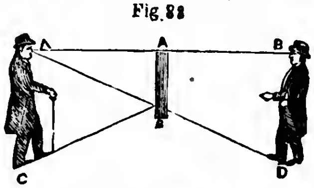
87



Let. A B, represent a mirror, and O C, a person looking into it. If we conceive a ray, proceeding from the forehead C E, it will be

Fig.88



reflected to the eye at O, agreeably to the angle of incidence and reflection; but, the mind puts C E O, into one line, and the forehead is seen at H, as if the lines C E O, had turned on a hinge at E. It is a peculiar faculty of the mind to put two oblique lines C E and O E, into one straight line O H; yet, it is seen every time we look at ourselves in a mirror. For the ray really strikes the mirror from C at E, and thence strikes the eye at O; and it is that journey which determines the distance of the object; and hence we see our image as far behind the mirror as we stand before it. Though a ray is here taken only from one part of the face, it may be easily conceived that rays from every part of the face must produce a similar effect.

In every plane mirror, the image is always equal to the object, at what distance soever it may be placed; and as the mirror is only at half the distance of the image, from the eye, it will completely receive an image of *twice* its own length. Hence a man six feet in height may view himself completely from tip to toe in a looking-glass of three feet in length, and half his own breadth; and this will be the case at whatever distance he may stand from th

s is shown in figure 88.

always such that the sine of the incident angle is to the sine of the refracted angle in a given proportion*. The *incident* angle is the angle made by a ray of light and a line drawn perpendicular to the refracting surface, at the point where the light enters the new medium. The *refracted* angle is the angle made by the ray in the refracting medium with the same perpendicular produced. The sine of the angle is a line which serves to measure the angle, being drawn from a point in one side perpendicular to the other.

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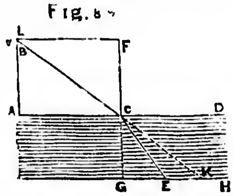
* For illustration of refraction: Let A D H I, fig. 89, be a body of water, A D its surface, C a point in which a ray of light, B C, enters from the air into the water. This ray, by the greater density of the water, instead of passing straight forward in its first direction to K, will be bent at the point C, and pass along in the direction C E, which is called the refracted ray. Let the line F G be drawn perpendicular to the surface of the water in C; then it is evident that the ray B C, in passing out of the air, a *rare* medium, into a *dense* medium, as water, is refracted into a ray C E, which is nearer to the perpendicular C G than the incident ray B C; and, on the contrary, the ray E C passing out of a denser medium into a rarer, is refracted into C B, which is further from the perpendicular.

The same thing may be otherwise illustrated, as follows:—Suppose a hole made in one of the sides of the vessel, as at A, and a lighted candle placed within two or three feet of it, when empty, so that its flame may be at L; a ray of light proceeding from it will pass through the hole A in a straight line, L B C K, until it reach the bottom of the vessel at K, where it will form a small circle of light. Having put a mark at the point K, pour water into the vessel until it rise to the height A D; and the spot of light which was formerly at K will appear at E; that is, the ray which went straight forward when the vessel was empty, to K, has been bent at the point C, where it strikes the water, into the line C E. In this experiment it will be necessary that the front of the vessel be of glass, in order that the course of the ray may be seen; and if a little soap be mixed with the water, so as to give it a little mistiness, the ray C E will be distinctly perceived. If, instead of fresh water, we fill the vessel with salt water, it will be found that the ray B C is more bent at C.

In like manner alcohol will refract the ray B C more than salt water, and oil more than alcohol; and a piece of solid glass, of the shape of the water, will refract the ray still more than the oil. Further explanation: In this figure B C is the incident ray, F G the perpendicular, B F the sine of the angle of incidence B C F, and G E the sine of the angle of refraction G C E. Now, it is a proposition that the sine B F, of the angle of incidence B C F, is either accurately, or very nearly, in a given proportion to the sine G E of the angle of refraction G C E. This ratio of the signs is as 4 to 3 when the refraction is made out of air into water; that is B F : G E :: 4 : 3. When the refraction is made out of air into glass, the proportion is about as 31 to 20, or nearly as 3 to 2. If the refraction be out of air into diamond, it is as 5 to 2, that is B F : G E :: 5 : 2. The denser the medium is the less is the angle and sine of refraction. If a ray of light, F G, were to pass from air into water, or empty space into air, in the direction C F, perpendicular to the plane A D, which separates the two mediums, it would suffer no refraction, because one of the essentials to that effect is wanting, namely, the obliquity of the incidence.

Fig. 89



The refraction of the atmosphere produces an effect upon the heavenly bodies that their apparent positions are generally different from their real. In consequence of this the sun is seen before he comes to the horizon in the morning, and after he has sunk beneath it in the evening; and hence this luminary is never seen in the place in which it really is, except in places within the torrid zone, when it passes the zenith at noon. The sun is visible when thirty-two minutes of a degree below the horizon, and when the opaque curvature of the earth is interposed between our eye and that orb.

On the principle of refraction, you may, by means of a multiplying glass, see as many images of a luminous object as the glass has different surfaces. If the multiplying glass have twenty different surfaces, you see twenty different images; or, if the surfaces could be cut and polished so small that it has five hundred surfaces, then you see five hundred images of the same luminous object. Thus, it is seen, the light of a given luminous object will be the more diffused, the more surfaces there are for it to be refracted and reflected from. But if a luminous object be completely separated from you by the intervention of an opaque body, as is the sun from us during our night by the intervention of the body of the earth, then you have no light from the luminous object. Light passes through all transparent substances, such as the atmosphere, water, and glass; and in its passage through these substances of different densities it is refracted, as we have explained, according to certain laws. A body, ordinarily speaking, is said to be transparent when every part between its two surfaces is of the same density, and therefore the ray of light emerges on the opposite side. In the case of the looking-glass, the ray of light would pass through it, being refracted, but for the coating of quicksilver which it has on its back, which prevents it passing through, and causes it to be reflected. A body is said to be opaque when the parts between its two opposite surfaces are of different densities, and so the rays of light are destroyed by the many refractions and reflections, and do not emerge on the opposite side. All substances that are not transparent are opaque, though there are different degrees both of transparency and opacity. Light and heat usually accompany each other, but light is not always manifested where strong heat is evolved. The heat accompanying the solar light is so great that when concentrated on double-convex lenses it will be sufficient to fuse the densest metals. Mr. Parker, of Fleet Street, London, once made a burning glass three feet in diameter, and when fixed in its frame it exposed a clear surface of more than two feet eight inches in diameter, and its focus, by means of another lens, was reduced to a diameter of half an inch. The heat produced by this lens was so great, that iron plates were melted in a few seconds; tiles and slate became red-hot in a moment, and were vitrified, or changed into glass. Sulphur, pitch, and other resinous bodies were melted under water; wood-ashes, and those of other vegetable substances, were turned in a moment into transparent glass, even gold was rendered fluid in a few seconds; and notwithstanding the intense heat at the focus, the finger might without the slightest injury be placed in the cone of rays within an inch of the focus. The force of the heat collected in the focus of the double-convex glass is to the common heat of the sun as the area of the glass is to that of the focus; it may, of course, be a hundred or even a thousand times greater in the one case than in the other. When a fire or a candle burns, or a horse strikes his shoe against a stone, light as well as heat is evolved; but a stack of hay, or a pile of dry goods, if allowed to stand long enough in a damp condition, may be heated to a high pitch without any light being evolved. Light is produced in many ways artificially, as by chemical action in the combustion of solids, liquids, and gases; by percussion, as in the use of the flint and steel, which is called "striking fire," and by the electric light, which may be considered the most intense and brilliant of all artificial lights. This last is procured from the ignition of two points of charcoal through which the current of electricity from a powerful battery is passed. But all terrestrial modes of obtaining light, such as chemical action, friction, ignition of solids, phosphorescence, crystallization, and the electric light, sink into insignificance before the great natural source of light, the sun, the centre of our planetary system, and the source both of light and heat to our world. Sir John Herschell has estimated that "the sun gives out as much light as 146 lime lights would do if each ball of lime were as large as the sun, and gave out light from all parts of its surface; and that the heat evolved from every square yard of the sun's surface is as great as that which would be produced by the burning of six tons of coal on it each hour."

Although it is said that light is emitted in straight lines from a luminous body it must not be understood that a given quantity of light goes on continuously in the same bulk or volume; it is continually expanding as it recedes from the point of emission. The areas of space filled with it as it proceeds are to each other as the squares of their respective distances from the luminous point of emission; and consequently the intensity or illuminating power of the light is inversely as the areas. Thus luminous bodies give, at the respective distances of two, three, or four yards, a fourth, a ninth, and a sixteenth, respectively, of the light they give at one yard from them; the areas illuminated and filled with the diffusing light being, at these several distances, four, nine, and sixteen times as great as at one yard distance. It may, therefore, be said more correctly that light diffuses itself universally in expanding volumes, bounded as the volumes increase by straight diverging surfaces, which form the boundaries of areas whose relative magnitudes are as the square of their distances. *

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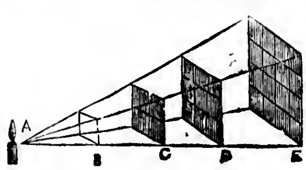
* This may be illustrated by the following figure. Suppose that light which flows from a candle A, and passes through a square hole B, is received upon a plane C, parallel to the plane of the hole; or let the figure C be considered as the shadow of the plane B. When the distance of C is double of B the length and breadth of the shadow C will be each double of the length and breadth of the plane B, and treble when A D is treble of A B, and so on. Therefore the surface of the shadow C at the distance A C, double of A B, is divisible into four squares, and at a treble distance into nine squares severally equal to the square B. The light then which falls upon



The larger the luminous body is the more space it will enlighten; and it is plain that the enlightened space will correspond in form with the body which enlightens it. Thus, the sun being of globular figure,—and, as we may here, for illustration, suppose it, luminous all over its surface,—enlightens an area, however great in extent, of spherical shape; the space nearest the sun being most enlightened, and the light becoming less as the distance from it becomes greater. The larger the luminous body is, too, at the greater distance will it be seen by the eye; also, the larger it appears at a given place the more light it will diffuse at that place; for the larger will its image be to be reflected and refracted from all objects; and, conversely, the smaller a luminous body appears from a given place the less light will it diffuse at that place, for the smaller will its image be to be reflected from all objects. When, therefore, a luminous body, of however great a size, is at so great a distance from a place as not to be perceivable by the eye, then it gives no light at that place, from the fact that there is no image of it to be reflected. Also, if one was situated beyond the range of our atmosphere, away out in the ethereal regions, it is determined he would experience no such flood of light as he does at the earth's surface, because of the absence of a reflecting medium. The denser and rougher in surface bodies are the better in general they reflect the light; for the image of the sun is reflected from one corner, face, or angle of rough surfaces to the other so as to make them more luminous than if they were smooth, though of the same density as they are. But the ether which exists beyond the limits of our atmosphere being so exceedingly rare, does not reflect the image of the sun; and the sun to an observer situated there would appear like a luminous globe placed in a black canopy, and surrounded on all sides with pitchy darkness. So the stars might appear like luminous points scarcely distinguishable, in regions of the blackest darkness. The appearance of the earth would depend upon the distance of the observer from it; the nearer he would be to the earth the more luminous would it appear, the light being reflected from its surface and atmosphere.

On the subject of light, two leading theories have been propounded in the philosophic world. Sir Isaac Newton supposed that light was corpuscular, or composed of minute particles of a material nature, which are

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the plane B, being suffered to pass to double that distance, will be uniformly spread over four times the space, and consequently will be four times less intense in every part of that space. And at treble distance it will be nine times thinner, and at a quadruple distance sixteen times thinner than it was at first. The quantities, therefore, of this rarified light received upon a surface of any given size and shape, when removed successively to their several distances, will be but one-fourth, one-ninth, one-sixteenth of the whole quantity received by it at the first distance A B. This law holds good with respect to the quantity of light received by the planets at their respective distances from the sun.

constantly emitted in all directions by luminous bodies. This hypothesis was adopted to a great extent, especially by British philosophers; but in later times it has given way to the theory of Huygens, who assumed that all space is pervaded by an elastic ether, the undulatory motions of which, when it is disturbed, manifest themselves in light, just as motion in water gives waves, or sound in air gives vibrations. Neither of these theories, it was afterwards thought, having fully explained the phenomena of light, another explanation was propounded, which corresponds very much with that of Huygens. This is that all space is filled with electricity, the elastic ether of Huygens, which, as is known, penetrates all bodies; and that the great ocean of electricity in free space, having nothing to compress it, yields freely in all directions, and only undulates when passing through other media, such as the atmosphere, where it suffers interruption, and also, to a certain extent, absorption. Thus far as to the theories. But the fact is that men will be ever changing their theories, rejecting old ones and substituting new ones, until they have come to a knowledge of the subject concerning which the theory is. No false theory will fully satisfy the mind, or last permanently. The phenomenon of light does not depend upon the emission of luminous particles from luminous bodies; neither does it depend upon all space being filled with a particular substance called ether or electricity, or of any other name; but it consists simply in this, the infinite multiplication of the image of the luminous object by reflection and refraction from the media on all sides of it, and to all visible distances from it. It depends simply upon this, that a luminous body exists, and is within visible distance; and then the amount of light places possess will depend upon the adaptedness or unfitness for reflection of the media of these places. When a body is permanently luminous, as the sun is, then the space which it illuminates is always illuminated, (unless parts of it which, during certain intervals, are separated from the luminous body by the intervention of opaque bodies,) and so the light cannot be said to occupy any time in passing from one point of that space to another, or from the luminous body to any point of that space, as the common theories suppose, one of which has it to travel at the rate of nearly 200,000 miles a second. This theory is based upon deductions which have been drawn from observations made upon the satellites of Jupiter, at the time of their emergence from an eclipse. From these observations it was determined that it took the light a certain length of time to reach the earth from the satellites after their emergence from behind the body of the planet. But it appears quite evident that at the instant of their emergence, coming into the flood of solar light, they would be visible from the earth; and that no perceptible time might intervene between their emergence and their being seen by an observer on the earth. Light cannot be said to occupy any time in moving through a space in which it is constantly present. The reason why we do not always experience the light of the sun is because we are prevented from doing so by the intervention of the body of the earth between us and the sun during the night time, or by the intervention of some other object between us and the sun. But when the morning has come, and the side of the earth on which we live has come round to face the sun; or when any other body, which has shut out from us the light of the sun, has been removed, and that luminary shines with a clear face, we can see him just in the same time as it takes us to see our neighbor standing at our elbow. No perceptible time intervenes between our opening our eyes to see the sun and our seeing him, although we are certainly separated from that luminary over ninety millions of miles. Nor does it take the light of any of the stars that are visible to us any length of time to travel from them to us. The light of the stars visible to us is always present to the earth, and we only need to be on the side of the earth facing those stars, on a clear night, in order to see them instantly. The only condition necessary to our seeing the star instantly is for the star to be visible, and we then may see it in the same length of time it takes us to see the sun when that luminary is visible; that is, when our eyes are opened and directed toward it, no time at all; although it may be more than a thousand millions of times the distance from us that the sun is. A lighted candle, it is said, can illuminate a space of four cubical miles; that is, a spherical space whose diameter is four miles, the candle being placed in the centre. This candle, therefore, would be seen by an observer placed at any point in that space, say any extremity of a radius; and neither would it take the light any time to reach his eye, nor would there necessarily be any luminous particles emitted by the candle toward his eye. But the image of the candle is present in every point in the space, and is reflected from all the reflecting media. The nearer the observer is to the candle the larger it appears, and the more intense is its light; the farther he removes from it the smaller it appears, and the less intense the light becomes, until finally the candle vanishes entirely from his sight, and there is no perceptible light from it in the surrounding space. So it is evident that when, on their emergence from behind the body of the planet, a sufficiently large portion of the surface of Jupiter's satellites has become enlightened to render them visible to a telescopic observer at the earth, (for these satellites are not discernible by the naked eye,) no perceptible time need intervene until he sees them, provided no other body, as clouds, intervene to obstruct his view of them.

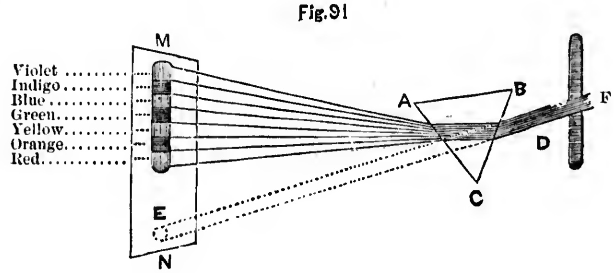
Nor is electricity found to occupy any perceptible time in travelling, by means of wires, to any distance on the earth's surface; that is, the instant the message is sent by the telegraph operator, *that same instant* it is received at the other end of the wire, if the distance be over twelve thousand miles, or half the earth's circumference. The farthest point on the earth's surface, reckoning from any given place, is somewhat over twelve thousand miles, or half the earth's circumference.

The reader will be likely to observe, himself, the absurdity of the theory which supposed light to be dependent upon the emission of luminous particles from a luminous body; for, for example, not a particle of the matter of which the sun is composed can ever go beyond the range of his immediate attraction; that is, every particle of the matter of which that body consists always did and always will belong to him; he cannot lose it. Secondly, he will see the absurdity of supposing that luminous particles of matter could penetrate through thick plates of glass or other transparent substances, which admit the light so freely, as windows, double or multiple; or the glass globes which surround our common lamps; or diamond, one of the hardest known substances. But, as we have said before, light is only a phenomenon, the image of the luminous object infinitely multiplied, as well as the object itself, as far as the manifestation of light is concerned; while, on the other hand, the substance of which light is a manifestation may be called electricity, or any other name one pleases. It is everywhere present, and manifests the light when the conditions necessary for that manifestation exist. All bodies possess in themselves, to a greater or less extent, the principle of light and of heat. But it mostly exists in a latent state in terrestrial bodies, needing to be called into action in order that it become apparent. These principles exist in an active state in the sun; and, therefore, that luminary is the great source not only of light but of heat to the earth. That part of the earth situated most favorably towards him receives the greatest quantity of his light and heat. The space which is constantly filled with the solar light is as constantly filled with the solar heat, and the reason we do not experience as much light and heat at one season of the year as we do at another is because the situation of the earth in relation to the sun does not admit of it. The earth is more than three millions of miles nearer the sun in December than in June, yet we have less light and heat in the former season than in the latter, owing to the parts of the earth which we occupy being turned away from the sun, or, in other words, being situated more obliquely towards him. The earth is a dense body situated in the mighty ocean of the solar light, as a theatre upon which he may display his exhaustless power and energy, and give animation, beauty and sublimity, to every surrounding scene.

The Prism is the most important and instructive of all optical lenses, and it has enabled philosophers to add what may be called another branch of science, "Spectrum Analysis," to those already known. This instrument is triangular, and generally about three or four inches long. It is commonly made of white glass, as free as possible from veins, and bubbles, and other similar defects, and solid throuhgout. Its lateral faces and sides are perfectly plane and finely polished. The angle formed by the two faces, one receiving the ray of light that is refracted in the instrument, and the other giving it an issue on its return into the air, is called the refracting angle of the prism. By means of this triangular piece of glass we are enabled to decompose and analyze a ray of light, and, from the knowledge so obtained, to account for the phenomena of colors. If a ray of light, proceeding directly from the sun, be admitted through a circular hole, half an inch in diameter, into a room, the walls of which should be as dark as possible, or hung with black calico, and a prism intersect it near the window, the ray will cease to go forward in a straight line, being refracted, or bent a little upwards out of its original direction, and will be decomposed, and exhibit, on a white screen placed opposite to the window to receive it, a beautiful spectrum, consisting of seven colors, beginning below and extending upwards in the order of red, yellow, orange, green, blue, indigo, and violet. If the refracting angle of the prism A C B, in the figure,* be sixty-four degrees, and the distance of the white screen from the prism eighteen feet, the length of the image will be about ten inches, and the breadth two inches. This oblong image is called the *prismatic spectrum*, and in it the red color is least, and the violet the most bent from the original direction of the solar beam. The sides of the spectrum are right lines, distinctly bounded; and the ends are *semi-circular*. This circumstance shows that it is still the image of the sun, but elongated by the refractive power of the prism. By an ordinary glass prism, such as those used for glass lustres, the margins of the colors are not clearly defined, but seem to melt or mix, the one into the other. If a hollow glass

* The separation of a ray of white light into different colors, by refraction, may be more accurately understood as represented in figure 91, where a ray of light is admitted through an aperture F in a window shutter into a darkened chamber, and causing it to fall on the prism A B C. A ray, D, thus entering, and suffered to pass unobstructed, would form on a plane surface a circular disc of white light E; but the prism being so placed that the ray may enter and quit it at equal angles, it will be refracted in such a manner as to form on a screen M N, properly placed, an oblong image, called the solar spectrum, and divided horizontally into seven colored spaces or bands of unequal extent. The angle A C B is the refracting angle of the prism. It is seen that the ends of the spectrum are semicircular.

Fig. 91



prism filled with bisulphide of carbon be used, the seven colors of the spectrum are much more clearly defined. Sir Isaac Newton made this interesting and important discovery, that white light is a compound of rays of various kinds, having different colors, and indices of refraction; and that all the substances which appear colored when illuminated with white light, derive their colors only from a kind of "natural selection," that is, they may reflect certain colored rays and absorb or transmit others. He, however, concluded, from various experiments on this subject, *that every substance in nature, provided it be reduced to the requisite degree of thinness, is transparent.* This is plain also, from the fact that all substances are of a nature reducible to an invisible gas. Many transparent media reflect one color and transmit another; gold leaf reflects the yellow, but it transmits a sort of green color by holding it up against a strong light.

Light is said to be the source of all colors; but, if the principle of light is inherent in all substances, how can it be said that colors are not inherent in them? Light itself is, in every case, a manifestation of matter. The matter which gives rise to the light is sometimes, as in the case of carburetted hydrogen gas, itself invisible; yet, when properly examined, the light proceeding from it displays all colors, and renders them apparent in all other objects. The colors displayed by different objects, owing to their peculiar adaptedness for absorbing or reflecting certain of the colors of light, are various, and of different degrees of intensity; but the colors displayed by light in the prism are permanently the same, only, it may be, differing slightly in their intensity, according to the source whence the light is derived.

When the solar spectrum, obtained as already described, is thrown upon a white screen, it is amusing to see the effect of different colored rays upon different pigments; and if slips of colored paper be used the results are very distinct. By passing the ray of white light through two prisms, inverted to each other, and filled with bisulphide of carbon, the spectrum may be made to stretch much farther across the screen, and the sunbeam undergoes by the double refraction a greater amount of dispersion. The colors are now more clearly separated, and the experiments with the slips of colored paper or other pigments, can be made with much greater facility. The drawing apart or separation of the colors is called dispersion, and thus the structure may be made shorter or longer, by using prisms of different dispersive powers. Although it is difficult for the best eyes to point out the exact boundaries of each color, Sir Isaac Newton concluded, after repeated experiments, that the lengths of the colors with the particular glass prism which he used were as follows: Red 45, orange 27, yellow 40, green 60, blue 60, indigo 48, violet 80; total number of equal spaces into which the spectrum was divided, 360°. By making a hole in the screen opposite any one of the colors of the spectrum, and placing the screen in such a position as to allow that color only to pass, and by letting the color thus separated fall upon a second prism, he found that each of the colors was alike refrangible, because the second prism could not separate them into an oblong image, or into any other color. Hence he called all the seven colors *simple* or homogeneous, in contradistinction to white light, which he called compound or heterogeneous. For he also ascertained that the colors could be brought together, again recombined; and that the result was the recomposition of white light. This synthesis of colors is readily shown by using a second prism placed in an inverted position to the other, and allowing the ray of light to pass through this; or by allowing the colored rays to fall upon a double-convex lens, when they are brought to a focus, and a spot of white light alone is visible. The experiment can be varied by mixing seven different colored powders together, the colors being, of course, as near as possible to those of the solar spectrum; or these colors may be painted on a circular piece of cardboard, and when this is properly adjusted, and whirled round with sufficient velocity, the colors seem all blended together, and produce the near estimitation of white light.

If a sunbeam is passed through a double-convex *lens, which represents a series of prisms with their bases attached to each other*, and their thinnest edges outward, it is not to be wondered at that the disc of light obtained should be *fringed with colors*, because it has been shown that a prism decomposes white light. If all the colors were of the same refrangibility there would be no fringes of colors on the edges of bodies seen through a common telescope or microscope; but as the focus of the red ray is formed further away from the lens than that of the blue ray, because the latter is more refractive than the former, it follows that a separation of color must occur, which is technically termed *chromatic aberration.* Newton, however, examined the ratio between the sines of incidence and refraction of the decompounded rays, and found that each of the seven primary color-making rays had certain limits within which they were confined. Thus, let the sine of incidence in glass be divided into 50 equal parts, the sine of refraction into air of the *least* refrangible, and the *most* refrangible rays will contain respectively 77 and 78 such parts. The sines of refraction of all the degrees of red will have the intermediate degrees of magnitude from 77 to $77\frac{1}{8}$; orange from $77\frac{1}{8}$ to $77\frac{1}{5}$; yellow from $77\frac{1}{5}$ to $77\frac{1}{3}$; green from $77\frac{1}{3}$ to $77\frac{1}{2}$; blue from $77\frac{1}{2}$ to $77\frac{2}{3}$; indigo from $77\frac{2}{3}$ to $77\frac{7}{9}$; and violet from $77\frac{7}{9}$ to 78. From the foregoing statements it is evident, as has been shown above in the case of double-convex lenses, that as any portion of an optic glass bears a resemblance to the form of a prism, the component rays which pass through it must necessarily be separated, and will consequently paint or tinge the object with colors. The edges of every convex lens approximate to this form, and it is on this account that the edges of objects viewed through them are found to be tinged with the prismatic colors. In such a glass, therefore, the different colored rays will have different foci, and will form their respective images at different distances from the lens.

The amount of dispersion of the colored rays in convex lenses depends upon the focal length of the glass, the space which the colored images occupy being about the twenty-eighth part. Thus, if the lens be twenty-eight inches focal distance, the space between the red and the violet colors of the spectrum will be about one inch; if it be twenty-eight feet focal distance the same space will be one foot, and so on in proportion. When such a succession of images, formed by the different colored rays, is viewed through an eye-glass, it will appear to form but one image, and consequently very indistinct, and fringed with various colors; and as the red color is largest or seen under the greatest angle, the extreme parts of the confused image will be red, and a succession of the prismatic colors will be formed within this red fringe, as is generally formed in common refracting telescopes, constructed with a single object-glass. To this circumstance it is owing that the common refracting telescope cannot be much improved without having recourse to lenses of very long focal distance; and hence about 180 years ago such telescopes were constructed of 80,100, and 120 feet focal length. But still the image was not formed so distinctly as desired, and the aperture of the object-glass had to be limited. This is a defect which was long regarded as without a remedy, and even Newton himself despaired of discovering any means by which the defects of refracting telescopes might be remedied, and their improvement effected. But this difficulty has been most ingeniously surmounted by combining lenses of unequal dispersive material; and it was Mr. Dollond who proved in 1757 that by combining a concavo-convex lens of flint glass with a double-convex one of crown glass a lens was obtained which virtually refracts the various colored rays to one focus, and is, therefore, *achromatic*, that is, free from color. For absolute achromatism various lenses are necessary, but for all practical purposes two are found to be sufficient, provided their curvatures are such as to combine the yellow and red rays.

It was originally observed by Newton, and the fact has since been confirmed by the experiments of Herschell, that the different colored rays have not all the same illuminating power. The violet rays appear to have the least illuminating effect; the indigo more; and the effect increases in the order of the colors, the green being very great; between the green and yellow the greatest of all; the yellow the same as the green; but the red less than the yellow. Herschell also endeavored to determine whether the power of the differently colored rays to *heat* bodies varied with their power to illuminate them. He introduced into a dark room a beam of light which was decomposed by a prism, and then exposed a very sensible thermometer to all the rays in succession, and observed the heights to which it rose in a given time. He thus found that their power to heat increased from the violet to the red. The mercury in the thermometer rose higher when its bulb was placed in the indigo, than when it was placed in the violet; still higher in blue, and highest of all at red. Upon placing the bulb of the thermometer below the red, quite out of the spectrum, he was surprised to find that the mercury rose highest of all, and concluded that rays proceed from the sun, which have the power of heating, but not of illuminating bodies. These rays have been called invisible solar rays; they were about half an inch from the beginning of the red rays; at a greater distance from this point the heat began to diminish, but was quite perceptible at a distance of one and a half inches. He determined that the heating power of the red to that of the green rays was as $2\frac{3}{4}$ to 1, and of red to violet as $3\frac{1}{2}$ to 1. He afterwards made experiments to collect these invisible caloric rays, and caused them to act independently of the light, from which he concluded that they are sufficient to account for all the effects produced by the solar rays in exciting heat; that they are capable of passing through glass, and of being refracted and reflected, after they have been finally detached from the solar beam.

Mr. Ritter of Jena, Dr. Wollaston, Beckman and others have discovered that the rays of the spectrum are possessed of certain *chemical properties;* that beyond the least brilliant extremity of the spectrum, namely, a little beyond the violet ray, there are invisible rays which act chemically, while they have neither the power of heating nor of illuminating bodies. Muriate of silver exposed to the action of the red rays becomes blackish; a greater effect is produced by the yellow; a still greater by the violet; and the greatest of all by the invisible rays beyond the violet. When phosphorus is exposed to the action of the invisible rays beyond the red, it emits white fumes, but the invisible rays beyond the violet extinguish them.

It has likewise been found that certain rays of the spectrum, particularly the violet, possess the property of communicating the magnetic influence. Morchini, of Rome, appears to have been the first who discovered that the violet rays of the spectrum had this property. The result of his experiments was, however, involved in doubt, but it was believed to be established by a series of experiments, carried out by Mrs. Somerville, a lady who is celebrated for her scientific pursuits. This lady, having covered half a sewing needle, of about an inch long, with paper, exposed the other half for two hours to the violet rays. The needle had then acquired north polarity. The indigo rays produced nearly the same effect; and the blue and green rays produced it in a still less degree. In the yellow, orange, red, and invisible rays, no magnetic influence was exhibited, although the experiment was continued for three successive days. The same effects were produced by enclosing the needle in blue or green glass, or wrapping it in blue or green ribbon, one half of the needle being always covered with paper.

Though the whole space of the solar system is constantly replenished with light and heat, yet the whole system is constantly dependant on the sun for them; and as a candle when extinguished leaves darkness instantly behind it, so the sun, if by any means it were extinguished, would leave our whole system instantly in pitchy darkness. This we positively know from the fact that no image can exist without that of which it is an image existing; and that the sun exists in a luminous state we know from the fact that, when all things are prepared for it, his luminous image is instantly impressed upon the spectrum. That it is the sun's elongated image is evident from the ends of the spectrum being arcs of a circle; the elongation being effected by the different refractive powers of the different colored rays. Now it seems quite evident that the different powers of dispersion, of illuminating, of heating, of producing chemical or magnetic effects, possessed by the different colored rays, and by the invisible rays beyond these, may arise, as the different degrees of light and heat themselves, from the nature of the different combustible substances of which the sun is made up. That these substances are not in general very different from the substances which produce light in the earth, we reasonably infer from the consideration that any common artificial light, such as a candle, a gas, or a petroleum light, gives the same spectral colors as the solar light does; only the colors may vary slightly in intensity. The *spectral bands*, however, which we shall next consider, may give us some insight into the nature of the component substances of the sun's ignited parts.

There was one feature of the solar spectrum which escaped the observation of Newton, and it tends to show how much knowledge may be lost by performing an experiment in the least perfect manner. He allowed his sunbeam to pass through a circular hole to the prism, and thus missed the dark bands and fixed lines which cross the colors from end to end of the spectrum at right angles to its length. Dr. Wollaston made an important discovery by admitting the light through a narrow slit, instead of a circular aperture, which is thus described by Sir David Brewster. In the year 1802, Dr. Wollaston announced that in the spectrum formed by a fine prism of flint glass, free from veins, when the luminous object was a slit the twentieth part of an inch wide, and viewed at the distance of ten or twelve feet, there were two fixed dark lines, one in the green and the other in the blue spaces. This discovery did not excite any attention, and was not followed out by its ingenious author." Without knowing of Wollaston's observations, Mr. Fraunhofer, of Munich, by viewing through a telescope the spectrum formed from a narrow line of solar light with the finest prism of flint glass, discovered that the surface of the spectrum was crossed throughout its whole length by dark lines of different breadths. None of these lines coincide with the boundaries of the colored spaces. They are nearly 600 in number. The largest of them subtends an angle of from five seconds to ten seconds. From their distinctness, and the facility with which they may be found five of these lines have been particularly distinguished by Fraunhofer. One of the important practical results of this discovery is that those lines are fixed points in the spectrum, or rather that they have always the same position in the colored spaces in which they are found. Fraunhofer likewise discovered in the spectrum produced by the light of Venus, the same streaks as in the solar spectrum; in the spectrum of the light of the star Sirius he perceived three large streaks which,according to appearance, had no resemblance to those of the solar spectrum; one of these was in the green, two in the blue. The stars appear to differ from one another in their streaks. The electric light also is found to differ somewhat from the light of the sun, and that of a candle, in regard to the spectral streaks. When the spectrum is formed by the sun's rays, either direct or indirect, as from the sky, clouds, rainbow, moon or planets, the black bands are always found to be in the same parts of the spectrum, and under all circumstances to maintain the same relative position, breadth and intensities.

A very convenient instrument has been invented by Mr. John Browning, called the "Miniature Spectroscope" by which, at any time, the solar spectrum may be observed in all its beauty of color; and the dark lines are easily seen by properly adjusting the width of the slit. When this is widely opened, the spectrum is more brilliant, because more light is admitted to the series of prisms contained in the instrument, but the lines are not then visible. By reducing the size of the aperture, it presents the appearance of striped ribbon, and is found to be crossed in the direction of its breadth by a number of dark lines. This instrument in the case measures four inches in length, and rather more than three-fourths of an inch in diameter; it is therefore easily portable in the pocket, and is thus kept ready for any special use, such for instance as observing the bright bands of color emitted by certain flames, or intensely hot gaseous matter, similar to that coming from the furnace in which the Bessemer process is carried on; and it is by the employment of the spectroscope that the exact moment of the completion of the process for making steel or pure iron may be determined by a person skilled in the use of this instrument.

In order to properly distinguish the spectral lines, it is necessary to classify the spectra obtained from the different sources of light. Thus, the light obtained from the incandescence of two graphite electrodes by the voltaic battery, and called the "electric light," will, provided the graphite be middling pure, exhibit a continuous band of colors, perfectly free from all black lines. Such a spectrum teaches us nothing more than that light can be decomposed into seven colors. An observer looking at such a spectrum could not tell the exact source of the light, or say whether it was evolved by incandescent charcoal, lime, or platinum. Such a pure band of colors is called *a spectrum of the first order*. If a spirit lamp, burning pure and good spirit, is used as the source of heat, and a platinum wire, looped at the end, and dipped into a solution of common salt, is now held in the spirit flame, it changes yellow : and if the little hand spectroscope is directed towards it a yellow line is distinctly seen, whose position is toward the red end of the spectrum. When a more intense heat is used, such as the electric arc, the sodium line is double, and is then exactly coincident with the dark, double solar line known as Fraunhofer's (D) line. If nitrate or chloride of strontium be used, and placed, like the chloride of sodium, upon the looped platinum wire in the flame, and observed with the spectroscope, the colored bands are more numerous. There are eight remarkable lines, one blue band, one orange, and six red. All the metals and the salts which can be converted into *luminous* gas give bright lines instead of dark ones; and the various spectra obtained in this way are called *spectra of the second order*.

The fact that metals and their salts will always give the same colored bands invariably in some particular part of the spectrum, affords a most delicate measure of quantitative analysis, which is generally employed where the presence of a minute quantity of some metallic salt is suspected. By means of spectral analysis, the three-millionth part of a millogramme of soda can be easily detected, of lithium the nine-millionth part, of calcium the ten-thousanth part of a milligramme. The spark from the great induction coil, when passed through the air, is always of a light-yellow color, and when examined by the spectroscope it gives the yellow line of sodium; and this is said to be supplied from the dust always floating in the air, which is continually supplied with particles of salt from the spray carried by the winds from the ocean.

There is but one more order to speak of; this is, *spectra of the third order*, of which the best type is the solar spectrum, crossed by black lines. "The spectra of this order," says Mr. Huggins, "consist of the spectra of incandescent, solid or liquid bodies, in which the continuity of the colored light is broken by dark lines. These dark spaces are not produced by the source of the light. They tell us of vapors through which the light has passed on its way, and which have robbed the light, by absorption of certain definite colors, or rates of motion. Such spectra are formed by the light of the sun and stars." If the light producing the yellow lines in sodium by the electric arc be allowed to pass through the vapor of metallic sodium, the yellow lines change to black lines. The sodium vapor absorbs the same kind of light as it emits; and it was by this remarkable discovery that Kirchoff identified many of the dark lines in the solar spectrum, with the bright lines obtainable from terrestrial substances; and ascertained that, in the solar atmosphere, there existed sodium, calcium, barium, magnesium, iron, chromium, nickel, copper, zinc, strontium, cadmium, cobalt, and hydrogen. If the evidence depended only on the coincidence of one or two dark solar lines with the bright bands from the vapors of the terrestrial metals, it would be worth little or nothing; but in a complicated series of sets of lines, such as would be produced by the above metals, *all the lines coincide;* and in speaking of one of those metals, Kirchoff remarks: "The observations of the solar spectrum appear to me to prove the presence of iron-vapor in the solar atmosphere, with as great a degree of certainty as we can attain in any question of natural science." Messrs. Huggins and Miller have continued observations with the planets, the stars, the nebulæ, and the comets, and have added largely to our knowledge of the constitution of these distant heavenly bodies.

The Rainbow.

At certain times, when there is a shower, either around us, or at a distance from us, in an opposite direction to that of the sun, we see a kind of arch or bow in the sky, adorned with all the primary colors of light. This phenomenon, which is one of the most beautiful meteors in nature, is named the rainbow. The rainbow was for ages considered as an unexplainable mystery, and by some nations it is said to have been adored as a deity. Even after the light of modern science had begun to dispel the ignorance from the minds of men, it was a considerable time before any discovery of importance was made as to the true causes which co-operate in the production of this phenomenon; and it was not until Newton discocovered the different refrangibility of the rays of light, that a complete and satisfactory explanation could be given of all the circumstances connected with the rainbow. This most beautiful meteor never makes its appearance to the spectator but when he is situated between the sun and the shower; and it is produced by the reflection and refraction of the rays of light from the falling drops of rain. It has been observed before that water is a transparent medium, and transmits the rays of light, refracting or bending them a little from the course they were pursuing before entering it; but while it transmits some rays of light, refracting them, it reflects others, both from its surface and inside its surface. There are usually two bows seen at the same time, one a little above the other, and encircling it; the inside one is called the *primary*, the outside the *secondary* bow. The secondary bow is usually much fainter in its colors than the primary. Now these bows are formed by the drops of rain in a given circle acting like prisms, and separating the rays of light, by refraction and reflection, into their prismatic colors; the red being lowest and the violet highest in the primary bow; and the violet lowest and red highest in the secondary. It has been shown from the experiments of scientific men, who possessed both the inclination and leisure for such pursuits, that the first or primary bow is produced by one reflection and two refractions of the ray of light in the drop of rain; and the secondary bow by two refractions and two reflections in the drop. In the first case, the ray of light enters the drop from above, and on entering a new medium is, of course, refracted; it pursues its course in the drop, is reflected inside of it, and emerges from the same hemisphere of the drop as that in which it entered, and in emerging is refracted. Thus, the ray is refracted in entering the drop, a new and denser medium; is reflected in the drop, the same medium; and is refracted again in emerging from the drop to the air, a different medium from the drop.

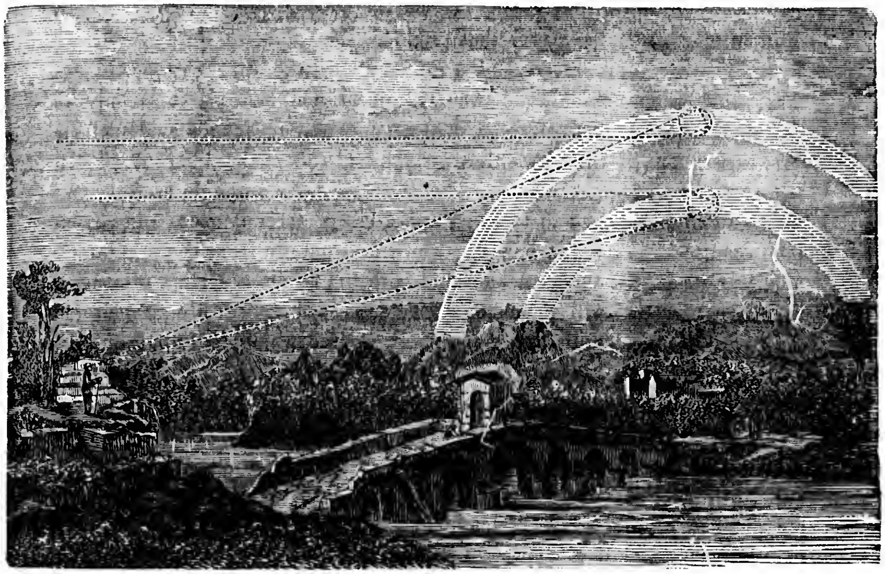


Fig. 92.—CAUSE OF THE PHENOMENON OF THE RAINBOW.

In the second case the ray strikes the drop rather on the lower side, and is refracted on entering it; pursues its course to the other side of the drop on the inside, and is reflected from the lower part of the inside surface of the drop; is reflected again from the inside of the upper surface of the drop; and in emerging from the drop is refracted. Thus, as in the first case, the ray is refracted in entering the drop, a new medium; is reflected twice in the drop, the same medium; and in emerging to the air is again refracted. Hence in consequence of the two reflections in the drop in the last case the ray must in its course have described a four-sided figure, perhaps a square or a parallelogram. The same thing happens in the given circular space with respect to a whole shower as happens with respect to one or two drops; and by the constant falling of the rain the image is preserved constant and perfect. This subject may be partially illustrated in this way; take either a small solid glass globe or a small glass globe filled with water, and suspend it so high in the solar rays that the observer with his back to the sun can see the globe *red*; if it then b lowered slowly he will see it orange, then yellow, then green, then blue, then indigo, and then violet; so that the drop of rain, as this, at different heights shall present to the eye of the observer the seven prismatic colors in succession. It must not be thought that any perceptible time is taken up in the refractions and reflections we speak of, as by which the rainbow is formed in the falling rain-drops, or in the lowering glass globe; the phenomenon is produced by the positions of the falling drops, or of the globe, in relation to our eye and to the sun. Fig. 92 illustrates the cause that produces the rainbow; the lower drop, or series of drops, representing the primary bow, the upper the secondary. The rainbow assumes a semi-circular appearance because it is only at certain angles that the refracted rays come to our eyes, as is evident from this experiment of the glass globe, which will reflect the different colored rays only in a certain position. The red rays make an angle of forty-two degrees two minutes; and the violet an angle of forty degrees and seventeen minutes. Thus if a line be drawn horizontally from the spectator's eye, it is plain that the angles formed with the line of a certain dimension in every direction will produce a circle, as will appear by attaching a cord of a certain length to a given point, around which, as round an axis, it may turn; and, in every point it will describe an angle with the horizontal line of a certain and determinate length. Now all the drops of water within the *difference* of these two angles, namely, one degree and forty-five minutes, (supposing the ray to proceed from the centre of the sun), will exhibit severally the colors of the prism and constitute the interior bow of the cloud. This holds good at whatever height the sun may happen to be in a shower of rain. If he be at a high altitude the rainbow will be low; if at a low elevation the rainbow must be high; and if a shower happen in a vale when the observer is on a mountain he will sometimes see the bow in the form of a *complete circle* below him. The largest angle then, or circle, is formed by the red rays, the middle one the green, and the smallest the purple or violet. If the spectator alters his position, he will see a bow, but not the same as before; and if there be many spectators they will see each a different bow, though it appears to be the same. If there were no ground to intercept the rain and the view of the spectator, the rainbow would form a complete circle whose centre is diametrically opposite to the sun. Such circles are often seen in the spray of the sea or of a cascade, or from the tops of lofty mountains when the shower happens in the vale below. Rainbows of various descriptions are frequently seen rising amid the spray and exhalations of waterfalls, and among the waves of the sea, whose tops are blown by the wind into small drops. There is one regularly seen when the sun is shining, and the observer in a proper position, at the Fall of Staubback, in the bosom of the Alps; one near Schaffhausen; one at the Cascade of Lauffen; and one at the Cataract of Niagara.

A more beautiful one than any of these is said to be seen at Terni, where the whole current of the river Velino, rushing from a steep precipice of nearly two hundred feet high, presents to the observer below a variegated circle, overreaching the fall, and two other bows suddenly reflected on the right and left. Don Ulloa, in the account of his travels in South America, relates that circular rainbows are frequently seen on the mountains above Quito, in Peru. A naval friend, says Mr. Bucke, informed me that as he was one day watching the sun's effect upon the exhalations near Juan Fernandez, he saw upwards of five-and-twenty *ires marinæ* animate the sea at the same time. In those marine bows the concave sides were turned upward, the drops of water rising from below, and not falling from above, as in the instance of the aerial arches. Rainbows are also occasionally seen on the grass in the morning dew, and likewise when the hoar-frost is descending. Dr. Langwith once saw a bow lying on the ground, the colors of which were almost as lively as those of a common rainbow. It was not circular, but oblong, and was extended several hundred yards. The colors took up less space and were much more vivid in those parts of the bow which were near him, than in those which were at a distance. When M. Labillardiere was on Mount Teneriffe, he saw the contour of his body traced on the clouds beneath him, in all the colors of the solar bow. He had previously witnessed this phenomenon on the Kesrouan, in Asia Minor. The rainbows of Greenland are said to be frequently of a pale white, fringed with a brownish yellow, arising from the rays of the sun being reflected from a frozen cloud.

A rainbow may be produced at any time by artificial means, when the sun is shining, and not at too great an altitude above the horizon. This is effected by means of artificial fountains which are intended to throw up streams of water to a great height. These streams, when they spread very wide and blend together in their upper parts, form, when falling, an artificial shower of rain. If then, when the fountain is playing, we move between it and the sun to a proper distance from the fountain, until our shadow point directly toward it, and look at the shower, we shall observe the colors of the rainbow strong and lively; and what is especially noticeable, the bow appears, notwithstanding the nearness of the shower, to be as large and as far off as the rainbow which we see in a natural shower of rain. The same experiment may be made with candle-light and with any instrument that will form an artificial shower.

The following is a summary of the principal facts which have been ascertained respecting the rainbow. 1. The ordinary rainbow can only be seen when it rains, and in that part of the heavens opposite to the sun. 2. Both the primary and secondary bows are variegated with all the prismatic colors, the red being the highest color in the primary, or brightest bow ; and the violet the highest in the secondary or exterior bow. 3. The primary rainbow can never be a greater arc than a semicircle ; and when the sun is set no bow in ordinary circumstances can be seen. 4. The breadth of the inner or primary bow, supposing the sun but a point, is one degree and forty-five minutes ; and the breadth of the exterior bow three degrees and twelve minutes, which is nearly twice as great as that of the other ; and the distance between the bows is eight degrees and fifty-five minutes. But since the body of the sun subtends an angle of about half a degree, by so much will each bow be increased, and their distance diminished ; and therefore, the breadth of the interior bow will be two degrees, fifteen minutes ; and that of the exterior three degrees, forty-two minutes ; and their distance eight degrees, twenty-five minutes. The greatest semi-diameter of the interior bow, on the same grounds, will be forty-two degrees, seventeen minutes ; and the least of the exterior bow fifty degrees, forty-three minutes. 5. When the sun is in the horizon, either in the morning or evening, the bows will appear complete semicircles. On the contrary, when the sun's altitude is equal to forty-two degrees, two minutes, or to fifty-four degrees, ten minutes, the summits of the bows will be depressed below the horizon. Hence during the days of summer within a certain interval each day no visible rainbows can be formed, on account of the sun's high elevation above the horizon. 6. The altitude of the bows above the horizon, or surface of the earth, varies according to the elevation of the sun. The altitude at any time may be taken by a common quadrant or any other angle-measuring instrument; but if the sun's altitude at any particular time be known the height of the summit of any of the bows may be found by subtracting the sun's altitude from forty-two degrees, two minutes, for the inner bow ; and from fifty-four degrees, ten minutes for the outer. Thus, if the sun's altitude be twenty-six degrees, the height of the primary bow would be sixteen degrees, two minutes ; and that of the secondary bow twenty-eight degrees, ten minutes. It follows that the height and the size of the bows diminish as the altitude of the sun increases. 7. If the sun's altitude be more than forty-two degrees, and less than fifty-four, the exterior bow may be seen, though the interior one is invisible. Sometimes only a portion of an arch will be visible, while all the other parts of the bow are invisible. This happens when the rain does not occur in a space of sufficient extent to complete the bow; and the appearances of the position, and even of the bow itself, will be various, according to the nature of the situation, and the space occupied by the rain.

Lunar rainbows are sometimes formed at night by the rays of the moon striking on a rain-cloud, especially when the moon is about at its full; but such phenomena are not often observed. Aristotle is said to have considered himself the first who saw a lunar rainbow. These bows appear distinct and well-defined, but the prismatic colors are usually not very distinct. They may be all distinguished by attending to the phases and position of the moon. If the moon be not visible above the horizon, if she be in her first or last quarter, or if an observed phenomenon is not in a direction opposite to the moon, we may conclude with certainty that whatever appearance is presented no lunar rainbow appears. The writers of the Bible frequently allude to the rainbow as one of the emblems of the majesty and glory of the Deity. Ezekiel represents the throne of the Almighty as adorned with a brightness "like the appearance of a bow that is in the cloud in the day of rain; the appearance of the likeness of the glory of Jehovah." And in the visions recorded in the book of Revelation, where the Most High is represented as sitting on a throne, it is said; "there was a rainbow round about the throne, in sight like unto an emerald," an emblem of his glory, and holiness, as well as of his propitious character, as there represented. In the aprocryphal book of Ecclesiasticus it is alluded to by the son of Sirach after this manner: "Look upon the rainbow, and praise Him that made it; very beautiful it is in the brightness thereof. It compasseth the heavens about with a glorious circle, and the hands of the Most High have bended it."

ON COLORS; AND OTHER EFFECTS OF LIGHT.

The common theory supposes or represents that colors are inherent in light alone; whereas it is evident light only makes manifest what exists in something or in everything else. The principles of light, of colors, and of heat co-exist in everything. Burn a stick of wood and you obtain a blaze, from which you can derive all the prismatic colors; you derive light, heat, electricity, and colors, from the same bit of fuel. Light is that manifestation of matter which opens up to us the universe, displays to us all other objects, and is an object itself for us to experiment upon. Thus, we can experiment upon the properties of light, as well as upon all other things by means of light. It is essential to the existence of all vegetables and animals; and this is a proof that the solar light has always existed as now, and, therefore, that all colors have always been displayed. It is, however, strictly true, that without light there would be no colors: although they existed in principle everywhere and in everything. All colors, therefore, are dependent upon light. Of all the phenomena which vegetables exhibit, there are few that appear more extraordinary than the energy and constancy with which their stems incline toward the light. Most of the discous flowers follow the sun in his course. They attend him to his retreat in the evening, and meet his rising lustre in the morning, with the same unerring law. They unfold their petals on the approach of this luminary; they follow his course by turning on their stems, and close them as soon as he disappears. Also, if a plant be shut up in a dark room, and a small hole be afterwards opened, by which the light of the sun may enter, the plant will turn toward that hole, and even alter its shape, in order to incline towards it; so that, though it was straight before, it will in time become crooked, that it may get near the light. Vegetables placed in rooms where they receive light only from one direction always extend themselves in that direction. If they receive light from two directions, they incline rather toward that which is strongest. It seems to be rather the light than the heat of the sun which the plant thus covets; for though a fire be kept in the room capable of giving out a much stronger heat than the sun gives there, the plant will turn away from the fire, in order to enjoy the solar light. Trees growing in dense forests, where they receive most of their light from above, direct their shoots almost invariably upward, and, therefore, become much taller and less spreading than such as stand single; they are also more intensely green toward the tops. The green color of vegetables is found to depend upon the sun's light being allowed to shine on them; for without the influence of the solar light they are always of a whitish aspect. It is found by experiment that if a plant, which has been reared in darkness, is exposed to the light of the day, in two or three days it will acquire a green color, perceptibly similar to that of plants which have grown in open daylight. If we expose to the light one part of the plant, whether leaf or branch, this part alone will become green. If we cover any part of a leaf with an opaque substance, this place will remain white, while the rest becomes green. The whiteness of the inner leaves of cabbages is a partial effect of the same cause; and any one may produce many other examples of the same kind. M. Decandolle, who seems to have paid particular attention to this subject, makes the following remarks; "It is certain that between the white state of plants vegetating in darkness and complete greenness, every possible intermediate degree exists, determined by the intensity of the light. Of this, any one may easily satisfy himself by attending to the color of a plant exposed to the full daylight; it exhibits in succession all the degrees of verdure. I had already seen the same phenomenon in a particular manner, by exposing plants reared in darkness to the light of lamps. In these experiments, I not only saw the color come on gradually, according to the continuance of the exposure to light, but I satisfied myself that a certain intensity of permanent light never gives to a plant more than a certain degree of color. The same fact readily shows itself in nature, when we examine the plants that grow under shelter or in forests, or when we examine in succession the state of the leaves that form the heads of cabbages." *

It is likewise found that the perspiration of vegetables is increased or diminished in a certain measure by the degree of light which falls upon them. M. Guetard informs us that a plant exposed to the rays of the sun has its perspiration increased to a much greater degree that if it had been exposed to the same heat inside the shade. And, it is said, the experiments of Mr. P. Miller, and others, go to prove that plants uniformly perspire most in the forenoon, though the temperature of the air in which they are placed should be unvaried. Vegetables are likewise found to be indebted to light for their smell, taste, and combustibility, maturity, and the resinous principles which equally depend upon it. The aromatic substances, resins, and volatile oils, are the productions of Southern climates, where the light is more pure and intense. Another remarkable property of light on the vegetable kingdom is, that when vegetables are exposed to open daylight, or to the sun's rays, they emit oxygen gas, or vital air. It has been proved that in the production of this effect the sun does not act as a body that heats. The emission of the gas is determined by the light; pure air is, therefore, separated by the action of light, and the operation is stronger as the light is more intense. By this continual emission, the atmosphere is continually purified, and the loss of pure air occasioned by respiration, combustion, fermentation, putrefaction and numerous other processes which have a tendency to vitiate this fluid, so essential to the maintenance and vigor of animal life, is repaired; so that in this way, by the agency of light, a due equilibrium is always maintained between the constituent parts of the atmosphere.

It is evident that colors exist but in principle, except for the agency of light; and it is owing to the surfaces of bodies being disposed to reflect certain colors rather than others that we have such a variety of colors. When the disposition is such that a body reflects every kind of ray in the mixed state in which it receives them, that body appears white to us, which, properly speaking, is no color, but rather the combination of all the colors. When a body absorbs nearly all the light which falls upon it that body appears *black*; it transmits to the eye so few reflected rays that it is scarce perceptible in itself, and its presence and form make no impression upon us unless as it interrupts the brightness of the surrounding space. Black is therefore the absence of all colors. If the body has a fitness to reflect one sort of rays more abundantly than others, by absorbing all the

* Memoires de la Société d'Arencil.

others, it will appear of the color belonging to that species of rays. Thus, the grass is green because it absorbs all the colors except green. It is the green rays only which the grass, the foliage of the trees and shrubs, and all the other verdant parts of the landscape reflect to our sight, and which make them appear green. In the same manner the different flowers reflect their respective colors; the rose the red rays; the jonquil the yellow; the marigold, the orange; and every object, whether natural or artificial,appears of the color which its peculiar texture is adapted to reflect. A great number of bodies are fitted to reflect at once several kinds of rays, and consequently they appear under mixed colors. It often happens that of two bodies which are green, for example, one may reflect the green of light and the other the mixture of yellow and blue. This quality, which varies to infinity, occasions the different kinds of rays to unite in every possible manner, and every possible proportion; and hence the inexhaustible variety of shades and hues which is seen diffused over the scene of creation.

Every object is black or colorless in perfect darkness, and it only appears colored as soon as light renders it visible. This will become more plain from the following experiment. If we place a colored body in one of the colors of the spectrum which is formed by the prism it appears of the color of the rays in which it is placed. Take, for illustration, a red rose, and expose it first to the red rays, and it will appear of a more brilliant, ruddy hue; hold it in the blue rays and it appears no longer red, but of a dingy blue color; and in like manner its color will appear different when exposed to all the other differently colored rays. This is the reason why the colors of objects are altered by the nature of the light in which they are seen. The colors of ribbons, of cloths, of silks, or woollen stuffs, are not exactly the same when viewed by candle-light as in the day time. In the light of a lamp or of a candle blue sometimes appears green, and yellow objects assume a whitish aspect. The reason is that the light of a candle or of a lamp is not as pure a white as that of the sun, but has a yellowish tinge, and therefore, when refracted by the prism, the yellowish rays are found to predominate, and the superabundance of yellow rays gives to blue objects a greenish hue. The following experiment, as described by Sir D. Brewster, may further illustrate our subject: "Having obtained the means of illuminating any apartment with yellow light, let the exhibition be made in a room with furniture of various bright colors, and with oil or water-colored paintings on the wall. The party which is to witness the experiment should be dressed in a diversity of the gayest colors, and the brightest-colored flowers and highly-colored drawings should be placed on the tables. The room being at first lighted with ordinary lights the bright and gay colors of everything that it contains will be finely displayed. If the white lights are now suddenly extinguished, and the yellow lamps lighted, the most appalling metamorphosis will be exhibited. The astonished individuals will no longer be able to recognize each other. All the furniture of the room, and all the objects it contains, will exhibit only one color. The flowers will lose their hues; the paintings and drawings will appear as if they were executed in China ink; and the gayest dresses, the brightest scarlets, the purest lilacs, the richest blues, and the most vivid greens, will all be converted into one monotonous yellow. The complexions of the parties, too, will suffer a corresponding change. One pallid, death-like yellow, 'like the unnatural hue which Autumn paints upon the perished leaf,' will envelop the young and the old; and the sallow face will alone escape from the metamorphosis. Each individual derives merriment from the cadaverous appearance of his neighbor, without being sensible that he is one of the ghastly assemblage."

From such experiments we might conclude that were the colors of the solar spectrum different from what they are the colors which adorn the face of nature and embellish the landscape of the world would be of another aspect, and appear very different from what we are now accustomed to behold. Some of the distant stars appear to display light different in color from solar light; and hence some have concluded that the coloring thrown upon the different scenes of the universe may vary somewhat in different systems, and that, along with other arrangements, an infinite variety of coloring of scenery may be displayed throughout the immensity of creation. The different coloring, however, which these distant stars appear to exhibit may arise from complementary colors, which we shall soon come to consider. The atmosphere, in consequence of its refractive and reflective powers, is the source of a diversity of colors which frequently embellish and adorn the aspect of our sky. The atmosphere reflects the blue rays most plentifully, which is the cause of its blue aspect, and must, therefore, transmit the red, orange, and yellow more copiously than the other rays. When the sun and other heavenly bodies are at an high altitude their light is transmitted without any perceptible change to the earth's surface; but when they are near the horizon their light has to pass through an extended tract of dense air, and must therefore, be considerably modified by reflection before it reaches the eye of the observer. If the light of the setting sun, by thus passing through a long tract of dense air, be divested of its green, blue, indigo, and violet rays, the remaining rays which are transmitted through the atmosphere will illuminate the western clouds, first, with an orange color, and, then, as the sun gradually sinks below the horizon, the track through which the rays must pass becoming longer, the yellow and orange are reflected, and the clouds grow more deeply red, until at length the departure of the sun leaves them of a leaden hue, by the reflection of the blue light through the air. Similar changes may sometimes be seen on the eastern and western fronts of white buildings. From such atmospherical refractions and reflections those beautiful and varied hues are produced with which our western sky is gilded by the setting sun, and the glowing red which tinges the morning and evening clouds, until their ruddy glare is tempered by the purple of twilight, and the reflected azure of the sky. When a direct spectrum is thrown upon colors darker than itself it mixes with them, as the yellow spectrum of the setting sun, thrown on the verdant grass, becomes a greener yellow. But when a direct spectrum is thrown on colors brighter than itself it becomes instantly changed into the reverse spectrum, which blends with these brighter colors. Thus, the yellow spectrum of the setting sun thrown on the luminous sky becomes blue and changes with the color or brightness of the clouds on which it appears. The red rays of light being capable of appearing through thick and resisting media which intercept all other colors is likewise the cause why the sun appears red when seen through a fog; why lamps at a distance, seen through the smoke of a large street, are red, while those near by are white. To the same cause it is owing that a diver at the bottom of the sea is surrounded with the red light which appears through the superincumbent fluid, while the blue light is reflected from the surface of the water.

COMPLEMENTARY, OR ACCIDENTAL, COLORS.

When the eye is impressed with a brilliant light or color, after it has been removed, the retina of the eye remains for a short time impressed with a color which is usually complementary to the one first observed. Complementary colors mean any two colors which will, when combined, form white light; in short, any two colors which contain red, yellow, and blue. Thus, a brilliant yellow light would leave upon the eye the impression of violet-colored light, composed of red and blue; a green would leave a reddish violet; a red a bluish green; a black a white; a white a black; an orange a blue; a blue an orange red; indigo an orange yellow; and violet a yellow green. This can be illustrated by placing some strips, say of bright red paper, in the form of a cross on a sheet of white cardboard. If the oxyhydrogen light is projected from a lantern with condenser lenses on to the red cross, and the spectator directed to watch it steadily, on suddenly removing the card with the red cross, and having another white card behind it, it will usually be noticed that nearly all those who are watching the experiment will exclaim that they see a green cross, faint green of course, but still quite sufficiently defined to enable them to determine that it is so. If instead of the red cross green be employed, red remains visible, and black, as already stated, becomes white. These effects are described by Sir D. Brewster, under the name of "Accidental colors"; and he appears to regard them as synonymous with the term already explained, that is, complementary colors. He thus explains the phenomena:

"When the eye has been for some time fixed on the red cross, the part of the retina occupied by the red image is strongly excited, or, as it were, deadened, by its continued action. The sensibility of red light will therefore be diminished; and, consequently, when the eye is turned from the red cross to the white card, the deadened portion of the retina will be insensible to the red rays which form part of the white light of the paper, and consequently will see the paper of that color which arises from all the rays in the white light of the paper, but the red; that is, of a bluish green color, which is therefore the true complementary color of the red cross." "When a black cross is placed on a white ground, the portion of the retina on which the black image falls in place of being deadened is protected, as it were, by the absence of light, while all the surrounding parts of the retina, being excited by the white light of the paper, will be deadened by its continual action. Hence when the eye is directed to the white card, it will see a white cross, corresponding to the black image on the retina; so that the accidental color of black is white." For the same reason if a white cross is placed on a black ground and viewed steadily for some time, the eye will always see a black cross; so that the accidental color of white is black. The same author remarks: "It is not, however, necessary that the eye should be strongly impressed previously by some colored light, as the phenomena of accidental colors are sometimes seen without it."

He states that in order to see this class of phenomena, he found the following method the simplest and the best. "Having lighted two candles hold before one of them a piece of colored glass, suppose bright red, and remove the other candle to such a distance, that the two shadows of any body formed upon a piece of white paper may be equally dark. In this case, one of the shadows will be red and the other green. With blue glass, one of them will be blue and the other orange-yellow, the one being invariably the accidental or complementary color of the other. The very same effect may be produced in daylight by two holes in a window-shutter; the one being covered with colored glass, and the other transmitting the white light of the sky."

Mr. Rose, in a paper on "Persistence," in which he describes experiments devised and carried out by himself, shows that with no color whatever to look upon, and only gazing on a white card, while the starry light falling on it is gradually reduced and restored, the white appearance of light passes into the various gradations of colored light. He thus describes this very interesting experiment. "An intensely white card is held before the eye, whilst a strong light, falling on it, is gradually reduced and restored. As the light is reduced, the whiteness passes into yellow, orange, red, and sometimes thence into blue. Whilst at other times colors intermediate between the red and blue are apprehended, the gradual reduction of the light brings up the color by successive steps, and in reverse order to whiteness. All eyes, as might be expected, are not affected alike by these experiments; but all see whiteness passing into yellow, orange, and blue; and blue returning back in deep orange, yellow, and white. The restoration of the light is on the whole less satisfactory than its reduction, for when by reduction a deeply intense blue is obtained the light cannot, to some eyes, be restored slowly enough to prevent a sudden change to deep orange. The colors that succeed each other as the light is gradually, reduced have none of the accepted relations between any given color and its complement. The white is not succeeded by their blackness, the yellow by faint purple, or the orange invariably by blue: but the different hues do come up in an order that suggests the great probability that *what we name colors is only the various affection of the optic nerve by a greater or less quantity of light radiating from a focal point in an imperfect reflector.*" It is said the above experiment was the result of accident. Mr. Rose had been looking upon a white surface lying near a powerful gaslight, when, his arm having caught the tap and reduced the light, his attention was drawn to a sudden change from white to red color.

Another experiment of great beauty and interest was also suggested to him by an accidental circumstance. He was observing the effect of flashes of intermittent, artificial light on a revolving disc, having twelve large circular black spaces, ranged equidistantly around the margin. It was broad day, and the window-shutters were closed to exclude the natural light. While the experiment was going on the shutter accidentally started open, and admitted a little daylight, when the remarkable appearance was presented of twelve blue circular spaces, lying upon a zone of bright orange. Mr. Rose regarded this at the time as simply the presentation of a complementary color, under singular conditions which kept it permanently before the eye; but as leisure afforded him opportunity to repeat the experiment, he soon began to perceive that he had taken far too limited and narrow a view. The misconception arose out of a fact connected with the painting of the discs. He found that lampblack alone would not give the depth and intensity required in the devices, and to remedy the defect he added a little indigo. The circular spaces, to the eye, were certainly intense black, and nothing more; but he considered that they had a tendency to blueness, and that under the rotation they were reduced to a lighter blue, and drew after them trains of complementary orange, in the same way that a black fly, walking across a pane of ground glass, backed by gray light, is seen to draw a white spectrum after him.

But he dismissed this idea as soon as he found that absolute unmixed black produced the same effect, and that the nearer the artificial light approached to intensity of whiteness, the more decided and satisfactory was the result. But how is this effect to be explained ? Mr. Rose goes on to say : The diffused light of the zone is continually falling upon the eye ; but the intermittent flashes find the negations or black portions always in the same areas, and hence from the spaces no part of the flash is reflected, whilst it mingles with, and adds to, the diffused light in the spaces between the negations. Now the diffused light is, we assume, intense light reduced by distribution to blueness ; and in this blueness the negative spaces participate ; but in the rest of the zone the flash brings up the light in such quality in relation to space as is necessary for the presentation of orange. We have more light from diffusion at the outer and inner edges than at the centre of the zone or ring, and hence the light blue at the inner margin, and the light blue, passing into green, at the outer margin. This common quality of the zone is shown in the negative spaces. But from the intervals between them there comes the diffused light variously affected by the flash, and conveying the graduated tints of orange." Mr. Rose thinks this explanation of the subject will appear reasonable, if the conditions of the action are thoughtfully considered. Eight circular spaces of absolute blackness produce under rotation and by persistence a nebulous ring. " If, he says, this is to be viewed as a mixture of light and shadow, or of black and white, we cannot explain the manner of its affection by the intermittent light, which shows the apparently stationary negations as blue, and the remainder of the zone as orange. But if we regard the black spaces as utter absence of light, reducing the quantity of light for distribution over the zone, but giving it no quality by admixture, all difficulty is at an end. A quantity of light is then understood to be diffused over a certain space, whence it comes modified to blueness ; and when this reduced light receives the impression of the flash, it is increased in relation to surface, and raised to orange."

In the " Edinburgh Journal of Science " Mr. Smith has described a very curious instance of the change of white light into complementary tints. In his directions for the performance of this experiment he tells the operator to hold a strip of white cardboard upright about twelve inches from the eyes. The card may be six inches long, and a quarter of an inch wide. If the eyes are now fixed upon some object at a distance of ten or twelve feet behind it, so that the card becomes doubled, and a lighted candle is now placed close to the right eye, and shaded from the left one, the latter will see the white strip of card *green*, while the former will appreciate the complementary color or red. On changing the candle so that the light falls upon the left eye the phenomena are reversed. We shall conclude this part of our subject, on the persistence of vision and its illusions, by presenting a general summary of the effects. 1. *Persistence* is the retention of an image by the eye not for an absolute instant, but for an interval,—an interval sufficiently long for an object to pass over a succession of points, in all of which itwill be apprehen ded by the eye at the same instant. For illustration, a lighted stick whirled round rapidly in a circle presents a ring of light, because the eye retains an impression of the light at any given point, until the stick has returned to the same point again. 2. *Simple Persistence* presents only illusions of the simplest character, as the commingling of the elements of white light, the composition of color, etc. 3. *Persistence under Conditions of Interrupted Vision* offers an indefinite variety of illusions, depending upon the fact that a disc in rapid revolution, presenting the points in its circumference only for an instant to the eye, is virtually stationary; and any objectsituated in these points is distinctly seen, because of its making no sensibl eadvance during the exceedingly brief interval of its apparitions. 4. *Disc Action* presents the illusions of vision under various arrangements, in which discs revolving with different degrees of velocity, and bearing multiform devices, impress the eye with a number of images at virtually the same instant. 5. *Single Disc Action* is tolerably well known in its application to ordinary optical instruments, and as the vehicle for the amusements presented in the thaumatrope, etc. The single action has this advantage in connection with the thaumatrope and kindred devices, that it shows true form, and does not make anamorphoses or distorted figures, in one point of view confused, in another exact and regular. 6. *Double Disc Action* produces, under certain arrangements, an almost unlimited variety of illusions. The double disc movement, as arranged by Mr. Rose, consists of two wheels, one of which receives a disc bearing the devices, and the other a black disc perforated with a number of slots or slits. The wheels revolve in contrary directions, and their relative velocities can be varied at pleasure within certain limitations. In these illusions the aim is at something higher than a mere optical toy; the double disc action will be more estimable since it presents the most interesting illustrations of recondite optical principles, and also examples of compound motion, multiplication, involution and combinations of the most attractive and pleasing character.

Color is that property of light to which the universe is indebted for the beauties and sublimities with which it is adorned. It is color, in all its diversified shades, which presents to the view of intelligent beings that almost infinite variety of aspect which the scenes of nature display, which directs the eye and the imagination, and gives a pleasing variety to every new landscape we behold. Every flower which adorns our fields and gardens presents its various hues; every landscape presents its shrubs and trees of different degrees of intensity of verdure; and almost every mountain is covered with herbs and grass of different shades from those which are seen on the hills and plains surrounding it. In the rural districts during the summer nature is daily varying her appearance by the multitude and diversity of her hues and decorations, so that the eye rambles with pleasure over objects continually diversified, and extending on all sides as far as the sight can reach. In the flowers which deck every landscape, what an admirable assemblage of colors, and what a wonderful art in the disposition of their shades does nature display. Here appears a light pencilling of delicate tints; there they are blended in a manner surpassing the nicest rules of the most exquisite art. Although green is the general color which prevails over our earthly scene, yet it is diversified by a thousand different shades, so that every kind of tree, shrub, and herb, is covered with its own peculiar verdure. The dark green of the forests is thus easily distinguished from the lighter shades of corn-fields, and the verdure of the pastures.

The world of animated nature also displays a great variety of beautiful colors. The plumage of birds; the brilliant feathers of the peacock, and the guinea-fowl, of the robin, the goldfinch, and the humming-bird, and the various embellishments of many species of the insect class, present to the eye in every region of the globe an interesting scene of diversified beauty. Nor is the mineral kingdom destitute of such beauties of color, for not only all crystals, and precious stones, but some of the roughest and unshapeliest stones and minerals, when polished artificially, display a mixture of the most delicate and variegated colors. Now all these beauties in the scene around us are owing to that property in the rays of light by which they can be separated into their primary colors. To the same cause are to be attributed those beautiful and diversified appearances, which frequently adorn the face of the heavens, the yellow, orange and ruby hues which embellish the sky at the rising and setting of the sun; and those aerial scenes so frequently beheld in tropical climes, where rivers, houses, and mountains are depicted as rolling over each other along the circle of the horizon. The clouds, particularly in some countries, reflect almost every shade of color in nature; sometimes they are of a roseate hue; sometimes they appear like bands of deep vermilion: and sometimes like huge brilliant masses heaped one upon another and tinged with various hues: now they are white, like ivory; now as yellow as native gold. In short color diversifies every scene with which we are acquainted, whether on the earth or in the heavens. It imparts beauty to the rainbow, to the coruscations of the Aurora Borealis, and gives a splendor and sublimity to the spacious vault of heaven.

But let us consider for a moment what the aspect of nature would be if instead of the beautiful diversity of embellishment which now appears on every side one uniform color were spread over the scenery of the universe. Conceive the whole of terrestrial nature to be covered with snow, so that no object on earth appeared of any other hue; and that the vast expanse of the sky presented the same uniform aspect; what would be the condition of human beings, supposing them existing in such a world?

The light of the sun would be strongly reflected from every object within the bounds of our horizon, and would produce such illumination as would dazzle every eye. The day would exhibit a greater brightness than it now does; and our eyes, having become accustomed to it, might be enabled freely to expatiate on the surrounding landscape; but everything, though enlightened, would appear confused, and particular objects would scarcely be distinguishable. A house or a tree near at hand might possibly be distinguished on account of its elevation above the general level of the ground, and rivers, and valleys, and other hollow places, by reason of their being depressed below it. But we should be obliged rather to guess and conjecture as to the particular objects we wished to distinguish than be able to arrive at any certain conclusion concerning them; and if objects lay at a considerable distance from us it would be impossible for us with any degree of probability to distinguish one object from another. Notwithstanding the universal brightness of the scene the uniformity of color of every object would certainly prevent us from easily distinguishing them from one another. In such a condition human beings would be confounded, and friends and neighbors be at a loss to recognize each other!

The heavens, too, would wear a uniform aspect; neither the moon nor planets would be visible to the eye, nor those numberless stars which now shine with such brilliancy and adorn the nocturnal sky; for it is by the contrast produced by the white radiance of the stars, and the deep azure of the sky, that those distant bodies are rendered discernible. Were they depicted on a snow-white ground they would not be distinguishable from that ground, and consequently would be invisible.

Of course, all that beautiful variety of aspect which now appears on our terrestrial scene,—the rich verdure of the fields, the dark green foliage of the stately forest trees, the rivers meandering through the valleys, and the splendid hues which variegate and adorn our gardens and meadows, the gay coloring of the morning and evening clouds, and all that variety which distinguishes the different seasons,—would not at all appear. As every landscape would exhibit nearly the same aspect, the poet, the philosopher, the antiquarian, the scholar, or the man of science, would have no inducement to visit distant countries to investigate the scenes of nature or the productions of art; and tours from one region of the earth to another would scarcely be productive of enjoyment.

The prevalence of any other single color would be attended with nearly the same results. Were a deep red to be uniformly spread over the scene of nature, it would not only be disagreeable to the eye, but prevent all distinction of objects. Were a dark blue or a deep violet to prevail, similar effects would follow, and the scene of nature would present a dismal and gloomy appearance. Even if all nature were arrayed in a robe of green, which is a more pleasing color to the eye, were it not diversified with the different shades which it now exhibits, every object would be equally undistinguishable. Such would be the aspect of nature and the inconveniences to which human beings would be doomed, were it that the light which shone upon them was without that intermixture of colors which now appears over the face of all nature, and which serves to discriminate one object from another. Even our domestic apartments could not be decorated in the least degree, and the articles with which they would be furnished would be almost undistinguishable, so that in discriminating one object from another, we would be as much indebted to the sense of touch as to the sense of sight. But worst of all would be the numerous delays, uncertainties, and perplexities to which we should be subjected, were we under the necessity every moment of distinguishing objects by trains of reasoning, and by circumstances of time, place, and relative position. An artificer, when commencing his work in the morning, with his numerous tools of nearly the same size and shape, would have to spend a considerable portion of his time before he could select those he wanted to use, or the objects to which he wanted to apply them ; and in every department of society, and in all intercourses of persons by travel from one place to another, similar inconveniences and perplexities would occur. People would have to spend one half their time in uncertain guesses and perplexing reasonings respecting the real nature and individuality of objects, rather than in a consecutive train of thought, or a regular employment ; and after all the perplexities and conjectures they must remain in the utmost uncertainty and ignorance of the thousands of scenes and objects which are now obvious through the instrumentality of colors.

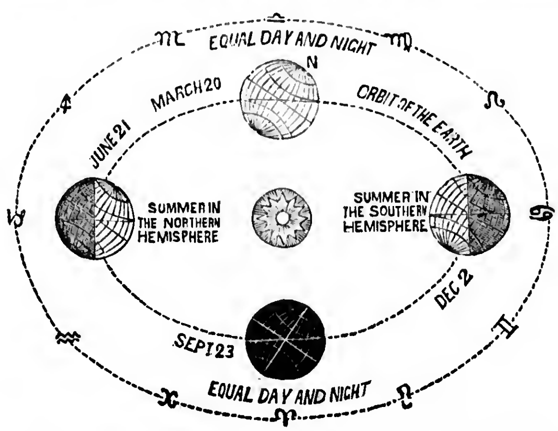
For the existing state of things in the visible universe, and for thus enabling us to distinguish objects by such an easy and expeditious mode as that of color, which in a moment distinguishes every object and its several relations, we cannot but admire the wisdom and goodness of the Creator ! We rise in the morning to our respective employments, and our tools, our books, and whatever is necessary for our subsistence and comforts, are at once discriminated. Without the least hesitation, and without any perplexing process of reasoning, we can lay our hands upon whatever article we require. Color clothes every object in its peculiar livery, and infallibly directs the hand in its movements, and the eye in its surveys and observations. But this is not the only end which is answered by the diversity of colors. They minister largely to our pleasures as well as to our wants. To those favored with a refined taste, as well as to almost every human being, the exquisite coloring of flowers, the delicate tints with which they are painted, the varied shades of green with which the hills and dales, the mountains and valleys, are arrayed, and that beautiful variety which appears on a bright summer's day on all the objects of universal nature, are sources of the purest enjoyment and delight. Color too, as well as magnitude, adds to the sublimity of objects. Were the canopy of heaven of one uniform color, it would not produce those lofty conceptions, and those delightful and transporting emotions, which a contemplation of its august scenery never fails to inspire. The colors displayed in the solar light are common to all the globes which compose the solar system, and must necessarily be reflected in all their diversified hues from all objects on their surfaces. Some of the double stars appear to emit light of different hues, which is thought by some astronomers to arise from complementary colors. The larger star sometimes exhibits light of a ruddy or orange hue, and the smaller one a radiance which approaches to blue or green. There may, therefore, be some reason to conclude that the objects connected with the planets which revolve around such stars, being occasionally enlightened with suns of different hues, display a more diversified and splendid scenery of coloring than is ever beheld in our world; and that one of the distinguishing characteristics of different worlds in regard to their embellishments, may consist in the variety and splendor of colours with which the objects connected with them are adorned.

It need not be inferred from what has been said that we intend to convey the idea that the light, or colors which human beings have experienced in any past time were ever different from what we find them now to be. We believe on the contrary that light has always been what it is now, and that it has always displayed the same variety of colors. Moreover, light, with its inherent colors, is a creation in the same sense as any other object is; and in the same sense as any other natural object it is an eternally created thing; that is to say, it has always been and it will always be, created. It is a new manifestation or combination of matter, as a man, or tree, or any other natural object is a new manifestation or combination of matter. It is everywhere present in principle, and is always manifested wherever the conditions necessary for that manifestation exist. In this, as well as in many other arrangements in nature, we have a sensible proof of the presence and agency of that Almighty Intelligence in whom we live, and move, and have our being. None but an infinitely wise and beneficent Being, intimately present in all places, could thus so regularly create in us by means of color those exquisite sensations which afford us so much delight, and which unite us, as it were, to everything around us. In the variety of hues spread over the face of creation we have as real a display of the Divine presence as Moses may have had at the burning bush. The only difference is that the one was out of the common order of Divine procedure, while the other is in accordance with those permanent laws which regulate the economy of the universe. In every color which we contemplate we have a sensible remembrancer of the presence and benevolence of that Being whose spirit hath garnished the heavens and the earth, and by whose power and agency we are every moment sustained in existence. Oh that men would, therefore, praise the Lord, for his goodness, for his wonderful works to the children of men! He giveth rain to the evil and the good, and causeth his sun to shine upon the just and upon the unjust!

ON ASTRONOMY.

The object of the science of Astronomy is to explain the motions and magnitudes of the earth and the heavenly bodies, their various aspects, and other facts which have been ascertained concerning them. It is a science that has to do with our subject, since it illustrates the changes of place effected in the earth and the heavenly bodies by their motions; gives the mind a more expansive idea of the infinite Creator, and gives it to understand that it cannot possibly comprehend the mode of existence of that Being who is everywhere present in essence and power, amid such varied and complex changes and revolutions.

It will first be expedient for us to say a few words in relation to the apparent motions of the heavenly bodies during the day and night, and as to the form and motions of the earth, before proceeding to describe particularly the phenomenon of the other heavenly bodies. When we look up toward the sky we perceive an apparent concave hemisphere, placed at an indefinite distance from us, and surrounding the earth on every side. During the day the principal luminous object that appears in this hemisphere is the sun. In the morning we see him rise beyond the distant mountains or the extremity of the ocean; he gradually ascends the vault of heaven, and then declines and disappears in the opposite quarter



* This diagram of the seasons will tend to illustrate the subject more clearly. It shows the positions of the signs of the Zodiac Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces.

of the sky. In the northern parts of the globe, where we reside, if, about the 20th of March, we place ourselves in an open plain at about six o'clock in the morning with our face toward the South, the sun will appear to rise on our left, or due East, and at about the same hour in the evening he will set on our right hand or due West. This time is called the *vernal equinox,* when day and night are equal. About the 21st of June he rises to our left, but somewhat behind us in the direction of the North-east, reaches a greater height at noon than on the 21st of March, and, after describing a large circuit of the heavens, sets on our right hand and still behind us, in the North-western quarter of the sky. This time is called the *summer solstice,* or the time when the sun appears to stand still a few days, and then begins to retrace his steps. At this time the day is longest and the night shortest. At about the 23rd of September the sun again rises due East, and sets due West, as on the 20th of March; and this is called the *Autumnal Equinox*, day and night being now again equal. At about the 21st of December, if we observe from the same position, we may see without turning our eyes the points at which he rises and sets. He rises in the South-east, ascends to a small elevation at noon, and sets in the South-west, after having described a very small arc of the heavens. This time is called the *Winter Solstice*, when the sun seems to remain stationary for a short time, as it were, preparatory to his advancing to describe larger circles of the heavens. The day is now shortest and the night longest. Each succeeding day after this he appears to rise a little farther toward the East, for the stars which are seen to the Eastward of him appear every succeeding day to be nearer to the place where he is seen. All these various and successive changes are accomplished within the period of three hundred and sixty-five days, six hours, in which time he appears to have made a complete revolution round the heavens from West to East, at the rate of about one degree each day.

The moon is the next object in the heavens which naturally attracts our attention, and she goes through similar changes in the course of a month. When she first becomes visible at *new moon*, she appears in the Western part of the heavens, near where the sun went down, and she appears in the form of a crescent, having the horns pointed toward the East, the sun being now to the Westward of her. Every night she appears increased in size and removed to a greater distance from the sun, until, after the lapse of about two weeks, she appears in the Eastern part of the horizon, just as the sun disappears in the Western, at which time she presents a round, full, enlightened face, and is called *full moon*. After this she gradually moves farther and farther Eastward, and her enlightened part gradually decreases, until at last she seems to approach the sun as nearly in the East as she did in the West, and rises only a little before him in the morning, in the form of a crescent, having its horns pointed toward the West, the sun being now to the Eastward of her. All these different changes may be traced by attending to her apparent positions from time to time with respect to the fixed stars.

Again, if on a winter evening, about six o'clock, we direct our view to the Eastern quarter of the sky, we shall perceive certain stars just risen above the horizon; if we observe the same stars at midnight, we shall see them at a considerable elevation in the South, having apparently moved over a space equal to one-half of the whole hemisphere. On the next morning, about six o'clock, the same stars will be seen to set in the Western part of the sky. If we now look quite toward the South, we shall find that the stars there only describe very small arcs, rising but a little above the horizon, and setting again, after a short time, not far from the same point; the highest altitude attained at any time not being more than a few degrees. If we turn our eyes toward the North, we shall perceive a similar apparent motion of these twinkling orbs, but with this difference, that a considerable number of them neither rise nor set, but seem to describe circles of greater or less diameter, round an apparently immovable point called the North Pole. Near this point is situated the pole star, which in our latitude appears elevated about half way between the horizon, and the zenith, or point directly over our heads; and to a common observer seems fixed; but is found by the telescope to describe circles of about three degrees in diameter around the north polar point, from which the star is, therefore, really distant about one and a-half degrees. Thus, these Northern stars never set to us, but seem sometimes above, sometimes below, and sometimes to the East or to the West of the north polar point; the dimensions of the circles they describe depending upon their distances from the north pole; and the time they occupy in completing their circles is about 24 hours; or more accurately 23 hours, 56 minutes, and 4 seconds, that is, one day; and they all finish their revolutions in exactly the same period of time.

A person who has for the first time directed his attention to the heavens after having made such observations, will naturally enquire; whence come these stars that begin to appear in the East? Whither have those gone that have disappeared in the West? And what becomes during the day of the stars which are visible during the night? It occurs at once to an intelligent observer who is convinced of the roundness of the earth, that the stars which rise above the Eastern horizon come from another hemisphere, which we are apt to imagine below us, and when they set return to that hemisphere again; and that the reason why stars are not apparent during the day-time is not because they are absent from our hemisphere, or have ceased to shine, but because their light is obscured by the more vivid splendor of the sun. The fact of their presence in our hemisphere during the day is put beyond all doubt by the use of the telescope, which instrument, adapted to an equatorial motion, enables us to see many of the stars even at noon-day. We ourself have seen with the naked eye one of the planets at a pretty high elevation in the North-Eastern part of the heavens, on the forenoon of a day when the sun was shining brightly; its appearance at that time excited the attention of many others also. From such observations we are led to conclude that the earth on which we dwell exists in empty space surrounded on all sides by the celestial vault, and that the whole sphere of the heavens has an apparent motion round the earth every twenty-four hours. Whether this motion be real or only apparent is, however, determined by other considerations.

Although such general views of the nocturnal heavens, which every common observer may take, have a tendency to expand the mind, and to elevate it to the contemplation of an invisible Power by which such movements are conducted; yet such is the apathy with which the greater portion of mankind gaze at the heavens, that there are thousands who have

Fig. 93.—THE CONSTELLATION ORION.

occasionally viewed the stars for the space of fifty years, who are still ignorant of the fact that they perform an apparent diurnal revolution round our globe.

Again, if we contemplate the heavens with some attention for a number of nights in succession, we shall find that by far the greater number of the stars never seem to alter their positions with respect to each other. If we observe two stars at a certain apparent distance from each other either North or South, or in any other direction, they will appear at the same

Fig. 94.

distance, and in the same relative position, the next evening, the next month, and the next year. The stars, for instance, which form the sword and belt of Orion, (which constellation may be seen during the winter in the Southern part of the heavens), present to our view the same figure and relative aspect during the whole period they are visible in winter, and from one year to another. And the same is the case with the stars of the Great Bear, situated in the Northern parts of the sky*, and with all the fixed stars in the heavens.

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* Figure 93 represents the constellation Orion; 94 represents the constellations of the Great Bear, the Little Bear, and the Pole Star. The seven stars in the lower part of the figure represent Ursa Major, or the Great Bear, sometimes known as the *Plow* and *Charles' Wain*. The seven stars in the upper part represent Ursa Minor, or the Little Bear, the largest star of which on the right hand side is the pole star. The two stars on the right hand side of the Great Bear are called the *Pointers*, because they point straight toward the north pole, and they are distant from each other about 5°. If a line connecting these two stars be considered as prolonged upwards to a considerable distance, about 29°, until it meet the first bright star, that star is the pole star, which is here represented at the highest part of the figure. About the beginning of November, at 6 or 7 o'clock in the evening, the Great Bear will appear near the north, at a low elevation above the horizon, nearly in the position represented in the figure. Let an observation be made about the middle of April, at 10 o'clock in the evening, the Great Bear will appear almost directly over our heads, *above* the pole star; and then we must conceive the line joining the two pointers as drawn *downwards* toward the pole star. At different times of the night, and at different seasons of the year, the Great Bear will appear to be in different positions with respect to the pole star sometimes below, sometimes above, and sometimes to the East or the West of it. But in all positions a line drawn through the pointers will direct the eye to the pole star.

There is, however, another fact with respect to the general appearance of the sky, which the observer can likewise verify for himself. Having fixed upon any bright star, let him observe it carefully every evening at the exact time of its passing the meridian, or of its disappearance behind some conspicuous object, say a tree, or a church steeple. Let him observe it again on the following evening, and again after the lapse of a few days more, and he will find that the star is a little earlier every day in arriving at the place. Thus, if it be on the meridian, or in a line with the marking object, at nine o'clock, one day, it will be there about four minutes before nine on the next day, and so on. It is owing to this that we see different constellations at different seasons of the year. Many of those which shine brightly on a winter's night are above the horizon in summer, during the day-time, and hence are invisible. In this way, we see by far the larger portion of the stars at some time or other of the year; but just as those stars within fifty degrees of the north pole never set to us, so those within a similar distance of the south pole, never rise at all in our latitudes. Among the most brilliant of the constellations thus hidden from us is that called the Southern Cross, and when travellers are going toward the southern hemisphere they anxiously await the first appearance of this constellation. As they approach the tropics and the equator the north pole star seems to sink lower and lower in the sky, and the number of stars which never set in our latitudes becomes less and less, till, when they reach the equator, the pole is in their horizon, and all the stars are seen rising in the East, remaining visible exactly twelve hours, and then setting in the Western horizon. They all appear here also to travel in straight lines instead of in curves, as they appear to do in the north and south latitudes. By placing an artificial globe so that its axis is horizontal, and its pole in the horizon, one may obtain a representation of these phenomena.

But while the fixed stars never appear to alter their positions in relation to each other, we find, by a close inspection of the sky, another class of bodies, which regularly shift their positions; sometimes these appear to move toward the East, sometimes toward the West, and sometimes to remain stationary. These bodies have received the name of *planets*, or wandering stars, in opposition to those which do not alter their position and are hence called *fixed stars*. In our latitudes the planets are most frequently seen in the Eastern and Western, or in the Southern quarters of the heavens; and they are situated, with the exception of a few of the minor ones, in a belt called the zodiac, extending for nine degrees on both sides, of the ecliptic; (this is, the apparent path of the sun); and hence the planets are easily found by observers. More than one hundred of these planetary orbs have been discovered, six of which were known in times of great antiquity; and only about five are visible to the naked eye. By long continued and careful observations of the aspects and motions of these planets, astronomers have determined that they all move round the sun as the centre of their motions, and form, along with the earth, one grand and harmonious system. This assemblage of heavenly bodies in connection with the earth is termed the solar system, of which we shall exhibit a brief description after we shall have shown the ball of the earth to be in motion.

For a long time during the dark ages, and the infancy of science, the earth on which we live was considered the largest body in the universe. It was supposed to be an immense plane diversified with inequalities in the shape of mountains and valleys, and stretching out to an unlimited extent on all sides, bounded by the sky. What was below this immense mass of land and water, and how it was supported, none ventured positively to tell; though some of the Christian fathers strenuously asserted that the earth was extended infinitely downward, and established on several foundations; a plain contradiction, for what is infinite cannot have a foundation. According to the ideas of some of the ancients, however, Atlas bore up the world on his shoulders; and many of the Hindoos of the present day assert that it is supported by a serpent and a tortoise; but it is clear that these attempted solutions of the difficulty, as the foundations of the Christian fathers, only remove it one step farther; for we should have to seek some support for the man and the serpent. Such, however, were some of the absurd and foolish opinions of those who viewed the system of the universe through a false medium, and who were ignorant of the facts and principles of modern science. It is only within the period of the last three centuries that the true figure and dimensions of the earth have been accurately ascertained. This figure is now found to be that of a sphere or globe, deviating, however, from the perfect spherical form, only so slightly that it could not be perceived in any model we could make of it. Suppose for instance, we made a globe of thirty inches diameter, the difference between the polar and equatorial diameters would be only $\frac{1}{100}$th of an inch, a difference too small for the keenest eye to detect. The real dimensions of the earth's diameters are found to be as follows: The greater, or equatorial, diameter, 7925½ miles; the lesser, or polar, diameter 7899 miles; showing a difference of a little over twenty-six miles. We do not know but that further investigations will make this difference even less, so that the earth may be regarded as a perfect sphere. That this is in reality the form of the earth will appear from such considerations as the following; when we stand by the sea shore on a calm day we easily perceive that the surface of the water is not quite plane, but somewhat convex or rounded; and if we are on the shore of an arm of the sea, three or four miles broad, placing our eyes near the level of the water, and looking along its surface toward the opposite shore, we plainly see the water elevated about midway between our eyes and the opposite shore, so as to prevent us seeing the objects which are near the edge of the water there. If we make the same experiment on a lake of three or four miles in extent, a small boat near the end of the lake may be seen by one who is at some height above the water; but if we lay our eye near the surface the view of the boat will be intercepted by the convexity of the water, which proves the lake to be a small segment of a globe. On land, it is seldom a large tract of land can be chosen sufficiently level to answer the purpose of making such experiments, as even in large planes there are frequently undulations which materially alter the earth's natural convexity. Again, when we view a ship departing from the coast in any direction, as it retires from our view we still see the masts and rigging of the vessel, when the hull has disappeared, and has sunk, as it were, beyond the boundaries of our sight. First we lose sight of the hull, then of the sails, and last of all of the topmast. On the other hand, when a ship is approaching the shore, the first part of it which is visible when at a considerable distance is the topmast; as it approaches nearer the sails come into view; and last of all the hull gradually comes within the limits of our sight; but the vessel will pass over several miles of the sea, from the time of our first perceiving the topmast, until the hull appears in sight. In order that such observations should be made with accuracy it is requisite that a telescope should be used.

Fig. 95.

Here only that part of the ship above the line A C can be seen by the spectator A: the rest of the ship is hidden by the swell of the curve D E.

What is it then that prevents the hull of the ship, the largest part of it, from being seen when the topmasts are visible? It is evidently the round or convex surface of the water, bulging up, as it were, between our eye and the lower part of the ship. When the ship is at a certain distance

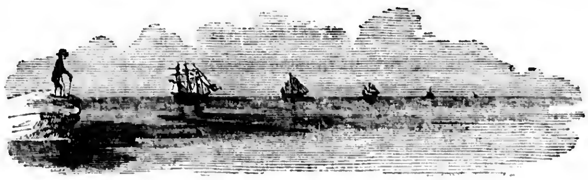


Fig. 96.

The diminution of the size of a ship seen at sea, owing to the convexity of the earth and the distance of the observer, is also illustrated in fig. 31.

from us; when the hull has just begun to disappear from a person standing on the surface of the ground, the whole will be visible to an observer on an elevated building; and if there be a lofty mountain near by the vessel will be seen from this after every portion of it is hidden from those on the beach. This proves without doubt that the earth's surface is round ; and, in fact, a rough estimate of the size of the earth may be formed in this way. We have only to fix upon two elevations of equal height, as, for instance, marked places on the masts of two vessels, and ascertain the exact distance at which they are hidden from each other by the curvature of the earth. We must also know the elevation of the marked places on the masts above the level of the sea, and then by a simple proportion we shall obtain the diameter of the earth. The question is stated thus : As the height of the station of observation is to the distance of the visible horizon (which is half the distance between the two stations), so is this distance to the diameter of the earth. By another calculation it is found that two places elevated ten feet become hidden from one another at a distance a little short of eight miles ; that is to say, a straight line drawn from one of these to the other would just touch the earth midway between them. The curvature then may be set down as ten feet in $3\frac{7}{8}$ miles ; and the proportion is as follows : As 10 feet : $3\frac{7}{8}$ miles : : $3\frac{7}{8}$ miles : the diameter of the earth. This gives about 8000 miles for the earth's diameter, which is not far from correct. But the more accurate and philosophical mode of ascertaining its dimensions is by measuring an arc of the meridian, which we shall have occasion afterwards to explain.

Now as such appearances as those we have mentioned with respect to the water's surface and the ship, are observed on every sea and ocean on the face of the earth, it follows that the ocean at large is a convex surface, or a portion of a globe ; and the waters cover more than three-fourths of the earth's surface ; and if the ocean, constituting three-fourths of the earth, be globular, so also is the land, the remaining one-fourth, notwithstanding that the hills and the mountains form a few inequalities on its surface ; for the regions of the land are all nearly on a level with the ocean, with the exception of the ranges of elevated mountains. The height of the table-lands and mountain ranges bears such a small proportion to the actual diameter of the earth, that they in no way interfere with its general spherical outline. The greatest elevations are only about five miles, and there are but a few of these ; while the diameter of the earth is about 8000 miles. If then we would accurately represent these on a globe having a diameter of 16 inches, we must make them $\frac{1}{100}$th of an inch high ; or they might be well represented by very small grains of sand. The thinnest tissue-paper would fully represent the elevation of table-lands ; and minute scratches, almost invisible without a microscope, would show the mountain gorges and valleys of rivers ; so that for all ordinary purposes the earth is considered as absolutely spherical.

On the other hand, were the surface of the sea a level plane the appearances would be very different. A straight line might be drawn from an object, as a ship, upon it, from any distance out, to the shore. In this case any object on the earth or sea would be visible at any distance, which was not so great as to make its appearance too small or faint to be perceived. An object would be visible at the same distance whether the eye were situated high or low. Sailors would not in such a case have to climb to the topmast in order to descry ships or other objects at a distance, for they could see them just as plain and at as great a distance from the deck, after the objects had come within visible distance. The largest and not the highest objects would be visible at the greatest distance. The topmast of a ship would first disappear, and the hull, as being the largest object, would be the longest visible; but this is contrary to all experience. The considerations already advanced are, therefore, clear and decisive proofs that the earth is not an extended plane, but a globular body; and it seems truly wonderful that such a conclusion was not generally arrived at until a comparatively recent date.

Moreover, that the earth is round from east to west is clear from the fact that navigation has long been conducted on that principle with the greatest precision, and that navigators have repeatedly sailed around it from east to west. They have set sail from England, crossed the Atlantic, rounded Cape Horn, sailed along the Pacific Ocean to the northern coasts of Australia, crossed the Indian Ocean, and, passing the Cape of Good Hope, have again arrived, by traversing the Atlantic, at the port whence they set sail. These experiments, therefore, show that the earth is round from east to west, but they do not prove that it is also round from north to south, for it has never been actually circumnavigated in that direction, owing to the obstruction caused to navigation by the immense masses of ice within the polar regions. Had we, therefore, no other proof of the earth's rotundity than this, we might be apt to suppose it somewhat resembling the shape of a cylinder; but that the earth is really round from north to south appears from the following considerations. When we travel a considerable distance from north to south, or from south to north, a number of new stars successively arise in the quarter of the heavens (whichever it may be) to which we are advancing, and many of those in the opposite quarter gradually disappear. For example, in sailing toward the south, when we approach the equator the brilliant constellation called the Southern Cross, before mentioned, which is never seen in our northern latitudes, makes its appearance; and if we go farther south the constellations of the Great Bear, Cassiopeia, and other stars, visible in our northern sky, will entirely disappear, which could not happen if the earth were a plane in that direction; for in such a case all the stars of heaven would be visible in every point from the north to the south pole. Another corroborative proof of the earth's globularity is this. In excavating a canal of any length, in order to have the waters on a level, certain allowances require to be made for the earth's convexity. The slope required to be made on this account is about eight inches in the mile, thirty-two inches in two miles, and so on, increasing with the square of the distance. If the earth were a level surface no allowances of this kind would need to be made in order that the water in a long canal might stand on a level.

But another most evident and conclusive proof of the earth's rotundity is that afforded in the shape of its shadow. The earth is an opaque body, shines by reflected light; and must, therefore, cast a dark shadow in the direction opposite to the sun; but the shape of this shadow can only be seen when there is some solid body on which it can be thrown. Now there is but one body which ever comes near enough to the earth to receive this, and this body is the moon. When, therefore, the lunar eclipse happens, if we watch the moon as it enters the shadow of the earth, and again as it emerges from it, we shall find that the dark line of the shadow on the moon's disc is *always curved* to an arc of a circle The earth therefore must either be a globe or a flat circular disc, and at first sight we might incline to the latter view, and imagine, with some of the ancients, that we dwelt on a flat surface, like the top of a round table. When, however, we remember that *in all cases* and *in every position* of the earth and moon at the time of an eclipse the shadow is *always circular*, we are assured that the earth must be globular, as no other figure could always cast a circular shadow.

It is to be presumed that after the sensible and undeniable demonstrations that have been given of the rotundity of the earth, none of our readers will have any doubts left that the earth in which we live is of globular form, but there may still be some who are not yet convinced that it moves round its axis, and with immense velocity, through the regions of space, in company with the other planets. On this subject, therefore, we shall now offer a few considerations tending to show that the earth we inhabit, however steadfast it may appear to the eye of sense, is really a moving body, and that it moves with a velocity far greater than we are accustomed to see around us. There are two different motions considered as connected with the earth; one by which it is viewed as turning round its axis every twenty-four hours, and producing the succession of day and night; and another by which it moves round the sun every year, bringing about the changes of the seasons.

We shall here chiefly illustrate those arguments by which its diurnal motion may be demonstrated, and its annual motion afterwards. In the first place then there is one thing of which we all are certain; that is, that motion does actually exist, either in the earth or in all the heavenly bodies around the earth. We behold every day the sun apparently moving from the Eastern to the Western horizon. We observe also all the stars apparently moving in a body round the earth in the course of twenty-four hours, and in the manner described above. Such observations, which everyone has it in their power to make, clearly show, that there is motion somewhere; and the question is, is this only apparent with respect to the heavens, or is it the motion of the earth that produces this appearance? Let us suppose for a moment that it is the earth which moves; what will be the rate of its motion in turning round its axis to produce the apparent revolution of the heavens? For if the earth really revolves round its axis from West to East, the heavens will, of course, appear to revolve round us from East to West, just as when one is on board a steamboat on a river, and not noticing the motion of the vessel, he sees the trees and other objects on the bank, *apparently* moving in the opposite direction to that in which the vessel is *really* going. The same kind of appearances often happen to a person sitting in a railroad car when in motion; one is apt to think the fields and fences, the whole side of the country, to be moving in the contrary direction to that of the cars' motion. The rate of the earth's motion will depend upon its magnitude. Now we know that the earth is a globe somewhat more than twenty-four thousand miles in circumference, and consequently in turning round every twenty-four hours some portions of its surface must move, at least, a thousand miles every hour. This is a motion far more rapid than has ever been produced in the smallest bodies by human art; and, therefore, it may appear incredible to some that such a motion can exist in a globe of such vast dimensions as the earth. But if such persons deny that the earth thus moves then they *must admit* that the heavens move. There is no alternative, for motion actually exists either in the one or in the other. Now if the motion is to be considered as existing in the heavens, let us see what the rate of this motion must necessarily be. If a small globe of eighteen inches diameter globe of two thousand yards, or seventy-two thousand inches in diameter, to were supposed to perform a revolution round its axis in two seconds, and a finish a rotation in the same time, this large globe would move with a velocity four thousand times greater than the other. In the annexed figure, if A B in the centre, represent the earth, then if the circle C E revolve around it in a certain time, and the other two circles revolve round it in the same time, it is certain that the circle F H must revolve with a quicker motion than the circle C E; and the circle I L with a still greater velocity, in proportion to its greater distance from the centre of motion A B. We shall consider then what would be the rate of motion of some of the heavenly

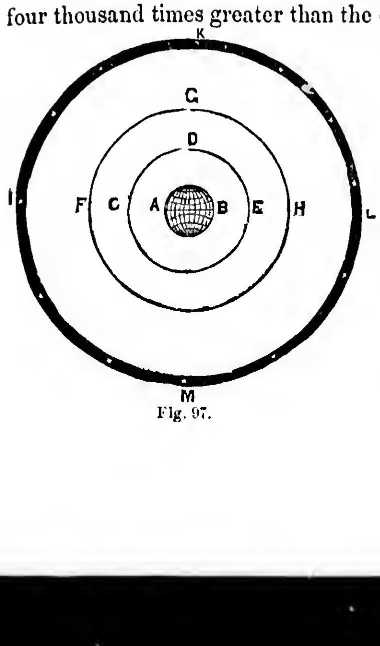


Fig. 97.

bodies whose distances from the earth are known. The sun is ascertained to be somewhat near ninety-five millions of mil... distant from the earth; and, consequently, were he to move round the earth every day, as he appears to do, he would move along a circumference of five hundred and ninety-seven millions of miles every day; that is, at the rate of about twenty-four millions of miles an hour, four hundred and fourteen thousand miles a minute, and six thousand nine hundred miles a second. Again the planet Uranus at its nearest point to the earth is more than one thousand seven hundred millions of miles distant; and consequently the circumference of its orbit is more than ten thousand six hundred millions of miles. If, therefore, this planet were supposed to move round the earth every day, its motions would be at the rate of four hundred and forty-five millions of miles in an hour, seven million four hundred and twenty thousand miles in a minute, and one hundred and twenty-three thousand six hundred and seventy-seven miles every second. Again the nearest fixed stars are known not to be within 20,000,000,000,000, or twenty billions of miles off the earth; and consequently their daily circuit round our globe would measure 125,000,000,000,000, or one hundred and twenty-five billions of miles; that is, at the rate of fourteen hundred millions of miles in the space of a single second, or the interval of time which the pendulum of a common clock takes in moving from one side to the other; stars at distances hundreds of times greater, of which there are many in our firmament, would move with a rapidity of hundreds of times swifter; and those still further removed from us in the depths of immensity with a velocity far exceeding human conception; yet all the stars of heaven appear to move round our globe every twenty-four hours. If the circle C D E of the figure represent the supposed diurnal orbit of the sun; F G H that of Uranus; and I K L M that of some of the fixed stars; then it is evident that in proportion to the distance of the body from the earth will the velocity of its motion be, if it be supposed to move round the earth every day.

If, therefore, there be any reader disposed to reject the motion of the earth because it is inconceivable he must necessarily admit of motions ten hundred thousand times greater and far more incomprehensible; more especially when it is considered that the bodies in the heavens to which we have alluded are incomparably greater than this globe of earth on which we live; the planet Uranus being eighty times, and the sun more than one million three hundred thousand times larger than the earth, and the fixed stars on an average as large as the sun. Such a rate of motion in such a number of magnificent globes appears altogether overwhelming, incomprehensible, and incredible.

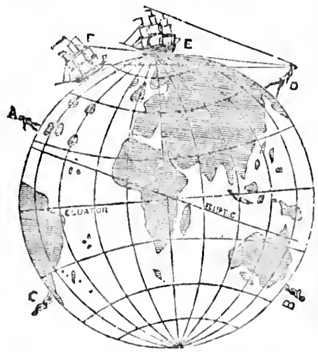
The question, then, that is to be decided is, which of the motions to which we have referred is the most probable,—the motion of the earth or that of the heavens? Is it really necessary that the whole universe, composed of sun, moon, planets, comets, stars, and nebulæ, should move round our globe with such astonishing velocities in order to produce the alternate succession of day and night on the earth? Reason says that it is not. It would contradict all our ideas of the simple and reasonable operations of nature, and of the intelligence of the Deity. The succession of day and night can be accomplished by a simple rotation of the earth on its axis, which is found to *completely account* for all the apparent diurnal revolutions of the celestial bodies. This is found to be actually the case with the other planets of the solar system. The planet Jupiter is fourteen hundred times larger than the earth, and is said to move round its axis in less than ten hours, at the rate of 28,000 miles an hour, which is a velocity twenty-eight times greater than that of the earth, supposing the latter to move round its axis. The planet Saturn is about a thousand times larger than our globe, and it is said to revolve round its axis in ten hours and a-half, at the rate of 24,000 miles an hour in those places near its equator. To a spectator then, placed on these planets, the heavens would appear to revolve around him every ten hours, as they appear to us to revolve every twenty-four hours, but with an apparently more rapid motion; while he, himself, might suppose, as we are apt to do, that the planet on which he is is really at rest. The earth, therefore, must be considered as revolving round its axis, in accordance with the revolutions of the other planets of the system to which it belongs; and to suppose otherwise would be in opposition to all the laws which govern the material universe, and would distort all our ideas of the harmony and order of the operations of nature.

Another consideration which demonstrates the diurnal motion of the earth is this; that such a rate of motion in the heavenly bodies as has now been stated would shatter the material universe to atoms. Were a ball of soft wood projected from a cannon at the rate of 800 miles an hour, in a few moments it would be reduced to splinters; and hence the forage and other light substances projected from a piece of ordnance are instantly torn to pieces. What then might be supposed to be the consequence, were a body impelled through the ethereal regions with a velocity of a hundred thousand millions of miles in a minute, as multitudes of the stars behoved to be, were the earth at rest in the centre of the universe? It would undoubtedly reduce to atoms the most solid bodies in existence, though they were composed of substances harder than adamant.

Another corroborative argument which astronomers bring forward in support of the motion of the earth is this: that there is no instance known in the universe of a larger body revolving round a smaller one. We do not find, say they, such planets as Jupiter and Saturn revolving round their satellites; but all these satellites, which are much smaller than their primaries, perform their revolutions around the latter as the centre of their motions. The earth, which is fifty times greater than the moon, does not revolve round her, but that nocturnal luminary regularly revolves round the earth. The sun does not revolve round the planets Mercury or Venus, which are thousands of times less than that luminary, but they invariably revolve around him as their centre of attraction, light, and heat. As the sun is over one million three hundred thousand times larger than the earth it cannot, therefore, be supposed for a moment that such an enormous globe would revolve with such an inconceivably rapid motion round so inconceivable a ball as the earth, and much less that the whole universe should revolve around it every day. Were the earth not revolving round its circumference every day there would be an infraction of all the laws which are known to govern the system of universal nature; and, therefore, it is absolutely necessary to admit its motion in order to direct our views and to become fully convinced of the systematic order and harmony of the operations of universal nature. What would be thought of a machine (if such could be conceived to be constructed) as large as the city of London, or any other large city, bearing a huge lamp near its centre, and revolving daily round a little ball of one inch in diameter, suspended in empty space, merely for the purpose of giving light and heat to the surface of this little ball, when, at the same time, a revolution of the ball round its axis would answer the same purpose? The designer and constructor of such a system, however ingenious he might be thought by some for his great contrivance, would justly, by all wise men, be considered insane for having so disproportioned means to ends in the accomplishment of his object. Such a scheme, however, absurd as it seems, would not be half so preposterous as to suppose the vast universe to turn round so inconsiderable a ball as the earth to produce the alternate succession of day and night, when the same object could be effected by the earth's simply revolving round its axis once in twenty-four hours. But the whole system of universal nature is proportionate as to its constituent parts, and their operations; none of its parts are unnecessary; none of its operations take place inconsistently with infinite intelligence and wisdom; and its operations all appear simple and reasonable when rightly considered. Now, all these supposed inconsistencies and impossibilities, which we have been considering, are at once got rid of, and complete universal harmony and order restored, by the admission of the rotation of the earth round its axis every day.

Circles, Degrees, etc., explained.

If we refer to an ordinary terrestrial globe, such for example as those used in schools and colleges, we shall find that there are several circles drawn upon it, and we shall also observe that these are of different sizes, these called parallels of latitude near the poles and the polar circles being much smaller than those nearer the circle called the equator. These circles are accordingly divided into two classes, called respectively great and small circles. Great circles are those whose plane passes through the centre of the globe, so that they divide it into two equal portions; and, assuming the earth to be a perfect sphere, all these great circles will be exactly equal. All other circles are called small circles. The most important of the great circles is the equator, which is an imaginary line drawn round the earth, equally distant from the north and south poles, and therefore dividing the globe into two equal halves, called the northern and southern hemispheres. If now we conceive the plane of this circle to be extended to the sky, we shall have a great circle of the heavens, known as the *celestial equator*, or more usually the *equinoctial.* This latter term is derived from two Latin words signifying "equal," and "night," and is applied to it because when the sun appears to be on this line it shines equally on both hemispheres; and day and night are then of equal length in all parts of the earth, the sun being above the horizon at every place for about 12 hours, and below it for the same length of time. The days on which this happens are the 20th of March and the 23rd of September; and by counting the days between these dates we shall find that in the northern hemisphere the summer is a few days longer than the winter; or, in other words, that the period during which the sun is north of the equator is a few days longer than that during which he is south of it.



The sun's apparent path is not, however, along the equinoctial, but in a great circle, inclined to it at the present time at an angle of about 23° 27′ 30″, and known as the *ecliptic.* Round this the sun appears to travel, performing the complete circuit of it in the space of one year. The space extending for 9° on both sides of the ecliptic, and thus constituting a band or zone 18° wide, is known as the *zodiac*; and within this space, as we have already explained, all the planets, with the exception of a few of the minor ones, are constantly found; so that we can always tell somewhat of the position in which they are. The zodiac is divided into twelve equal portions, each containing 30°, and the stars in these spaces are mapped out into the constellations known as the "signs of the zodiac," which we shall notice hereafter.

As we shall have frequent occasion to speak of degrees, it is well that it be clearly understood at once what is meant by a degree, and the mode in which it is measured. It is evidently necessary for us to have some means of measuring the distances of the heavenly bodies from one another, and this can only be done by measuring the angle which imaginary lines, drawn from them to our eye, subtend. By a little consideration we shall find that it in the same way we form our estimate of the dimensions of ordinary objects around us, and hence when we bring them nearer to our eye they appear larger, because the rays coming from their extremes to our eye contain a larger angle. Now we want some means of measuring and expressing in words the angle thus contained, and this we do by means of degrees and fractions of a degree. A degree then is the 360th part of a circle ; that is, if we draw a large circle on paper, for example, and divide its circumference into 360 equal parts, and then draw straight lines from these divisions to the centre of the circle, the angle contained between any two adjacent lines will be just one degree. On any circle we can draw on paper these divisions will necessarily be very small ; when, however, we deal with a globe like the earth we find that a degree at the equator measures about 69 miles.

In a right angle there are, of course, ninety degrees, and if we can make a triangle with three equal sides, each angle will contain just sixty degrees. A degree is divided into sixty parts called minutes (*minute* parts); each of these is divided into sixty parts, called seconds ; and in more delicate and accurate observations each of these is again divided into sixty parts, called thirds. These divisions are usually expressed by the signs for degrees (°), minutes (′), seconds (″), thirds (‴) ; thus 16° 37′ 5″ 15‴. As a general guide to us in estimating approximately the distances or dimensions of the heavenly bodies it will be expedient to remember that the apparent diameter of the sun or moon is about half a degree ; the distance between the pointers in the Great Bear is six degrees, and that between the pole star and the pointer nearest to it is about twenty-four degrees. By means of an accurately graduated semi-circle we can easily measure any angle, and ascertain the number of degrees it contains.

We have stated above that the inclination of the ecliptic to the equator, or, as it is termed the " obliquity of the ecliptic " is nearly 23½ degrees. This amount, however, is not constantly the same, but varies a little in the lapse of centuries. The rate of this variation is very slight, being less than 1′ in 100 years, and it is found that it can only take place within very narrow limits. At present it is decreasing, but before it can have deviated as much as a degree and a-half the causes producing it will have been so modified as to act in a contrary direction, and increase the inclination again. All through astronomy instances are met with of these slow and gradual variations ; but all are confined within very narrow limits, and instead of tending to a total change in the status of the earth or the system to which it belongs, they tend to the permanency of the system.

Now since these two great circles are thus inclined there must be two points in which they intersect one another, and these are called the equinoctial points, or the vernal and autumnal equinoxes. One of these is the first degree in the sign *Aries*, and the other the first in *Libra*. The first of these, or the vernal equinox, is the most important, as it is taken as the fixed point to be employed in measuring distances from, when we want to indicate the place of any body. We then take the equinoctial or equator as our base line, and first of all measure the distance of any star north or south of that. On a terrestrial globe parallels of latitude, (these are circles parallel to the ecliptic, having the poles of the ecliptic as their centres,) are drawn at distances of ten degrees.* It must be remembered that when we speak of degrees of latitude what we really mean is the inclination, which a straight line drawn from the place to the earth's centre would have to the plane of the equator. A degree is a measure of an angle, and not of a distance. It is well that this point should be clearly understood, as mistakes often arise through want of understanding it. Some folks will say "a degree equals somewhat over sixty-nine miles," when what they really mean is that at the equator two lines meeting at the earth's centre, inclined to one another as this angle, would include between them a portion of the earth's surface of that length. On Jupiter, or any globe larger than the earth, the amount thus subtended at the equator would naturally be much greater; and on the other hand, in any small circle which we may draw on a piece of paper there is still 360°; each degree, therefore, is very minute.

In astronomy, the distance north or south of the equinoctial is called the *declination* of a heavenly body. If now we draw another great circle passing through the poles, and also through the star, it will intersect the equator in two places, and the one of these on the same side as that on which the star is situated will furnish us with the other distance required.

If we examine the equinoctial on a celestial globe, we shall find that it is divided into degrees from 0° to 360°, reckoning from east to west, the starting point being the first point of Aries.

The great circles to which we have referred, as passing through the poles perpendicular to the equator, are called *meridians*, and any number

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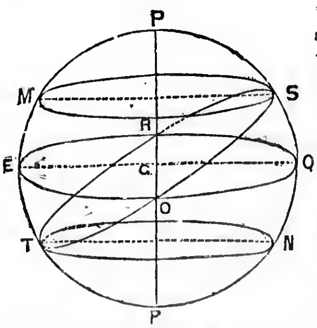


* In figure 98, the line P P represents the earth's axis, that is, the diameter of the sphere passing through the poles P P, and the centre C. The great circle E Q represents the equator, the great circle S T the ecliptic; the points R, and O, where it intersects the equator, are called the nodes, and also the equinoctial points; and the points S and T, its farthest points north and south of the equator, are called the solstices; respectively the summer and winter solstice. The two small circles M S, and T N, parallel to the equator, are called the tropics, that to the north the tropic of Cancer; and that to the south the tropic of Capricorn. The two great circles M P Q N P T E, and R P O P, (if the latter be conceived as a great circle at right angles with the other,) are called respectively the solstitial and equinoctial *colures*.

of them might be drawn ; usually, however, twenty-four are drawn on the globe, their distance apart being fifteen degrees. They are then frequently termed *hour lines*, as the firmament seems to move just the interval between two of them in the space of an hour. We can obtain a clearer idea of these meridians by taking the globe out of its framework, and letting the brass meridian be free to turn round on its poles ; we can then bring it over any star or place, and it will represent the meridian of that place. We shall likewise be able to see on the equator, the distance of its intersection from the first point in Aries. This distance is known as the *right ascension*, usually abbreviated thus, R. A. Thus, we see the way in which the position of a star is determined, the two measures being its right ascension and its declination. Suppose, for example, we wish to point out the place of a star in the tip of the tail of the Great Bear, we first find it on the globe, and bringing it to the brass meridian, we shall find that its elevation above the equinoctial is very nearly 50°, this is its declination. We now look to the equinoctial, and find the point of it directly under the meridian is 204°, or 13 hours, 36 minutes, from Aries ; and thus we assign its place as 50° north declination, and 204° right ascension. In a similar way when the right ascension and declination are given, the star can be found.

If we examine a celestial globe we shall find that though the mark ♈, signifying the commencement of the sign Aries, is placed at the intersection of the equinoctial and the ecliptic, yet the portion of the zodiac commencing at that sign is in reality occupied by the constellation *Pisces*. The stars forming Aries are moved 30° to the east, occupying the place assigned to Taurus, and all the other zodiacal constellations are moved one sign to the eastward. The cause of this is the precession of the equinoxes, which was first discovered by Hipparchus in the second century B.C. The points of intersection of the equator and the ecliptic, or as they are usually termed the *nodes*, do not remain constantly in the same place, but are slowly moving toward the west, that is in a retrograde direction. This was first observed by noticing that the right ascensions of all stars were slowly and uniformly increasing. This could only be accounted for in one of two ways ; either they must all be slowly moving forwards, or the point from which we measure their right ascension must be moving backwards. The latter of these explanations, being by far the most simple, has been adopted. The rate of this motion is but slow, so that its effect on the position of the stars from year to year can only be ascertained by the most careful and delicate observations. When, however, we compare the position of a star with that assigned to it by observers a few centuries ago we soon become aware of the change. The most careful observations fix the annual amount of this motion at 50′ 2″ ; so that the time occupied by the nodes in making a complete circuit of the heavens would be a little more than 25,800 years. By reckoning backward it is found that the constellations and the signs of the zodiac coincided with one another about the year 370, B.C. Besides this motion of which we have spoken, there is another of much smaller amount, which is known as *nutation* or the noding of the pole. It arises from the circumstance that the earth's distance from the sun varies at different times of the year, and thus the amount of precession varies slightly from day to day. The effect of this variation is to cause the pole to describe, in the course of about 18½ years, a very small ellipse, the longer axis being about 18½″, and the shorter nearly 14″. This motion, combined with the other, produces a vibratory or undulating movement of the pole; it is only, however, in very accurate observations that this has to be taken into account. One important effect of the precession of the equinoxes is to change the pole-star. That at present known by this name is distant about 1½° from the true pole; its distance is, however, gradually diminishing, so that in the course of years it will be within half a degree, and it will then commence to recede from it. In about 12,000 years it is estimated the brilliant star Vega, in the constellation Lyræ, will be very close to the pole, and serve as a pole star.

There are also two other points in the ecliptic especially distinguished, and known as the *solstital points*.* These are situated midway between the nodes, and are at the commencement of the signs Cancer and Capricornus. The term solstitial is derived from the Latin *sol*, the sun, and *stare*, to stand, and is applied to these points, because when the sun reaches them it has attained its greatest north or south declination, and appears to stand for a few days before commencing to retrace its steps. Two great circles are drawn on the celestial globe, passing through the poles, the one passing through the equinoctial points, and the other through the solstitial points; and these are distinguished as the equinoctial and solstitial *colures*. They divide the ecliptic into four equal portions, and mark the divisions of the seasons of the year. The days on which the sun is at the solstices are the 21st of June, and the 21st of December; and these are respectively the longest and the shortest days.

Two small circles, parallel to the equator, and passing through the solstitial points are called the *Tropics*, that to the north being distinguished as the tropic of Cancer, and that to the south as the tropic of Capricorn. These, however, are of more importance in the use of the terrestrial globe than in that of the celestial. There are also two circles situated at a similar distance from the poles which mark the limits of the polar regions, from which the sun is sometimes hidden for more than a complete day; that to the north is called the Arctic, and that to the south the Antarctic, Circle.

The most usual way of describing the position of any star in the heavens is by giving its declination and right ascension, as described above, the distances being reckoned from the equinoctial. Sometimes, however,

* See figure and note on page 270.

these distances are reckoned from the ecliptic, and are then called the latitude and longitude. Parallels of latitude, circles parallel to the ecliptic, are frequently drawn on celestial globes to enable the latitude to be found without difficulty; the pole of the ecliptic is, of course, the centre of these circles. Longitude, as right ascension, is reckoned from the point Aries, and like it is reckoned only in one direction from 0° to 360°. Terrestrial longitude, on the other hand, is reckoned from 0° to 180° east or west. Celestial longitude, therefore, measured from the point Aries on the ecliptic, corresponds to right ascension measured from the same point on the equinoctial; and celestial latitude measured from the ecliptic north or south, corresponds to declination measured from the equinoctial.

The Horizon.

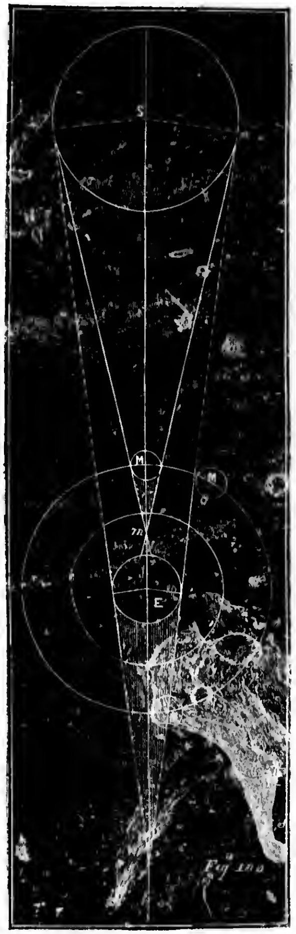
As we shall have sometimes to speak of the *horizon*, it will be well for us distinctly to state what we understand by it, as sometimes there is a little confusion on this matter.

The *rational* or true horizon is an imaginary plane drawn through the centre of the earth, so that the line, where it cuts the surface, is everywhere equidistant from the observer. If we take an orange or an apple, and divide it into two equal portions, or place a ring round it, so as to be midway between the *eye* and the *stalk*, it will represent the horizon. In an ordinary celestial globe, if the poles be elevated to the latitude of the place, the situation of the wooden horizon will correspond with that of the rational horizon to the observer. Thus, it will be seen that if this plane be extended on all sides to the sky it will divide it into two exactly equal hemispheres, one of which will be visible to the observer. There is, however, another sense in which the word horizon is used. When we ascend any height we see a line all round us where the earth and sky appear to touch; this is called the *sensible* or visible horizon. At sea or on a level plain this will appear to be a perfect circle; on land the elevations of the country usually interrupt the outline; still we can perceive that it is of a circular form, and that our point of observation is situated in the middle of it. The size of this circle increases with our elevation above the earth. Hence when a sailor wants to know if any vessel is in sight, he ascends to the mast-head, where his view is much more extensive than it is from the deck of the ship. In the same way, if we ascend a high mountain, we gain a very extensive view of the surrounding country. If we could place ourselves at a great distance from the earth, as for instance, on the surface of the moon, we should see just one half of the globe of the earth, and the rational and sensible horizon would then exactly coincide. This, of course, cannot be, and the highest elevation ever yet reached by man, or that in all probability ever will be attained, is so small when compared with the earth's diameter, that only a small portion of our globe has ever been visible at once.

The following general rule will enable us approximately to calculate the distance of the visible horizon when we know the height of the station of observation. Express the height in feet and increase it by a half; then extract the square root, and this will give the distance in miles. Thus, if a building be 24 feet high, we then add 12 feet to it, making it 36, the square root of which is 6. The visible horizon is, therefore, distant six miles.

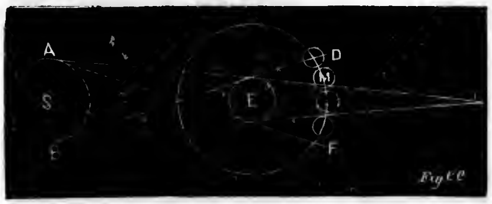
Eclipses explained.

A dark shadow is occasionally seen to move across the face of the moon which obscures her light, and gives her the appearance of tarnished copper. Sometimes this shadow covers only a small portion of her disc; at other times it obscures the whole of it for an hour or two, and its margin always appears of the form of the segment of a circle. This phenomenon, which happens on an average about twice every year, is termed an *eclipse of the moon*. It is produced by the shadow of the earth falling upon the moon, when the sun, the earth, and the moon are in the same straight line; the earth being interposed between the sun and moon: and this can only happen at the time of *full* moon. Sometimes the moon appears to pass across the disc of the sun, when her dark side is turned toward the earth, covering his disc, either in whole or in part, and intercepting his light from a certain portion of the earth. This is called an *eclipse of the sun*, and can happen only at the time of *new moon*, when the moon is interposed between the sun and the earth. In a total eclipse of the sun, which seldom happens, the darkness is so striking that some of the planets, and occasionally the larger stars, are seen, and the inferior animals appear struck with terror.



The theory of lunar eclipses will readily be understood by reference to the annexed figures. In figure 99, S represents the sun and E the earth, whose shadow is a long cone reaching into space. This dark shadow is called the *umbra*, and it gradually shades off into the *penumbra*, which is bounded by the lines B D, A F, and tapers toward the earth instead of away from it; M represents the moon revolving round the earth, and in its journey it sometimes passes through the dark cone and becomes for a time invisible. The commencement is marked by a faint shade, beginning to creep over the east side of the moon's disc. This is the first contact with the penumbra. As the moon travels onwards it enters the umbra, and the east side of its disc then becomes almost invisible. When fully immersed in the umbra, the moon may usually be feebly seen, and appears of a ruddy hue. The duration of a total eclipse of the moon may be as great as 1 hour 50 minutes. This is when the moon passes directly through the middle of the umbra. At other times it passes near the edge, and is then obscured for only a short period. When it passes through the centre of the shadow, the total duration, from the first contact to the last, may be 5½ hours.

Figure 100 shows at one view the phenomena of both lunar and solar eclipses. The solar eclipse represented here is an annular one, as the shadow of the moon terminates at *m* before it reaches the earth. A moment's careful inspection of this diagram will show that an eclipse of the sun can only take place at the period of the new moon, as the enlightened hemisphere is turned away from the earth; and that an eclipse of the moon, on the other hand, can only occur at full moon. The reason why eclipses do not happen at every new and full moon is that the moon's orbit is inclined to the earth's orbit at an angle of 5° 9′; so that during one half of its journey, the moon is below the plane of the ecliptic, and in the other above it. Now the earth's shadow is in the same plane as its orbit, and hence at the period of full moon the shadow may be above or below the moon, and in either case no eclipse will occur. The points in which these planes intersect are known as the *nodes*, and hence there is an eclipse of the moon whenever a full moon happens at or near one of the nodes. In a similar way a solar eclipse occurs when the moon is near one of the nodes at the time of new moon.



The position of the nodes of the moon's orbit is continually changing, at the rate of 19° 20 1-3 minutes in a year; so that they perform a complete revolution in a trifle less than 18 years and 219 days. After an interval of 346.62 days, they come again into the same position in regard to the sun; and this period is called a *synodical revolution of the node.* Now it happens that 19 of these periods are almost exactly equal to 223 synodical revolutions of the moon; so that after this interval the sun, earth, and moon, are again almost in the same relative positions and the same series of eclipses is therefore repeated. This period of 6,585 days, or 18 years and 10 days, is called *a cycle of the moon.* It was known to the ancients and called the *Saros*, and by means of it eclipses were roughly calculated before any great progress had been made in the science of astronomy.

Conjunction and Opposition.

When a heavenly body is said to be in *conjunction* it is meant that the body is in a line with the sun and the earth, either between the earth and the sun, or having the sun interposed between it and the earth. When the body is between the earth and sun it is in its *inferior* conjunction ; when on the other side of the sun from the earth it is in its *superior* conjunction. When a body is said to be in *opposition* it is meant that it is in a line with the sun, and the earth, the earth being interposed between it and the sun. The planets whose orbits lie between the earth's orbit and the sun, Mercury and Venus, have each two conjunctions, one inferior, or when either of them happens to be in a line between the earth and the sun ; the other superior, or when they are in that part of their orbit that lies beyond the sun from the earth, in a line with the earth and sun ; but these have no opposition. The superior planets, or those whose orbits lie without that of the earth have each one conjunction, the superior, and one opposition. The moon, whose movements are round the earth as a centre, and always accompanying the earth in its journey round the sun, has one conjunction, at new moon, the inferior ; and one opposition, at full moon.

Proofs of the Earth's Annual Motion.

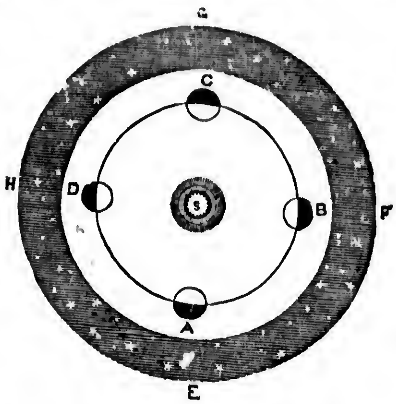
Now the *annual* motion of the earth and its position in the solar system are proved and illustrated by such considerations as the following : That if this motion did not exist, the motions of all the planets would present a scene of inextricable confusion, consisting of direct and retrograde movements, and looped curves so anomalous and irregular as to be altogether inconsistent with anything like harmony, order, or intelligence : That Mercury and Venus have two conjunctions with the sun, but no opposition, which could not happen did not the orbits of these planets lie within that of the earth : That Mars, Jupiter and all the other superior planets, have each their conjunctions with, and oppositions to the sun, which could not take place unless their orbits were exterior to that of the earth : That the greatest elongation (apparent distance) of Mercury from the Sun is only about 29°, and that of Venus 48° ; but if the earth were the centre of their motions, as the Ptolmaic system, and some other systems supposed, they might sometimes be seen 180° from the sun, or in opposition to him, which never happens : That some of the planets appear much larger and brighter at some times than at others on account of their different distances from the earth ; but on the other hypothesis, their brillancy and apparent size would be always about the same : That Mercury and Venus in their superior conjunctions with the sun, are sometimes hid behind his body, and in their inferior conjunctions sometimes appear to pass across the disc of the sun like round black spots, which would be impossible, according to the Ptolemaic system: And in short, that the times in which the conjunctions and oppositions, stations, (or when the planets are in that part of their orbit in relation to the earth and sun in which they appear to be stationary,) and retrogrations, (or when the planets are in that part of their orbits in relation to the sun and earth, in which they appear to go backward,) happen are not such as they would be if the earth were at rest in the centre of their motions, but precisely such as would happen if the earth move along with all the other planets in the stations and periods assigned them in the system which has the sun for its centre. For as the sun is intended to cheer and irradiate surrounding worlds, it is most fit that those agencies and influences should proceed from the centre of the system from which they are communicated in an uniform and equable mode to the planets in every part of their orbits. Were the earth the centre of the system and the sun and planets revolving around it, the planets, when nearest the sun, would be scorched with excessive heat; and when farthest distant would be frozen with excessive cold.

There is another potent consideration by which the earth's *revolution*, and its position in the system, are demonstrated, and that is that the inferior planets Mercury and Venus, when viewed through moderately good telescopes, are found to assume different phases in different parts of their orbits. Sometimes they appear as a crescent, sometimes with a gibbous phase, sometimes like a half moon, or having a full enlightened hemisphere, which could not happen if they revolved around the earth as their centre of motion, and if the earth were not situated in an orbit exterior to theirs. This can be illustrated with peculiar effect by means of an equatorial telescope and a planetarium. Having placed the Earth and Venus in their true positions on the planetarium by means of an ephemeris, (a little book showing the positions, etc., of the planets for every day in the year,) or the Nautical Almanack, the observer should place his eye in a line with the balls representing these planets, and mark the phases of Venus as seen from the earth, whether a crescent, a half moon, or a gibbous phase. He should then adjust the equatorial telescope for Venus, if she be within the range of view, and he will see the planet with the same phase in the heavens. This exhibition never fails to gratify and convince the observer. But it can seldom be done if we must wait until the planet be visible to the naked eye, and capable of being viewed with a common telescope; for it is sometimes invisible to the naked eye for nearly one half of its course from one conjunction to another. Beside, the phases of this planet are more distinctly marked in the day time, when it is near the meridian, than either in the morning or evening, when at a low elevation, in which case it appears glaring and undefined on account of the brilliancy of its light, and the undulating vapors near the horizon through which it must then be viewed. With an equatorial telescope of a power of 60 or 80 times, most of the stars of the first magnitude and some of those of the second, can be seen even at noonday. Venus may be seen with this instrument in the day time during the space of 19 months, with the interruption of only about 13 days at the time of her superior conjunction, and 3 days at the time of her inferior; so that the phase she exhibits may be seen almost every clear day.

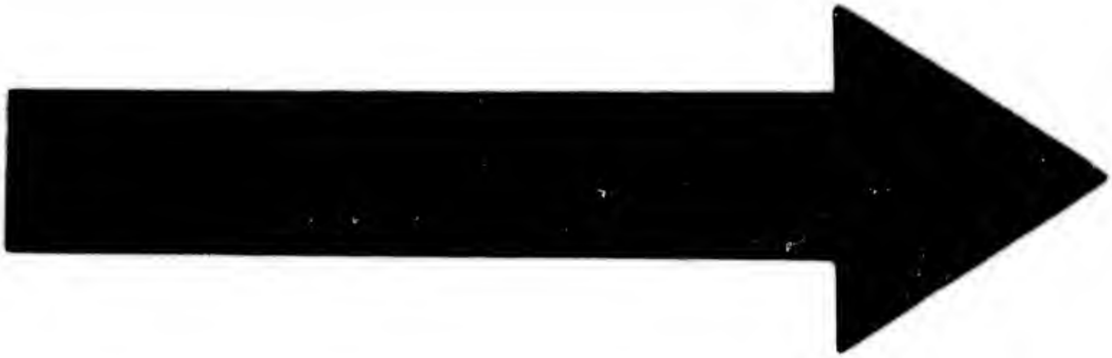
Admitting then that the earth is of globular form, as doubtless all our readers are now prepared to do, it necessarily follows that it may be inhabited on every side, and consequently that those who live on opposite sides of the globe must have the soles of their feet pointing towards each other, and their heads pointing in opposite directions; and that if by any motive power acting from the earth's interior, they should be carried forward in the directions to which their heads point, and the power to be continued in operation they would never meet during all eternity. This would result from the gradual and equal expansion of the earth on all sides by the operation of some expanding force in the interior, of which supposed circumstance we have spoken before. It also follows, that could we suppose a hole bored through the earth's centre, commencing at the point where we now stand, and extending to the opposite side, it would terminate at our antipodes, and would measure nearly eight thousand miles. It likewise is most evident that this terraqueous globe is either at rest in empty space or is moving round its axis every day, and with immense velocity round the sun every year. If we suppose the earth in a quiescent state in empty space, we have presented to our view a globe containing two hundred and sixty-four millions of cubical miles and weighing at the least calculation 2,200,000,000,000,000,000,000, or more than two thousand two hundred trillions of tons resting upon nothing, and surrounded with the immense bodies of the universe with no visible support to prevent it from sinking into the depths of infinity. If we suppose it to be revolving round its axis and at the same time round the sun, a globe of the huge dimensions now stated, moving with a velocity of over a thousand miles an hour round its circumference, and of at least sixty-eight thousand miles an hour in its course round the sun, without ever intermitting its speed a single moment, we have presented to us a view sublime and astonishing indeed, but not anything more so than what we see in the case of other heavenly bodies of a thousand times larger dimensions, and a view a great deal more reasonable than that of supposing it at rest in space with all the huge bodies of the universe revolving round it as their centre. It is plain, however, that whichever of these suppositions we hold to be the true one, an astonishing and sublime idea is conveyed to our mind.

Phenomena arising from the Earth's motion.

First; if the earth revolve round the sun once every year, it is evident that the sun will appear to make a revolution round the heavens in the same time. In the figure let S represent the sun in the centre, and A B C D, the earth, in four positions; and let us suppose the earth to move in the order of the letters A B C D; it is evident that when the earth is at A, the sun will appear in that part of the heavens in which the stars at G are situated. When the earth has moved to B, the sun will appear to have moved to the stars opposite to H. And, in like manner, when the earth has moved to C, the sun will appear opposite to E. And when it has moved to D, the sun will appear at F. And when the earth has moved to A, the sun will again appear at G. And, as the earth revolves round the sun in the orbit A B C D, so the sun will appear to a spectator on the earth, to describe the circle in the heavens, E F G H. Hence it is that we see the sun gradually proceeding in his course round the concave of the sky from west to east, at the rate of nearly one degree every day, through the twelve signs or constellations of the zodiac. And at the end of a year he returns to the same point from which he set out. Hence, also, it follows that, if the plane of the earth's orbit be conceived to be extended to the heavens, it will cut the starry firmament in that very circle in which a spectator in the sun would see the earth revolve every year, while an inhabitant of the earth observes the sun to go through the same circle in the same space of time. This circle, then, is called the ecliptic, the *apparent* path of the sun, the *real* path of the earth through the heavens. And, although the path of the sun, and the particular stars he is passing along, cannot be seen in the day-time, yet, by observing the stars which are directly opposite to him at night, we can tell at any time what particular stars the sun is passing along at every point of his course.



The inhabitants of all the other planets will perceive different motions in the sun as we observed, but performed in different periods of time, according to the times of their annual revolutions. An inhabitant of the planet Mars, for example, would see the sun apparently revolving round him in the heavens in the space of about one year and ten months. The circle which the sun would appear to him to describe would not be very



different from that of the earth, as the inclination of his axis to the plane of his orbit is not very different from that of the earth to the plane of the ecliptic. An inhabitant of the planet Jupiter would see the sun apparently revolving around him, describing a circle in the heavens in the space of twelve years. This circle would not be exactly the same as our ecliptic, because the orbit of this planet is somewhat inclined to that of the earth; but it would pass very near it. In the space of one of our years the sun from Jupiter would appear to pass through only a twelfth part of the circumference of the heavens. The sun from Saturn will appear to move in another circle in twenty-nine and a half years; and from Uranus, in another circle, in about eighty-four years; and a spectator in Venus will see the sun moving in a circle different from all these, with greater apparent rapidity, in the space of seven and a-half months. All these apparent motions of the sun arise from the real motions of the respective planets. Secondly; the annual motion of the earth shows why we behold one set of stars in our firmament at one season of the year, and another set of stars at a different season. For example, the stars and constellations which, in our northern latitudes, are seen in the south during the winter months, are altogether different from those which are seen in summer; and those stars which surround the pole in the north, and which never set, if they are below the pole in winter, they will be seen as far above the pole in summer. At the equator, where all the stars north and south rise and set, the stars which are seen in the middle of winter are all completely different from those that are seen at the same hour in the middle of summer. This is easily explainable by the preceding diagram, in which the earth, in four situations in its orbit, appears half enlightened and half in the dark, representing day and night. When it is at A the sun will appear at noon at G, and obscure all the stars in the hemisphere F G H; when, as at midnight, the point of the heavens E will be in the meridian, and all the stars in the other hemisphere, F E H, will be visible. Three months afterwards, when the earth comes to the situation B, the sun at noon will be seen at H, and all the heavens, G H E, will be day, illuminated by the sun; and over all the other half, E F G, the stars will shine at night; consequently, the stars in the quarter F G will now be visible, which, in the former position, were obscured by the sun; and those in the quarter H E, formerly visible, will become obscured by daylight. In like manner when the earth is at C, the heavens H E F will be day, and F G H night, when all the stars which were obscured when the earth was at A, will now be visible. And, lastly, when the earth is at D, the stars and constellations in the hemisphere E F G will be obscured by the light of the sun, and those on G H E will be visible during the night. Hence all who are accustomed to observe the heavens will have seen that the bright constellation Orion, the brilliant star Sirius, which follows it, and the Pleiades, or Seven Stars, which are visible in the southern sky during the winter and the approach of spring, are never seen during the summer months, because the sun is then illuminating that portion of the firmament where they are situated; but, being above the horizon in the day-time, they may be seen by means of equatorial telescopes.

By observation of the starry heavens we find that the stars never alter their positions in relation to each other. They appear to move round us in one compact body as the figures of the constellations do on a celestial globe, when that instrument is turned round its axis; but the stars of one constellation never approach or move away from those of another. If, for example, we direct our attention to the stars of the Great Bear in the northern sky we shall find that at all hours of the day and night, and at every season of the year they present the same definite figure, and maintain the same relative positions to each other, without any sensible variation of distance or magnitude; and the same may be observed from one year to another. Hence, as before mentioned, they are usually denominated the "Fixed Stars." But when we examine the heavens with more care and minuteness we occasionally perceive a few bodies, having the appearance of stars, which when carefully watched for a few weeks or months, are found shifting their positions with relation to the surrounding stars. In most cases their movements are toward the East, but not unfrequently toward the West; and at certain times no motion can be observed for a considerable number of days. The bodies which are thus perceived to change their positions among the stars are called planets, which word, as before mentioned, means "Wandering Stars." Until very recently there were only ten bodies of this description known to astronomers, and the paths of these had been traced in the heavens, and their motions accurately ascertained. Nearly one hundred of these bodies, all of them of small dimensions, have lately been discovered in the space intervening between Mars and Jupiter. Five of the planets are visible to the naked eye, and these were known to the ancients, who gave them the following names, derived from the heathen mythology: Mercury, Venus, Mars, Jupiter and Saturn; and if we count the Earth in it makes six. By long and careful investigations of the phenomena and motions of these planets astronomers have ascertained that they all move round the sun, as the centre of their motions; and along with the earth, the minor planets and the moons form one grand and harmonious system with which we are intimately connected, and which is called the solar system.

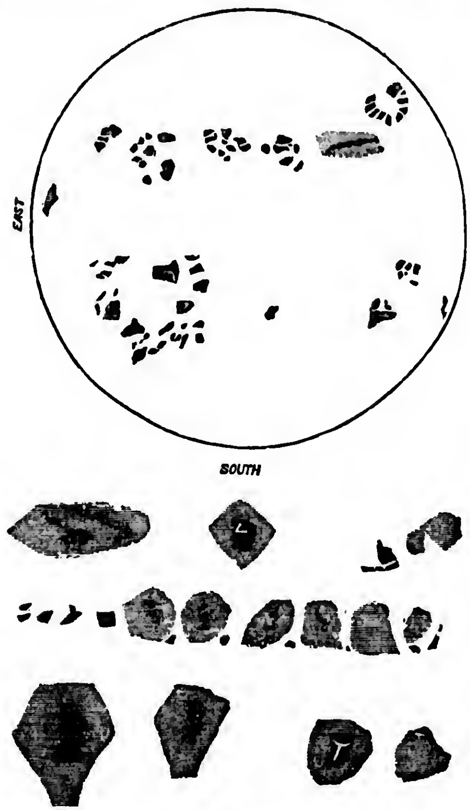
The following is a list of the principal bodies of this group, in their order in space: First the Sun, the common centre around which the planets all revolve; Vulcan, a planet very recently said to be discovered, but whose existence is as yet by some considered doubtful, Mercury, and Venus; which all are distinguished as the inferior planets, their orbits being included within that of the earth ; the Earth, and the superior planets : Mars, the minor planets or asteroids, Jupiter, Saturn, Uranus, and Neptune. There are also many secondary planets or moons, as well as comets, which are reckoned as belonging to this system : besides there may be many other planetary bodies in it ; doubtless there are many that yet remain undiscovered.

As we enquire more particularly into the movements of these bodies we discover many striking points of similarity. They all move round the sun in the same direction, and in elliptical paths of no great eccentricity. They are all opaque bodies, like the earth, shining only by reflected light ; and all rotate on their axes, so as to produce the alternation of day and night. Their orbits, too, are all inclined to the plane of the ecliptic or earth's orbit. The following is a method by which we may obtain a tolerably correct idea of their comparative magnitudes and distances, and the relative dimensions of their orbits. Select a large, clear space, and place, nearly in the centre, a ball of about two feet in diameter to represent the sun : Vulcan will then, supposing such a body to be really existing, be represented by a small pin's head 27 feet from the globe ; Mercury by a mustard seed 82 feet distant ; Venus by a pea at a distance of 142 feet ; the earth by a pea of about the same size, or slightly larger, at a distance of 215 feet ; Mars by a large pin's head at a distance of 327 feet ; the minor planets or Asteroids by very small grains of sand between 500 and 600 feet distant ; an orange of about 2½ inches diameter, and 1120 feet distant, will represent Jupiter ; one about 2 inches in diameter and distant two-fifths of a mile will stand for Saturn ; a full-sized cherry, three quarters of a mile distant, for Uranus ; and a plum, a mile and a quarter off, for Neptune. On this scale the distance of the nearest fixed star is reckoned at 7,500 miles.

The Sun.

As the sun is by far the largest of these bodies we shall treat of him first ; and the question which at once suggests itself is, what is the distance of this body ? The accurate solution of this question is found to be one of the most important problems in astronomy, as this distance is taken as the measure for determining the distances and magnitudes of the other heavenly bodies. There has always been great difficulty experienced in determining the distance of the sun, owing to the fact that the earth's diameter, being so small compared with the sun's distance, did not afford a base line of sufficient length for a triangle by which the sun's parallax, and thence his distance, might be obtained. There has, however, been obtained what is considered as a near approximation to it, by means of observations taken of the transits of Venus. As a result of these observations, the sun's mean distance is determined to be about 91,430,000 miles. Until recently the sun's distance has been taken at 95,000,000 miles; but subsequent investigations have shown an error in these measurements. The numbers here given however are only given as approximation ssubject to future correction. The next transit of Venus, which will take place in 1874, is anxiously awaited to settle the question decisively. It may be remembered too that the distance given above is the *mean,* the difference between the minimum and maximum being about 3,000,000 miles. Having ascertained the distance of the sun, and knowing its apparent diameter to be about 32', a little over half a degree, we obtain his real magnitude by a simple proportion; and in this way we find his diameter to be, in miles, about 853,000, or more than one hundred and eight times that of the earth. The sun's volume is so great that it would require over 1,300,000 globes of the size of the earth to be rolled into one to equal it; and it is computed to be 450 times as large as all the known planets which revolve around it taken together. Its surface contains more than 12,000 times the number of square miles on our globe. The reason why the sun appears so small to our eyes, although being a globe of such immense magnitude, is owing to its great distance from our world. This distance may be illustrated somewhat as follows: It would require a cannon ball, though flying continually with a velocity of 500 miles an hour, 21 years before it could reach the sun. Suppose a steam-carriage to set out from the earth in the direction of the sun, and to move without intermission at the rate of twenty miles an hour, it would require over 520 years before it had traversed the whole space which intervenes between us and that luminary. How wonderful then that the sun at such a distance should exert his attractive power upon the earth, raise the tides in the oceans, and diffuse light, heat, color, and animation over all its regions! Some idea can be formed of its light and heat when we remember the enormous distance at which we are from its surface, and the degree, notwithstanding this, to which we feel its power and influence. Its light is computed to be equal to that of 5,500 standard candles placed at a distance of a foot from the given surface to be illuminated. We naturally want to know something more about the physical properties of this wonderful and stupendous orb; but we are to a great extent baffled in this enquiry, just as we are in regard to the exact physical properties of the bodies which make up the earth's interior; though many great and important discoveries have been recently made by means of spectrum analysis. In this way, it has been ascertained that many of the metals present in the earth are also present in the sun.

When pieces of very dark glass are placed in front of the eye-piece of a telescope, so as to screen the eye from the intense glare of the sun, its surface may be carefully examined, and is found to present an appearance by no means uniform. Many dark spots termed maculæ are found at times to exist on its surface. See figures 102 and 103. The centre of these is usually of a very dark color, and is surrounded by a margin much lighter in appearance, which is known as the penumbra. These spots are very irregular in shape, and frequently change in size or disappear altogether. This may in the main be accounted for by the rotation of the sun on his axis, by which different portions of his surface are presented to the earth in succession. The spots appear first on his eastern margin, at which time they appear narrow and somewhat obscure; they move gradually onward to the centre of the disc, when they appear largest and most distinct; afterward they proceed toward the western margin, where they again



Figs. 102. and 103.

appear narrow and obscure: and after a period of about 13 days from their first appearance on the eastern edge, they disappear from the western limb; and, in many cases, they again appear on the eastern limb, after the same period of 13 days. But they are frequently somewhat changed in their aspect before they reappear; and, in numerous instances, after disappearing from the sun's western boundary, they are never again visible in the same shape; but other spots at uncertain intervals, are seen diversifying the solar disc; though not unfrequently scarcely a single spot is to be seen on the whole surface of the sun. The spots appearing narrower and less distinct on the eastern and western limbs, is owing to our viewing obliquely those parts of the sun's surface. The conclusions which may be deduced from these circumstances are: 1st. That the sun is a globe and not a flat surface, as it appears to the naked eye; otherwise the spots would appear equally large and distinct on every part of its surface: 2nd. That this luminary moves round his axis in the same direction as the rotation of the planets; for its spots do not alter their places on its disc, but are carried along with the whole body of the sun. The time of the apparent revolution of these spots is 27 days, 8 hours; but the real period of the sun's rotation on its axis is 25 days, 7 hours, and 48 minutes; and, therefore, the spaces about the sun's equator move at the rate of 4,407 miles an hour.*

The solar spots are of different sizes, and of different shapes. Their dimensions vary from the $\frac{1}{600}$th to the $\frac{1}{30}$th of the sun's diameter. The smallest of these spots which can be distinctly seen are nearly 1,000 miles in diameter. Spots the $\frac{1}{50}$th part of the sun's diameter, which are frequently seen, are 17,600 miles in diameter, or more than double the diameter of the earth; and if the spot be considered only as a plane, and somewhat circular, it will contain a considerably greater area than the whole terraqueous globe, and sometimes a spot of this vast size disappears in a few weeks, not unfrequently in a few days. Sometimes no spot is to be seen on the solar disc, for weeks and even for months together; at other times, over a hundred spots of different sizes are dispersed over its surface at one time. In such cases, there are generally five or six large spots such as that alluded to above, accompanied with ten, fifteen, or twenty smaller spots; but, after disappearing at the sun's western limb, it is seldom they come round again in the same order as before. Some appear to have been altogether dissipated, and others to have changed their shape and relative positions to surrounding spots in which they formerly appeared. Some of these spots of considerably larger dimensions than the earth, containing three or four hundred millions of square miles, occasionally appear and vanish in the space of 48 hours. The parts of the sun's surface where these spots most frequently appear, are those which lie adjacent to its equatorial regions; no spots being ever seen near its northern or southern poles. In some years these spots appear in

* This is obtained by dividing the sun's circumference 2,679,785 miles by the number of hours in which the rotation is performed, namely 608; and the quotient is the rate of motion per hour.

great numbers,and seldom a week passes without a few of them being seen; while in other years comparatively few are visible. Careful records have been kept of their appearance.

They are found to diminish in frequency for about five or five and a-half years, when the number is at a minimum, the surface being then free from them on more than half of the days of observation. They then increase again in number for the next five and a half years; and thus their period appears to be about eleven years. A remarkable fact has been noted in connection with this, and that is that the daily variation of the magnetic needle is found to have a precisely similar period, and to increase or diminish with the increase or diminution of the number of spots. Other phenomena seem further to show that there is an intimate relationship existing between the movements of the magnetic needle and the sun. Future observations will doubtless reveal to us more of this natural bond, and new discoveries on the subject are frequently being made.

Beside the dark spots, which we have now described, there are spots which display a bright, and mottled appearance, and which it is difficult in most cases to distinguish from the real body of the sun. These are termed *faculta*. They are chiefly to be seen when they first appear on the eastern margin of the sun, and when they approach near the western limb; but they are rarely seen near the middle of the disc. They are most generally seen in connection with clusters of dark spots, and when they are first seen near the eastern limb they frequently indicate that dark spots are about to appear. They appear like luminous mountain ranges, plainly indicating that the sun is not a smooth surface, but is diversified with elevations and depressions, or in other words, with mountains and vales of stupendous dimensions; otherwise we could by no means perceive them at the immense distance at which they are placed from us.

Recent telescopic investigations, however, show that, beside the markings of which we have spoken, the whole surface of the sun has somewhat of a mottled appearance. According to Nasmyth it presents an appearance as if it were covered over with scattered filaments, shaped like willow-leaves. This whole question of the physical constitution of the sun is now engaging the attention of many astronomers. A total eclipse of that body presents a good opportunity for the observation of many points, and among the most remarkable features in connection with these phenomena is the presence of dark flames or protuberances surrounding the dark body of the moon at the moment of total obscuration. These have recently been seen at other times also,and are believed by some to be connected with the solar atmosphere. They probably arise from certain portions of the sun being for the present more combustible, and in a state of more intense incandescence than others.

The question will naturally suggest itself—if the sun is continually in a state of combustion, will it not at some time be consumed? A knowledge of chemistry will go far towards answering such a question as this. Bodies, while undergoing combustion are also undergoing chemical decomposition, or a separation of their component parts into their primary elements, but

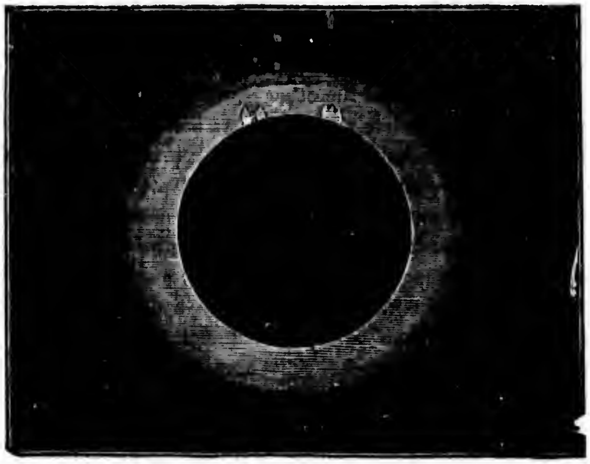


Fig. 104. ECLIPSE OF THE SUN, JULY 18, 1860.

not a single particle of them is lost by the process. Light is only a manifestation which attends combustion, and is equally attendant upon the combination as upon the separation of chemical elements; the matter of the body undergoing combustion, unless what residuum there may be from it, is revolved into gaseous elements, which ascend to the level of their gravitation in their atmosphere, and there float, until, perhaps, recombining with other chemical elements for which they have an affinity, they thus return to the surface of their sphere again, it may be—as in the case of the earth's atmosphere they do—in the form of a meteor, but in some way or other they eventually return to the surface of their spheres, not a particle of them being lost by the manifestation of light. By this, it is understood that the elements of the sun in connection with which light is manifested, may go on separating and recombining under the influence of combustion without any actual waste or exhaustion of matter, as long as the want of equilibrium between his elements makes combustion to be a consequence of their contact. The constitution of the sun appears to be of such a nature, and such is the purpose which it answers in the system, that it may have ever existed and may ever exist luminous. Albeit, what hinders that during certain periods of the past our system may not have been enlightened by some other luminous body?

According to Sir Wm. Herschell's estimate the atmosphere of the sun is not less than 1840 and not more than 2760 miles in depth. This he regards as the outermost coating of the sun, or his visible surface; and under this superior stratum he conceived there is another, more dense and highly reflective, which throws back the light of the upper regions, and that this lower atmosphere constitutes the umbra of the spots, and that the dark central parts of the spots, or the nuclei, are part of the solid matter of which the sun's body is composed. According to such views the globe of the sun may be regarded as of considerable density, not altogether unlike the earth and the other planets, and not a very great portion of its surface, comparatively speaking, as being in a state of combustion; and there is no improbability in supposing it to be inhabited with sensitive and intelligent beings having constitutions adapted for their situation; and it may constitute the most glorious habitation connected with the solar system. It is evident, however, whatever may be the real nature and constitution of this luminary, from the rapid and extensive changes which are seen to take place in connection with the spots on his surface that there are forces of prodigious power in continual operation there, producing the most astonishing effects in short spaces of time. And such changes are doubtless necessary for preserving the present state of the sun, for enabling him to diffuse light and heat, and to act as the soul of surrounding worlds. This magnificent luminary is the great source of light and heat and color to our world; and to all the planetary globes, with their satellites and rings, which belong to our system. By its influence it cheers, animates, and adorns a retinue of worlds; by its attractive energy it directs their motions, and confines them all to their proper paths, so that none can wander from their course or interfere with the others. Without the influence of this luminary darkness and all its gloomy accompaniments would involve our world: the beauties which adorn the face of nature would nowhere be seen; the warbling of the birds would not be heard; the flowers

Fig. 105.

would not be decked in their gay colors, nor shed their rich perfumes; our earth would be a hideous chaos. Can we reflect therefore upon the grandeur and magnitude of this luminary, and the manifold beneficial effects which it produces in our world, without raising our thoughts to Him who appoints it for this purpose! In all our surveys and contemplations of nature it becomes us to raise our thoughts from the effect to the cause, from the creature to the Creator,—for God is the Creator of the solar light, as of all other creatures,—and to give Him the glory due to His name.

The Planet Vulcan.

We now pass on to notice the planets which revolve in ceaseless courses round the sun. About fourteen years ago Le Verrier, a French astronomer, having very carefully examined the movements of the planet Mercury, found in it a slight variation which he could account for only by supposing that the mass of the planet Venus was incorrectly ascertained, or else that there was a planet revolving round the sun in an orbit within that of Mercury. He published some statements to this effect in the hope that some further light might be thrown on the matter. It must be remembered, however, that Mercury itself, which until now was considered the nearest planet to the sun, can only be seen at occasional intervals, and then with difficulty, on account of its apparent proximity to the sun; and that, therefore, a planet much nearer to the sun would never appear far enough removed from that body to be clearly discerned. Almost the only opportunity of observing it then would be when it should be in transit. As soon as Le Verrier had published his statement a French physician named Lescarbault announced that on the 26th of March 1859 he had seen a small body pass across the sun, but had not liked to announce the fact before, no other observer having called attention to it. Le Verrier at once saw him and carefully enquired into the matter. At first he thought the whole affair was a delusion; but after questioning the physician, and enquiring as to the apparatus he had used, he became convinced that he had indeed discovered a new planet, which was then called Vulcan. From this one observation no very decisive details could be drawn so as to calculate its orbit accurately; its distance from the sun was, however, set down at about 14,000,000 miles, and its time of revolution in its orbit at a period of a little under twenty days. It was conjectured that a second transit might be observed in March 1860; but though a careful watch was kept it was not seen; nor has it that we have learned been seen again up to the present time. Many on this account are disposed to treat the whole affair as a mistake. Instances have however been previously recorded of spots resembling planets being seen on the sun; and future observations will perhaps show, that the planet really exists as well as some others in that luminous space, and that these have been transits. Astronomers, however, do not pronounce definitely either way as to the alleged planet, and are only awaiting the results of future investigations concerning it.

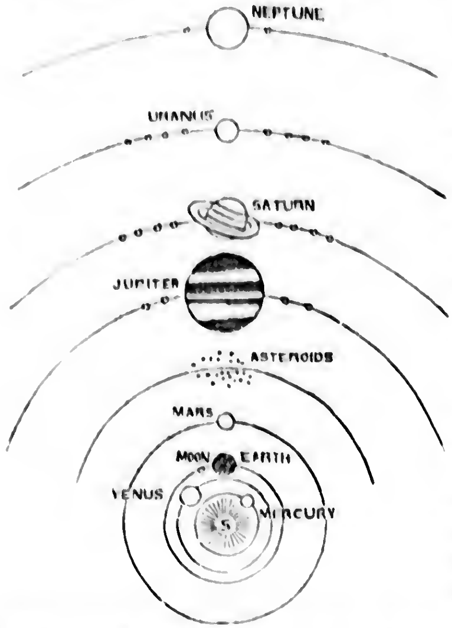


Diagram illustrating the relative positions, etc., of the sun planets, and planetoids.

The Planet Mercury.

This planet has been known from the earliest ages of astronomy of which we have any records. This speaks well for the research of the early astronomers; for, owing to its small size, and its proximity to the sun, it is very difficult to obtain a satisfactory view of this planet. It is said that the celebrated Copernicus, although the greatest part of his life was devoted to the study of the heavens, never once succeeded in obtaining a view of this orb. The greatest distance at which it can ever be from the sun is 29°, and sometimes its elongation before it begins to return is not more than 16½°. The mean distance of Mercury from the sun is nearly 35,390,000 miles. Its eccentricity, that is, the distance from the centre of its orbit to the centre of the sun, being very great, (about seven millions of miles,) its distance varies between 28,000,000 and 43,000,000 miles. It performs its journey round the sun in a trifle over 87 days, so that its year is less than a fourth the length of ours. Its speed in its orbit is far greater than that of any of the other known planets; being computed to be at an average 109,800 miles an hour, or 1,830 miles a minute; hence in the ancient mythology Mercury was represented with wings to his feet; and his name is said to signify the "swift messenger." This planet is but small, its diameter being reckoned at 2,960 miles, or rather more than one-third that of the earth. Hence its circumference, or a line extending quite round it, would measure about 9,299 miles; and the number of squares miles on its surface would be nearly 27,525,040. Its period of rotation round its axis is 24 hours 5½ minutes, and thus it clearly resembles the earth as to the length of its day. A transit of this planet occurs whenever it is in one of the nodes, (that is, at the point where its orbit intersects that of the earth,) at the time of an inferior conjunction. The next time this will occur will be on the 6th of May, 1878. If the orbit of this planet were in the same plane with that of the earth it would transit the sun's disc at every inferior conjunction, or three or four times every year. But as its orbit is inclined to the ecliptic a transit can happen only when it comes to the inferior conjunction at the time when it is at or near its nodes, and when the earth is in the same longitude; and this occurs only at intervals of several years. This planet exhibits phases corresponding to those of the moon. On account of its proximity to the sun few discoveries have been made on its surface by the telescope. It has been observed, however, that when it appears as a crescent one of its horns is truncated, or cut off at the point, by which the period of the planet's rotation round its axis has been determined. This truncature is doubtless the effect of elevations and depressions on its surface; and hence some astronomers have concluded that mountains of considerable height exist on Mercury, one of which is estimated to be 8 miles in perpendicular altitude. The quantity of light received on Mercury is nearly seven times that which we receive; and the sun will appear from Mercury seven times the size he does to us. This planet is supposed also to be enveloped with an extremely dense atmosphere.

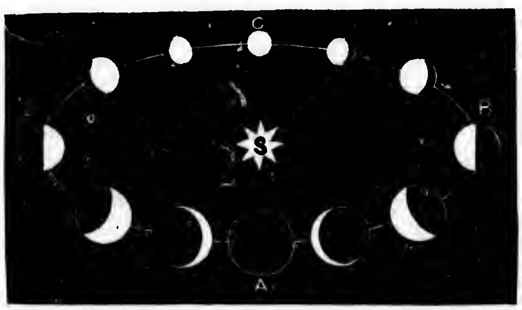
Though diminutive in its appearance, and seldom seen by the inhabitants of the earth, we can scarcely doubt that there exist on Mercury millions of sentient and intelligent creatures, perhaps superior in scale of being to man, with constitutions fitted for that sphere in which they are, and with mental powers which qualify them to know, to love, and to adore their great Creator.

Appearance of the Heavens as Viewed from Mercury.

The situation of this planet being so near the sun has prevented us from discovering various particulars which have been discovered in relation to several of the other planets; and therefore not much can be said with respect to the scenery of its firmament. The starry heavens will appear to move around it every 24 hours, as they do to us; but as the direction of its axis of rotation is not known we cannot tell what stars will appear near its equator or its poles. The sun will present a surface in the heavens seven times as large as he does to us, and of course will present a very grand and splendid appearance in the sky, and will produce a corresponding brightness and vividness of color on the objects which are distributed over the surface of the planet. Both Venus and the Earth will appear as superior planets; and when Venus is near its opposition to the sun, at which time it will rise when the sun sets, it will present a very brilliantappearance to the inhabitants of Mercury, and serve the purpose of a small moon to illuminate the evenings in the absence of the sun. As Venus presents a full enlightened hemisphere at this time to the inhabitants of Mercury, it will exhibit a surface six or seven times larger than it does to us when it shines with its greatest brilliancy, and, therefore, will appear a very bright and conspicuous object in the firmament of this planet. At all other times it will appear at least two or three times larger than it ever does to us. It will generally appear round; but at certain times it will exhibit a gibbous phase, as the planet Mars frequently does as seen from the earth. It will never appear to the inhabitants of Mercury in the form of a crescent or half moon, as it sometimes does through our telescopes. There is no celestial body within the range of this planet, of which we have any definite knowledge, which will exhibit either a half moon or a crescent phase, unless it be the supposed planet Vulcan, and unless the planet itself be accompanied with a satellite. The earth is another object in the sky of Mercury which appears next in splendor to Venus. The earth and Venus are nearly of an equal size; but the earth being nearly double the distance of Venus from Mercury its apparent size at the time of its opposition to the sun is only about half that of Venus. The earth, however, at this period will appear in the firmament of Mercury of a size and splendor three or four times greater than Venus does to us at the time of its greatest brilliancy. Our moon may also be seen, like a small star, accompanying the earth, sometimes approaching to or sometimes receding farther from the earth, and sometimes hidden from the view by passing across the disc of the earth, or through its shadow. It will probably appear about of the size and brightness of Mars, as seen from the earth. The earth, with its satellite, and Venus will be seen near the same point of the heavens at the end of every nineteen months, when they will appear for some time the most conspicuous objects in the sky, and diffuse a considerable portion of light in the absence of the sun. At other periods the one rises in the eastern horizon as the other sets in the western; so that the inhabitants of Mercury are seldom without a conspicuous object in their nocturnal firmament, diffusing an illumination far superior to that of any other stars or planets. The earth is in opposition to the sun every four months, and Venus after a period of five months. The planets Mars, Jupiter, and Saturn will appear with a somewhat inferior degree of magnitude and brilliancy than they do to us, particularly in the case of Mars. The period of the annual revolution of Mercury being 88 days, the sun will appear to move from west to east through the circle of the heavens at a rate more than four times as great as his apparent motion through the signs of our zodiac.

The Planet Venus.

This planet is the next in order from the sun. It has been known from remote antiquity as the morning and the evening star, because in one part of its course it makes its appearance in the West in the evening before any other star is visible, and in another part of its course it appears in the East in the morning, ushering in the dawn, and giving notice of the approach of the rising sun. So brightly indeed does it shine that it is visible at times to the naked eye during the day, and casts a shadow at night. But its apparent size and brilliancy vary very greatly, as will be easily understood if we remember that when in its inferior conjunction it is within twenty-five millions of miles of the earth ; while when it is in superior conjunction this distance is increased by the diameter of the orbit of Venus, and becomes nearly one hundred and sixty millions of miles. The quantity of light which this planet receives from the sun is nearly double that which falls upon the earth, owing to its greater nearness to the source of light ; so that the sun will appear from its surface twice at large as it does to us. When in the part of its orbit directly betweeen the earth and sun, that is, in inferior conjunction, it is at its least distance from us, and hence would appear most brilliant if it were luminous. If indeed at this point its enlightened side were turned toward the earth it would present a surface 25 times larger than it generally does, and shine with the splendor of a small moon ; but as its dark side is now turned toward the earth it is invisible just as the moon before new moon. Besides this, it appears so close to the sun as to be lost in his brightness, unless it should happen to pass across the sun's disc, where it appears as a round black spot. This will be seen as at A in the figure where S in the centre represents the sun, and the earth is conceived to be in a line with the sun and Venus on the dark side of the latter. As the planet now travels onwards towards B it gets further and further removed to the West of the sun, and thus rises earlier and earlier, being then known as Lucifer or the morning star. At the same time its bright hemisphere becomes partly turned toward the earth. When exactly half enlightened, as at B, it is at its greatest elongation from the sun, being distant



about 48°, Its period of greatest brilliancy is, however, a little before this when about one-third of its disc its illuminated. Having attained its greatest elongation, it seems stationary for a short time and then appears to return toward the sun, an increasing portion of the disc being illuminated, though, on account of its increasing distance, it appears smaller. It is then lost again in the sun's rays for a time, and when it reappears to the East of the sun, it does not rise till after that luminary, and, therefore, is no longer the morning star. At this time, however, it remains visible for some time after sunset, and is known as Hesperus, or the evening star. After attaining its greatest eastern elongation at D it returns to A to go through the same phases again. While travelling about half the distance between D and A, or that half next to D, it appears stationary; in the other half, or that nearest to A, it appears to retrograde; and so while travelling half the distance from A to B, or that half nearest A, it appears still to retrograde, while in the other half, or that nearest to B, it appears stationary. These phases are not visible to the naked eye, and hence the absence of them was adduced as an argument against the truth of the Copernican system. This was before the invention of the telescope. Galileo, however, in 1610, on turning his newly-constructed telescope to the planet, at once discovered the fact of their existence. This is one of the strongest arguments adduced in proof of the system which has the sun as the centre of the planets' motions. The period which elapses between one inferior conjunction and another, or that is occupied in going through this cycle of changes is 584 days, and this is called its *synodic* period. The time, however, that is occupied in completing a circuit round the sun is only 224 days and 17 hours. At first sight these results appear inconsistent, but the apparent discrepancy vanishes when we recollect that the earth is itself in rapid motion, so that by the time Venus has completed a revolution round the sun, the earth has travelled round a large portion of its orbit, and Venus has to overtake it before another conjunction can take place.

The distance of Venus from the Sun is about 66,130,000 miles; and its orbit is nearly circular, its eccentricity being less than half a million of miles, or about the 1-276th part of its diameter, so that its distance varies but slightly. When viewed through a good telescope this planet is a very beautiful object, especially when near its inferior conjunction, so as to appear in the form of a crescent; but the brilliancy with which it shines is so great that no distinct markings can be made out on its surface. The inner edge is, however, considerably indented, indicating the presence of inequalities on its surface; from this some observers have calculated that the height of its mountains is much greater than that of any on the earth. The height of such elevations is ascertained from the lengths of their shadows. M. Schroter, a celebrated German astronomer, estimated the perpendicular height of one of these mountains to be ten and a-half English miles, and that of another no less than nineteen miles.

Although these elevations so far surpass the highest mountains on our globe, yet, on this account, such estimates should not be considered as improbable. For in nature, there is an endless variety, and our observations on the moon and nearest planets show us that every planet differs from another in the peculiar features of its surface. Such lofty elevations must add to the sublimity of nature on the surface of Venus, and will afford, from their summits, prospects far more extensive than we can now conceive. M. Schroter also deduced from several observations that Venus has an atmosphere of considerable extent, the densest part of which is above three miles high. A similar conclusion was deduced by a number of observers in different places, when viewing the transit of this planet in 1761. At the time when the planet entered on the sun's disc, and when it was about to emerge from the eastern limb, a faint penumbra, or dusky shade, was seen surrounding the planet, which indicated an atmosphere of considerable height. The period of the rotation of this planet on its axis is not very different from that of the earth, being twenty-three hours twenty-one and a-half minutes; its day is, therefore, but thirty-five minutes shorter than ours. Its axis has an inclination of 73½°. Its diameter also closely approaches in dimension that of the earth, being 7,510 miles; so that the planet which is nearest to us is found in many important respects to resemble the earth very closely; and analogy leads us to infer that in many other respects it may be a counterpart. Its circumference, or a line extending quite round it, measures 23,593 miles, and the number of square miles on its surface is 177,183,430. Several observers assert that they have seen a satellite accompanying Venus. Observations of some able astronomers, who have given some attention to it, have as yet failed to corroborate these statements. The testimony of Mr. Montaigne, however, who observed it on several successive occasions, we consider to be decisive as to its existence.* But it is evident that this satellite would be

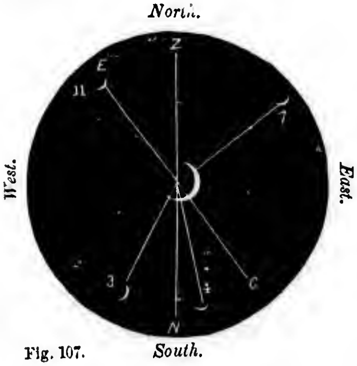


Fig. 107.

* Numbers 3, 4, 7, 11, in figure 107, mark the situations of the satellite, as seen by Mr. Montaigne, on May 3rd, 4th, 7th and 11th, 1760. On May 3rd he perceived, at 20′ distance from Venus, a small crescent, with the horns pointing the same way as those of Venus. Its diameter was one-fourth that of its primary; and a line drawn from Venus to the satellite, made below Venus, an angle with the vertical of about 20° toward the south, as seen in the figure, where Z N represents the vertical, and E C a parallel to the ecliptic, making then an angle with the vertical of 45°. On May 4th, at the same hour, he saw the same star, distant from Venus about one minute more than before, and making an angle with the vertical of 10° below, but on the north side, so that the satellite

difficult to detect, its diameter being so small as only one-fourth that of its primary It could not be seen at superior conjunction of the planet, for then it would be overpowered by the light of the sun; nor would it be easily seen in any other part of the orbit, its enlightened part being so extremely small. The best time to see it would be at the time of the planet's greatest elongation, when it would appear about half enlightened. Observers should not despair of finding it, for the satellite exists, awaiting their discovery.

The last transit of Venus happened in 1769, when the British government sent out an expedition for the purpose of making observations. The next one will take place on December 9th, 1874; then in 1882; and none will occur after that till June 8th, 2004.

This planet is doubtless well replenished with inhabitants, and may far surpass the world in which we dwell, not only in point of population but in sublimity of scenery. Its superficial area is nearly that of our globe; and it does not appear as if a very large portion of it is covered with water; otherwise it would not shine with such uniform brilliancy; the water not being as good a reflector of the light, as the solid, rough surface of the land. This beautiful planet, distinguished above all others by its great brilliancy, is occasionally alluded to by the writers of the Scriptures, as "the son of the morning," "the day star," and "the bright and morning star," emblematic of the enlightening and cheering effect of truth and godliness upon the minds and hearts of sinful men when the "day star" from on high hath risen in their hearts. When contemplating the bright luminaries of the sky, and especially the morning star, the placid influence they diffuse and the harmony with which all their movements are conducted, we can scarcely refrain from contrasting those scenes with the darkness and disorder which prevail in the moral world. While the sun diffuses his light by day, and the moon and the stars shed their mild radiance by night, it is still necessary to the well-being and happiness of mankind that intellectual light and sacred joy should be diffused in their minds and

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appeared to have described an arc of about 30°, whereof Venus was the centre, and the radius 20°. The two following nights being hazy, Venus could not be seen. But on May 7th, at the same hour as on the preceding days, he saw the satellite again, but above Venus, and on the north side, as represented at 7, between 25′ and 26′ upon a line which made an angle of 45°, with the vertical toward the right hand. On May 11th, at nine o'clock, p.m., the only night when the view of the planet was not obscured by moonlight, twilight or clouds, the satellite appeared nearly at the same distance from Venus as before, making with the vertical an angle of 45° toward the south, and above its primary. The light of the satellite was always very weak; but it had always the same phase with its primary, whether viewed with it in the field of the telescope or alone by itself. He imagined that the reason why the satellite has been looked for so often without success might be, that one part of its globe was crusted over with spots, or otherwise unfit to reflect the rays of the sun with any degree of brilliancy, as is supposed to be the case with the fifth satellite of Saturn.

hearts, of which the light of these luminaries has often served as an emblem. When the morning star makes its appearance near the eastern horizon it is a sign that the sun will ere long arise, and that the darkness of night will soon be dispelled. When the day star arises in the benighted mind it intimates that now the light of Divine truth has begun to irradiate it, and to dispel the darkness, with all its miserable accompaniments, which formerly reigned in it; it is a sign that this light will still increase and shine more and more unto the perfect day.

Celestial Phenomena, as Viewed from Venus.

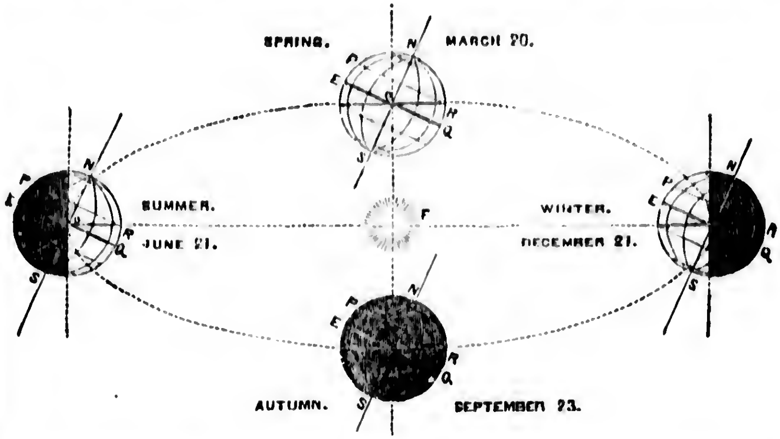
To the inhabitants of this planet the firmament will present an aspect nearly similar to that of Mercury, with a few variations. Mercury is to Venus an inferior planet which never appears beyond 38° or 40° from the sun. It will appear in the evening after sunset for the space of two or three hours when near its elongation, and in the morning before sunrise when in the opposite part of its course; and will be alternately a morning and an evening star to Venus, as that planet is to us, but with a less degree of splendor. The most splendid object in the nocturnal sky of Venus is the earth, when in opposition to the sun, when it appears with a magnitude and splendor five or six times greater than either Jupiter or Venus appear to us at the time of their greatest brilliancy. It will serve, in a great measure, the purpose of a moon to Venus, if this planet have no satellite; and will cause the several objects on its surface to project distinct and well defined shadows, as our moon does when she appears a crescent. Our moon in her revolutions round the earth appears also a prominent object in the heavens of Venus, and probably appears about the same size that Jupiter does to us. Her occultations, eclipses, and transits across the earth's disc will be distinctly visible. With telescopes such as the best we possess, the earth would appear from Venus a much larger and more variegated object than any of the planets do to us when viewed with high magnifying powers. The forms of our different continents, seas, and islands, the different strata of clouds in our atmosphere, with their several changes and motions, and the earth's diurnal rotation, would in all probability be distinctly perceived. Even the varieties which characterize the surface of our moon would be visible with telescopes of a high magnifying power. The circumstances now mentioned prove the connection of the different parts of the planetary system with one another; and that the parts of it are so arranged that one world is, in a certain degree, subservient to the benefit of another. Thus the earth serves as a large and splendid moon to the lunar inhabitants; it serves in a certain degree the purpose of a small moon to Mercury; it serves the purpose of a larger moon by exhibiting a surface and a radiance four times greater to the inhabitants of Venus; and it serves as a morning and an evening star to the planet Mars; so that while we experience enjoyment in contemplating the moon walking in brightness, and hail with pleasure the morning star as the harbinger of day, and feel a delight in surveying those nocturnal luminaries through our telescopes, the globe on which we dwell affords similar enjoyments to the intellectual beings in neighboring worlds, who behold our habitation from afar as a bright speck upon their firmament, diffusing amid the shades of night a mild and placid radiance. From Venus the planets Jupiter and Saturn will appear nearly as they do to us; but the planet Mars will appear considerably smaller. The sun to this planet will appear twice as large as he does in our sky, and will appear to make a revolution round the celestial sphere in the course of seven and half a months, which completes the year of Venus.

The Earth.

The next planet in order is the Earth, which we have hitherto considered as the base from which we made all our observations. It may still seem strange to some of our readers that this world on which we live should be considered a planetary orb; as at first view it does not appear to bear any resemblance to any of the luminaries that appear in our sky. The planets, as they are seen in the heavens by the naked eye, appear as only comparatively small points of light, whereas the earth, from whatever point we view it, appears the largest body our eyes anywhere behold, and when we traverse its surface either by sea or land there appear no boundaries to its dimensions. We have explained before that the nearer a body is to the eye the larger it appears, for the larger the angle is which its extremities subtend in the eye; and on the other hand the farther removed a body is the smaller it appears, for the smaller the angle it subtends in our eye. This is the reason why the planets, some of which are much larger than the earth, appear but as visible points in our sky; and why the moon, though sixty millions of times smaller than the sun, appears equal in bulk to that luminary. From the positions in which we can view any portion of the earth, even when we ascend several miles above its surface in balloons, it does not exhibit a luminous aspect, such as that which the celestial bodies present; so that at first view we might be inclined to suppose that no similarity exists between our sublunary world and the orbs of heaven. Beside, the celestial orbs are apparently in rapid motion from one region to another, while the earth appears to be at rest in the centre of their motions. There is not, perhaps, one out of a thousand of the earth's present inhabitants who has the least conception that beside every other motion of which he is susceptible, he is carried along through the regions of space with the rapidity of thousands of miles every hour. Yet this is a fact which is not merely probable but certain, and can be demonstrated to the conviction of every one who is both willing and qualified to enter into such investigations.

Could we stand on the surface of the moon we should behold the earth like a great globe in the firmament, appearing with a surface about 13 times larger than the moon does to us, and presenting its different sides to our view. Sometimes America and the Pacific Ocean ; and at other times Asia, Africa, Europe, and the Atlantic Ocean ; sometimes appearing like a large crescent, or half moon, and at other times with a full enlightened hemisphere. Could we take our station on the surface of Venus we should behold the globe on which we live appearing in the azure sky like a large bright star ; and the moon, which appears so large in our firmament, would be seen only like a very small star very near the earth and constantly moving around it. The earth would in general appear about of the same size that Venus does to us, but perhaps not quite so brilliant, owing to three-fourths of its surface being covered with water; at certain times, however, it would appear ten times larger than Venus does to us and like a small brilliant moon. (On the other hand, if the bright side of Venus were turned toward us at the time of her inferior conjunction, that planet would appear about 25 times as large as it usually does.) Were our situation on the planet Mars, which is much farther from the sun than Venus, the earth would appear alternately as a morning and evening star, exhibiting different phases, as Venus does to us, but with a less degree of size and splendor. It might not, perhaps, shine with so much brilliancy as Venus, but it would probably appear of a lustre similar to that which Mars presents to us, or somewhat brighter. It need not be wondered at that the earth would appear as a luminous body from such distant positions; for we have demonstrative proof that Venus, Mars, and all the other planets, though they appear like shining orbs, are in reality dark bodies like the earth, and receive their light from the sun,the reflection of which from their surfaces makes them appear luminous to us ; and it is only when the portions of their sides which are enlightened by the sun are turned toward us, that we see them in the heavens. On some occasions the dark side of Venus is completely turned toward the earth, and then she is invisible ; and sometimes in this position is seen to pass, as a dark spot, across the disc of the sun. These and many other circumstances demonstrate that the planets are in themselves dark bodies, and shine only by reflection ; and consequently that the earth,though a dark body,will appear luminous at a distance by reflecting the solar rays which fall upon it as the moon does to us. We have already proved that as a planet the earth turns round its axis every 24 hours, and also moves round the sun every year; this latter part of our position we will endeavor in the sequel to illustrate by a figure.

The earth's mean radius is 3,956½ English miles; its mean diameter being 7,913 miles; consequently its circumference, or a line extending quite round it, measures 24,859 miles; and the number of square miles on its surface is nearly 196,709,267. Of this it is estimated that 149,000,000 square miles are occupied by the seas and oceans; thus leaving 47,000,000 square miles of dry land, or less than one-third of that occupied by the water. The mean diameter of the earth's orbit is about 182,862,000 miles; and its approximate circumference about 574,709,000 miles. The linear eccentricity of the earth's orbit, being about one-sixtieth of its semi-axis major, or mean distance of the earth from the sun, we have 1,523,850 miles for the distance between the centre of the earth's orbit and the centre of the sun, or the focus of that orbit. Consequently the earth is about double this distance, or 3,047,700 miles nearer to the sun in winter than in summer. In the diagram the earth is represented in four different positions (momentary positions) in its orbit, namely, at mid-spring, mid-summer, mid-autumn, and mid-winter. In all these positions, as well as all round in its orbit, the parallellism of its axis N.S. is preserved, that is, its axis is always directed to the same points of the heavens. Some find it difficult to understand how the earth's axis in all parts of an elliptical orbit can remain parallel to itself. They should remember that the diameter of the earth's orbit is as nothing in comparison with the distance of the fixed stars. If two parallel lines are drawn at the distance of three or four yards from one another they will point directly to the moon, when she is in the horizon. Three or four yards are accounted as nothing in comparison of 240,000 miles, the distance of the moon from us. And perhaps three or four yards bear a greater proportion to 240,000 miles, than 182,862,000 miles, the diameter of the earth's orbit, bear to our distance from the pole-star. The earth's axis is inclined to the plane of its orbit at an angle of 66° 3″, hence it makes an angle of 23° 28′ with the perpendicular to the plane of its orbit: for the perpendicular, represented by the dotted line passing through the centre O, makes an angle of 90° with the plane of the orbit; and subtracting 66°′ from 90° leaves the remainder 23° 28′, which is the angle included between the axis, N. S., and the perpendicular or dotted line. The true cause of the variation of the seasons consists in the inclination of the axis of the earth to the plane of its orbit, or, in other words, to the ecliptic. If its axis were *perpendicular* to the ecliptic, the equator and the orbit would coincide; and as the sun is always in the plane of the ecliptic, it would in this case be always over the equator; the two poles would be always enlightened, and there would be no diversity in the length of days and nights, and but one season throughout the year. Because of the parallellism of the earth's axis it so happens that at mid-spring, or March 20th, this axis is perpendicular to a line drawn to the centre of the sun, and the sun being now directly vertical to the equator there is equal day and night to all places on the earth, the poles being the boundaries of



light and darkness; thus there are twelve hours of light and twelve hours of darkness to every spot on the earth's surface for this day. Hence this day is called the equinox (equal night) of spring, or the vernal equinox. At this time the earth is in the sign Libra, and the sun appears in the opposite sign Aries. As the earth travels onwards from March to June the northern hemisphere comes more into light; and on the 21st of that month the sun is vertical to the tropic of Cancer. The earth is now in Capricornus and the sun appears in the opposite sign of Cancer. At this time the half of the globe is illuminated from the circumference of the north polar circle at the distance of 23° 28′ beyond the north pole N, to the circumference of the south polar circle, at the same distance from the south pole S. At this time there is no day within the south polar circle, but the night continues twenty-four hours; and there is no night within the north polar circle, the day continuing for the same length. As at this point the earth begins to return to a position similar to that of the vernal equinox, and the sun seems to be stationary for two or three days before and after this day, it is called the summer solstice (sun standing,) or the tropic (turning) of summer. As the earth now travels on from June to September the sun shines less and less over the north pole, until on the 23rd of that month we find him again vertical to the equator. The days and nights are now again exactly equal all over the earth, or there are twelve hours of light, and twelve hours of darkness to every spot on the earth's surface for this day. At this time, as at March 20th, the earth's axis is perpendicular to a line drawn to the sun's centre. It is now called the equinox of autumn, or autumnal equinox; the earth is in the sign Aries, the sun appearing in the opposite sign Libra. Since it is summer to every part of the earth where the sun is vertical,(and we find it vertical to the equator twice in the year,) we see the reason why those living near the equator have two harvests every year. Following the earth in its journey to December we find that when it has arrived in the sign Cancer, at the 21st of that month, the sun appears in the opposite sign of Capricorn, and is now vertical to that part of the earth called the tropic of Capricorn. The half of the globe is now illuminated from the circumference of the south polar circle at a distance of 23° 28′ beyond the south pole, S, to the circumference of the north polar circle, at the same distance from the north pole, N. At this time there is no day within the north polar circle, the night continuing twenty-four hours; and there is no night within the south polar circle, the day continuing twenty-four hours.

In looking at the diagram, you see at the vernal equinox, or March 20th, the whole of the illuminated hemisphere of the globe, because from the representation of its position it is turned in front both to the sun at F, and to you the spectator. At the summer solstice, or June 21st, you see only half the illuminated hemisphere of the globe, because it is turned in front to the sun at F, but sideways to you the spectator, you being supposed outside of the orbit. At the autumnal equinox, or September 23rd, you see none of the illuminated hemisphere of the globe, because it is turned in front to the sun at F, but its back is to you the spectator, you being outside of the orbit, and as it were behind the globe. And at the winter solstice, or December 21st, you again see half of the illuminated hemisphere of the globe, because it is turned in front to the sun at F, but only sideways to you the spectator, for the same reason as before. But were you placed in the middle of the orbit, at the point F, you would, by turning round and round to the different positions we have been describing, see the whole of the illuminated hemisphere of the globe at each point of its course. In the course of this revolution the inhabitants of every clime experience, though at different times, a variety of seasons. Spring, summer, autumn, and winter follow each other in constant succession, diversifying the scenery of nature, and marking the different seasons of the year. In those countries which lie in the southern hemisphere of the globe November, December, and January are the summer months; while in the northern hemisphere, where we reside, these are our months of winter. In the northern and southern hemispheres the seasons are opposite to each other, so that when it is spring in the one it is autumn in the other; when it is winter in the one it is summer in the other. During six months, from March 20th to September 23rd, the sun shines without intermission on the north pole; so that there is no night there during all that interval, while the south pole is all this time enveloped in darkness.

During six months, from September 23rd to March 20th, the sun shines without intermission on the south pole, so that there is no night there during all that interval, while the north pole is, in its turn, deprived of the sun, and left in darkness. From 66½° north or south latitude the inhabitants of these two opposite climes enjoy a length of day during their respective summers varying from 24 hours to six months. The nearer the pole the longer is the day. Our summer is nearly eight days longer than our winter. By summer with us is meant the time which passes between March 20th and September 23rd, or between the vernal and autumnal equinoxes; and by winter the time between September 23rd and March 21st, or between the autumnal and vernal equinoxes. The portion of the earth's orbit that lies north of the equinoctial contains 184°, while that portion which is south of the equinoctial contains 176°; being 8° less than the other portion; which is the reason why the sun is nearly eight days longer on the north of the equator than on the south of it. In our summer the earth's motion is through the six southern signs, Libra, Scorpio, Sagitarius, Capricornus, Aquarius, Pisces, while the sun appears in the opposite or northern signs; and in the winter the earth moves through the six northern signs, Aries, Taurus, Gemini, Cancer, Leo, Virgo, while the sun appears in the opposite or southern signs. In the former case, from March 21st to September 23rd, the sun is about 186 days, 11 hours, in passing through the northern signs; and in the latter case only 178 days 18 hours, in passing through the southern signs, the difference being about 7 days, 17 hours. The reason of this difference is that the earth moves in an elliptical orbit, one portion of which is nearer the sun than another; in consequence of which the earth's motion is faster while moving through the northern signs in winter,—it being over three millions of miles nearer to the sun then than in summer; and the nearer the sun the planet approaches the quicker it moves;—and slower while passing through the southern signs in summer; which makes the sun appear to move slower through the northern signs. That the earth is nearer the sun in winter than in summer, is ascertained from the variation of the apparent diameter of the sun. About the first of January, when he is nearest the earth, the apparent diameter is 32′, 35″; and on the first of July, when he is most distant, it is only 32′ 31″. This proves that the earth is farther distant from the sun in one part of its orbit than in another. In January the earth's motion every hour is at the rate of 69,600 miles; but in July its rate of motion per hour is only about 66,400 miles; a difference of more than 3,000 miles an hour.

The earth completes its revolution in its orbit in 365 days, 5 hours, 48 minutes, and 49 seconds. This period is called a *solar*, or *tropical* year, and is reckoned from the time of the sun's passing the equinoctial point till it again reaches the same spot. The *siderial* year is reckoned from the time of the sun's passing any fixed star till its return to it again, and is 20′ 21″ longer than the solar; the reason of the difference being the retrograde motion of the equinoctical point (called the precession of the equinoxes, which is fifty seconds of a degree every year,) by which it travels as it were to meet the sun, so that he comes to it before he has quite completed his circuit. These two periods may be stated thus; solar year 365 days, 5 hours, 48 minutes, 49 seconds: siderial year 365 days, 6 hours, 9 minutes, 10 seconds. In early times the year was taken to consist of 365 days. As, however, the solar year is nearly 365¼ days, the date of the equinox soon became wrong; to remedy which Julius Cæsar introduced an additional day into February of every fourth year, thus making that year contain 366 days. This arrangement was known as the Julian style, and continued in use until nearly the end of the sixteenth century; but as the year is a few minutes shorter than 365¼ days, the equinoxes had by this time fallen back as much as 10 days. Pope Gregory XIII corrected this error by ordering ten days to be left out of the year 1582; and then he modified the Julian style by the following rule. Every year divisible by 4 was to contain 366 days; the even hundreds, however, unless divisible by 400, were to be considered as ordinary years of 365 days; thus 1800 and 1900 are ordinary years, while 2000 will be a leap-year. By this means the error is very nearly eliminated. This alteration, which is known as the Gregorian Calendar, was not adopted in England till 1752, and eleven days had then to be struck out of that year, to correct the error, which had increased one day in the 170 years.

In addition to its movement round the sun, by which the seasons are produced, the earth, as we have seen, has a rotation on its own axis, whereby are brought about the changes of day and night. The interval in which this diurnal rotation is completed, as ascertained by the passage of any star across the meridian on two successive days, is called a *siderial day*. It is in fact the time occupied by the heavens in making one apparent revolution. In this we have an *invariable measure*; it is therefore frequently adopted in the observatories; but for practical purposes of everyday life it would not answer well, as it is 3 minutes, 55. 91 seconds shorter than that determined by the sun; and thus clocks regulated by it would gain that amount on the sun every day. The day, therefore, in ordinary use is that reckoned by the movements of the sun, and is known as the *solar day*, being the interval which elapses between two successive meridian passages of the sun. As, however, the distance of the earth from the sun varies in different parts of its orbit, and its diurnal rate of motion varies in like manner, this period is not uniform; its mean length is, therefore, ascertained and taken as the natural or mean solar day. Our clocks are all regulated so as to indicate mean solar time, and hence they are sometimes faster than the sun, and sometimes slower. The greatest discrepancies are about February 10th, when the clock is fifteen minutes faster than true solar time, as indicated by a sun-dial; and October 27th, when it is sixteen minutes slower.

As the sun is further from us in summer than in winter some naturally enquire why we experience the greatest heat in the former season. The following among other reasons may be assigned, which will partly account for this effect: 1. The sun rises to a much greater altitude above our horizon in summer than in winter, and consequently its rays falling more directly upon the earth the thicker and denser will they be, and so much the hotter, when no counteracting causes from local circumstances exist. 2. The greater length of the day in summer contributes to augment the heat; for the earth and the atmosphere are heated by the sun in the day-time more than they are cooled in the night; and, on this account, the heat will go on increasing in the summer; and for the same reason will decrease in winter, when the nights are longer than the days. The main cause is that in summer when the sun rises to a great altitude his rays pass through a much smaller portion of the atmosphere, and are less weakened by it than when they come to the earth in an oblique direction, weakened by their passage through the dense vapors near the horizon, and by many refractions and reflections of the atmosphere.

The cause of the changes of the seasons can be exhibited with more clearness and precision by means of machinery than by verbal explanation; and therefore, those whose conceptions are not clear and well-defined on this subject should have recourse to planetariums, which exhibit the celestial motions by wheel-work. There has been some time ago a small instrument called a Tellurion, manufactured by Messrs. Jones, Holborn, London, which conveys a pretty clear idea of the motions and phases of the moon, the inclination of the earth's axis to the plane of its orbit, and the changes of the seasons. This instrument was sold at moderate prices according to the quantity of wheel-work, and doubtless it is yet obtainable.

The subject of the seasons and the variety of the phenomena they exhibit, have frequently been the theme of the poet and the philosopher, who have expatiated on the beauty of the arrangement, and the benignant effects they produce; and therefore they conclude that other planets experience the same vicissitudes and seasons similar to ours. This, however, by no means follows, for the cause of the changes of the seasons, as we have them, is owing to the degree of inclination which the earth's axis has to the plane of its orbit; and every planet discovered in our system has a different degree of inclination in that respect, and, therefore, the seasons of each will be different from ours, though they may be analogous. But though in the present constitution of our globe there are many benign agencies and effects, which accompany the revolutions of the seasons, and contribute to the wants and happiness of the earth's inhabitants, yet how few there are out of the great mass of mankind who properly appreciate them, and render to their Creator due praise for circumstances so good, and gifts so rare! Were the habitable parts of the earth generally well cultivated, its marshes drained, and its desolate parts reduced to order and vegetable beauty by the hand of art, and replenished with an industrious and enlightened population, there can be little doubt our seasons would be considerably meliorated, and many physical evils prevented with which we are now annoyed. And all this man has it in his power to accomplish provided he chooses to direct his wealth, and his physical, intellectual, and moral energies into this channel. We are highly favored, but we may to considerable extent improve our circumstances; and God always assists every effort that is made in the right direction.

The Moon.

The earth in its journey round the sun is attended by a secondary planet, or satellite, the moon. This globe may almost be considered as a part of the earth, for in its revolution round the sun it is not the earth's centre that travels along the orbit, but the centre of gravity of the earth and moon taken together. As the moon is our nearest neighbor in space, and exerts a greater influence on the earth than any of the other heavenly bodies, with the exception of the sun, it has at all times attracted a large share of attention. Its great apparent size and the phases it presents increase the interest. To the eye the moon appears very nearly as large as the sun. This, however, results entirely from its great proximity to us; it is in reality the smallest of the heavenly bodies which can be discerned by the naked eye. Although its apparent size is nearly equal to that of the sun, yet it would require more than 63 millions of globes of the size of the moon to form a globe equal in magnitude to the sun. The moon's distance from us is easily learned from its horizontal parallax, which is sufficiently great to be accurately measured. This varies in different parts of its orbit, but its mean value is about 57′, and thus the moon's distance is found to be 238,833 miles. We may here observe that the parallax of the moon or of any heavenly body is the difference in the apparent position of that body as viewed from two different stations on the earth's surface, which are the length of the earth's semi-diameter, about 4000 miles apart.*

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* In order that the general reader may understand what is meant by the diameter or semi-diameter of the earth forming the *base line* of those triangles by which the distances, etc., of the heavenly bodies are measured, we think it necessary to give the following explanation:

In any triangle, as A B C, if the length of the side A B be known, and likewise the quantity of the angles at A and B, or the number of degrees and minutes they subtend, be ascertained, we can find the length of the sides A C and B C. If A B represent a horizontal

This will be understood by reference to the subjoined figure and explanation at the bottom of the page. Knowing the moon's distance, and also the angle which its disc subtends to an observer, we easily ascertain its mean diameter to be 2,153 miles; its circumference 6,764 miles; and consequently its area 14,562,892 square miles. This body revolves in its orbit round the earth, and completes its circuit, reckoning from the time of its passing any star till its return to the same star, in 27 days, 7 hours, and 43 minutes, 11.5 seconds, which period is known as a *siderial* revolution. The more usual plan, however, of reckoning its period is by reckoning from the time of one full moon to the next. This period is the greater, the reason of the difference being that the moon is full, when it is in the part of the heavens diametrically opposite to the sun. Now, if the earth were stationary this would always happen in the same part of the sky; but as the earth is moving in its orbit round the sun, carrying the moon

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plane 100 feet in extent, and C B a tower whose height we wish to determine, and if with a quadrant we find the angle at A or C A B to be 44°, then by an easy process in trigonometry: Radius: is to the tangent of A, or 44° : : as the side A B. 100 feet: is to the height of the tower C B; which will give the answer.

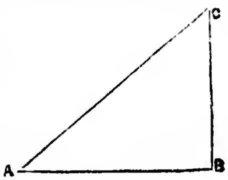


Fig. 108.

It is on this general principle that the distances and magnitudes of the celestial bodies are determined. But in all cases where we wish to ascertain the dimensions of the different parts of a triangle, the dimensions of at least one side must be given along with two angles; otherwise the length of the different sides of the triangle cannot be determined. Now, in measuring the distance of a heavenly body, such as the moon, the diameter or semi-diameter of the earth is the known side of the triangle by which such a distance is to be determined. In the annexed figure let E C, represent the earth; M the moon; and A B a portion of the starry sky. If a spectator at the earth's surface at E, view the moon in the horizon, he will see it in the line E M, among the stars at H. But if he view it from the centre of the earth at C, or from the surface at D, which will be the same in effect, he will see it in the line C D M, among the stars at S. The difference of position in which the moon is seen as viewed from the surface of the earth E, and the centre C, is called the moon's horizontal parallax, or the arc S H, which is subtended by the angle S M H, which is equal to the angle E M C. In determining the distance of the moon, therefore, we must first find by observation the horizontal parallax, or in other words the angle E M C: and the side E C, or the semi-diameter of the earth, being known to be about 4000 miles in extent, serves as the base line of the triangle E M C; and hence the other sides of the triangle E M, and C M, or the distance of the moon from the earth, can be found by an easy calculation.

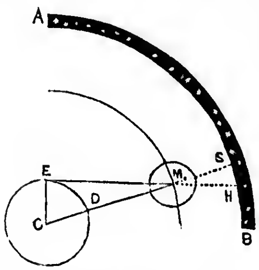


Fig. 109

From what has been now stated it will appear that it is of great importance that we have correctly ascertained the figure and magnitude of the earth; for if the length of the base line which we take in our trigonometrical calculations of the moon, or any other celestial body, be incorrectly stated, the whole calculation must be necessarily wrong, and the results false. In the foregoing explanation we have merely given the principle on which astronomers proceed in measuring the distance of the heavenly bodies, without entering into details.

with it,— by the time, therefore, that the moon has completed its circuit the earth has travelled round nearly one-thirteenth of its orbit, and the moon must overtake the earth by travelling so much farther, before it again comes opposite to the sun. This may be illustrated by the revolutions of the hour and minute hands of a watch or clock. Suppose the hour-hand to represent the sun, and a complete revolution of it to represent a year: suppose the minute hand to represent the moon, and its circuit round the dial plate a month, it is evident that the moon or minute-hand must go more than round the circle where it was last conjoined with the sun or hour-hand, before it can again overtake him. If, for example, they are in conjunction at 12 o'clock the minute-hand or moon must make a complete revolution, and above one-twelfth, before they can meet again at a little past 1; for the hour-hand, being in motion, can never be overtaken by the minute hand, at that point from which they started at their last conjunction. This surplus of motion occupies the moon 2 days, 5 hours, 0 minutes, 5½ seconds, which, added to the siderial, makes the *synodical* revolution, or the period between one new or full moon and another. The average length of this period is 29 days, 12 hours, 44 minutes, and 3 seconds. This interval is, therefore, termed a *lunar* month, and during it the moon passes in succession through all its phases. The sun always enlightens one half of the moon, and sometimes the whole of this enlightened side is turned toward the earth, when she appears a round luminous orb: but this happens only at one point of her orbit, namely, at full moon. At all other parts of her course only a portion of her enlightened side is

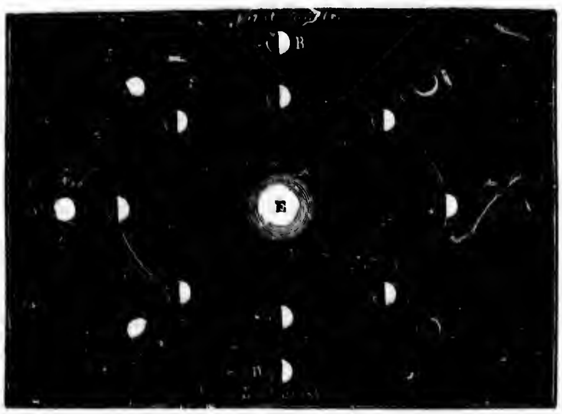


Fig. 110.

turned toward the earth; and in one particular part of her orbit, just before new moon, her enlightened side is altogether invisible At this part of her course she is invisible, both because she is in the same part of the heavens as the sun, and because the whole of her dark hemisphere is then turned toward the earth. After this it is generally two days or more before any of her enlightened surface is visible. About the third day after the *change*, that is, new moon, she is seen in the western sky at no great distance from the point at which the sun set, and then appears in the form of a slender crescent, having the horns pointed towards the east. The figure annexed will render this more clear. Here the sun must be considered as situated considerably to the right of the figure; consequently the illuminated part of the moon will always face that way. E represents the earth, and the moon is represented in eight different points of its orbit, the outer row of discs showing the appearance the moon presents to us when in each of these positions. When at A, her enlightened hemisphere being wholly turned toward the sun, the dark hemisphere is wholly turned toward the earth, and the moon is consequently wholly invisible. As it travels onwards in its orbit towards B, a small portion of its illuminated hemisphere comes into view, presenting the appearance of a slender crescent, having its horns pointed eastward, the sun being now to the west of her. At this time the greatest part of the moon may sometimes be faintly discerned by the naked eye. This is caused by the light which is reflected from the earth on the moon or the *Earth-shine*, as it is termed. A little consideration of the relative positions of the three bodies will show that at the time when the moon is *new* to us, the earth must appear *full* to the inhabitants of the moon; and it appears of a size thirteen times as large as the full moon does to us; for the hemisphere of our globe is thirteen times larger than that of the moon, and thus at this period the most powerful light will be reflected from the earth upon the moon. When the moon has arrived at B, she presents exactly one half her illuminated hemisphere to the earth, and this is called her *first quarter*. Still continuing her course she at length arrives at C, where the sun and the earth are on the same side of her, and accordingly the illuminated hemisphere is turned towards the earth, presenting the entire disc of the full moon. When now, the moon being at C, it is full moon to us, the dark side of the earth is wholly turned toward the moon, and the earth is consequently invisible to the inhabitants of the moon. When the moon is in the increase to us the earth is decreasing in its illuminated surface to the moon; and conversely, when the moon is in its decrease to us the earth is in its increase to the lunar inhabitants; so that the phases of the earth as seen from the moon are exactly opposite to the phases of the moon as seen from the earth. After passing C, the moon goes through the same series of changes, but in a reverse order; thus she presents, as first shown, a gibbous phase: at D, half her enlightened hemisphere is turned toward us, and it is called her *last quarter;* she then presents a slender crescent, having its horns pointed toward the west, the sun being now rather to the eastward of her; and she finally arrives at A, to go through the same series of changes again.

There is one remarkable circumstance in connection with the moon, which we shall see by-and-bye is not peculiar to her alone among the secondary planets; and that is, that the moon always presents the same side to the earth, so that we never see her opposite hemisphere. This proves that she turns round her circumference just once during her complete revolution round the earth. A great deal of fruitless controversy has frequently arisen upon the question as to whether the moon has an actual rotation or not. The fact that she always presents the one side to the earth is admitted by all. The only question is as to whether or not this motion can be called a rotation. A very little consideration will, however, make it clear that the moon does really rotate; for if the moon had no rotatory motion round her axis, we should see both her hemispheres in the course of every revolution she makes round the earth. This, we are aware, does not at first view appear obvious to those who have never directed their attention to the subject. Anyone, however, may convince himself of this fact by standing in the centre of a circle, and causing another person to carry round a terrestrial globe without turning it on its axis, when he will see every part of the surface of the globe in succession; and in order that one hemisphere only should be presented to his view, he will find that the globe will require to be gradually turned round its axis, so as to make a *complete* rotation in the time it is carried round the circle. The earth may in this case be considered a fixed station for observation, inasmuch as it turns round its circumference twenty-nine times during one rotation of the moon; and, therefore, the moon (its one hemisphere) is constantly seen by the inhabitants of the earth. Owing to the fact that the moon's axis is inclined 1° 31′ to the plane of its orbit, (the orbit itself being inclined to the ecliptic 5° 9′,) we occasionally see a little beyond its north pole, and then a similar distance beyond its south pole. Also we sometimes observe the spots on her eastern margin which were formerly visible on the western margin again withdraw themselves behind the limb, while the spots which became concealed behind the eastern margin again appear. These phenomena of the change of spots on the east and west limbs of the moon, as well as toward the north and south poles, sometimes occur for the space of about 3′ on the moon's disc, or about the eleventh part of her diameter. This is termed the *libration of the moon*; the one, north and south, her libration in latitude; the other, her libration in longitude.

The moon's orbit is, as we have stated, inclined to the ecliptic at an angle of 5° 9′; so that in one part of her course that luminary is above, and in another below the level of the earth's orbit. It is owing to this circumstance that our satellite is not eclipsed at every full moon, and the sun at every new moon, which would regularly occur did the moon move in an orbit exactly coincident with the plane of the ecliptic. The moon's orbit, of course, crosses the orbit of the earth in two opposite points called her nodes; and it is only when the new or full moon happens at or near these nodes that an eclipse of the sun or moon can take place; for it is only when she is in such a position that the sun, the moon, and the earth, are nearly in a straight line, and that the shadow of the one can fall upon the other. The shadow of the moon falling upon any part of the earth causes an eclipse of the sun; and the shadow of the earth falling upon the moon causes an eclipse of the moon. An eclipse of the moon can only take place at *full moon*, when the earth is between the sun and the moon; and an eclipse of the sun can only occur at *new moon*, when the moon comes between the sun and the earth. Lunar eclipses are visible at all places of the earth which have the moon above their horizon, and are everywhere of the same magnitude and duration; but a solar eclipse is never seen throughout the whole hemisphere of the earth where the sun is visible; as the moon's disc is too small to hide the whole or any part of the sun from the whole disc or hemisphere of the earth. Nor does an eclipse of the sun appear the same in all parts of the earth where it is visible, but when at one place it is total at another it is only partial.

The moon's orbit, like those of the planets, is an ellipse whose eccentricity is 12,960 miles, or the 1–37th part of its major axis. The moon is therefore at different distances from the earth in different parts of her orbit. When at her greatest distance from the earth she is said to be in her *apogee*; when at her least distance in her *perigee*. The nearer the moon is to the periods of full or change, the greater is her velocity: and the nearer to the quadratures or the periods of half-moon, the slower she moves. When the earth is in her *perihelion*, or nearest the sun, the moon's periodical time is the greatest. The earth is at its perihelion in winter, and consequently at this time the moon will describe the largest circles about the earth, and her periodical time will be the longest; but when the earth is in its aphelion, or farthest from the sun, which happens in summer, she will describe a smaller circle, and her periodical time will be the least; all which circumstances are found to agree with observation. These and many other circumstances which our space does not allow us to particularize, arise from the attractive influence of the sun upon the moon in different circumstances and in different parts of its course, so as to produce different degrees of accellerated and retarded motion.

The peculiarities of the moon's motions have much and frequently puzzled astronomers and mathematicians, and they render the calculation of her true place in the heavens a considerably difficult task. No less than thirty equations require to be applied to the mean longitude in order to obtain the true, and about twenty-four equations for the obtain-ment of her latitude and parallax. These problems have, however, been solved, and the moon's motions are now fully understood.

The moon's principal motion is, as has been explained, one of revolution round the earth; but the earth is at the same time pursuing her journey round the sun; and thus the combination of these two motions causes it to describe a path, which is in reality a succession of curves. If a pencil were attached to one of the spokes of a wheel, and made to trace a line on a piece of paper, as the wheel travelled onwards we should obtain a rough but somewhat true representation of this path. In her motion round the earth every month the moon pursues her course at the rate of 2,300 miles an hour, but she moves at the same time with the earth in her course round the sun, so that her real motion in space is much more rapid than what has now been stated—perhaps not less than 70,000 miles an hour—for while she accompanies the earth in her annual motion, which is at an average rate of 68,000 miles an hour, she also moves thirteen times round the earth in the same period, which is equal to a course of nearly twenty millions of miles.

By means of a good telescope a considerably distinct view may be obtained of the moon. A power of 1,000 brings us, as it were, within 239 miles of its surface, and on very favorable occasions a power even higher than this has been applied; but though a power of 2000 times could be used with distinctness it would make the moon appear no nearer to us than 120 miles, at which distance a living being, though a hundred feet high, could not be seen; for with such a power a space on the moon's surface of 183 feet in diameter could only be perceived as the smallest visible

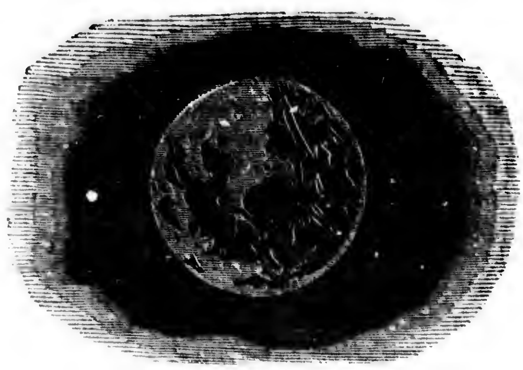


Fig. 111.

point. This perhaps is the reason why no trace of lunar inhabitants has as yet been discovered. Beside, we ought to consider that when we view objects on the moon's surface, we do not view them in perspective, as we do objects on the surface of the earth, but only obtain a bird's-eye view of them, as we do of objects on the earth's surface, which we view from a balloon elevated in the atmosphere; in which case, when we look down upon groups of human beings we see only the tops of their heads and their shoulders.

Dr. Olbers, a celebrated German astronomer, was fully of opinion from observations he had made "that the moon is inhabited by rational creatures, and that its surface is more or less covered with a vegetation not very dissimilar to that of our earth." Even to the naked eye the moon presents the appearance of an uneven and rugged surface; and telescopic observations confirm this impression. On many parts of its surface high mountains are seen to exist, and the altitudes of many of these have been approximately measured by observing the shadows cast by them when the sun shines obliquely. One peak, named Newton, is found to have an elevation of nearly 24,000 feet, and several others are very lofty. The elevated summits of these lunar mountains catch and reflect the rays of the sun long before the plains around them, and shine out brilliantly against the dark ground. The most remarkable characteristic feature, however, of the lunar surface, is the number of ring craters which exist on its surface. These resemble huge volcanic craters. In some a spacious plain somewhat circular in shape is surrounded by a lofty and rugged mountain-ridge, which almost or quite encloses it. Not unfrequently a solitary peak stands erect in the middle of this enclosed plain, attaining nearly the same height as the surrounding mountain-ridge; in other cases the interior is so extensive that mountain chains run across it. The number of these cavities, especially in the southern hemisphere of the moon, is very great; and some of them are of such a size as to be aptly designated "walled-plains." Even with the most powerful telescope the more minute features of these mountain ranges are unable to be distinguished thus far; the appearance of many of them, however, seems to indicate most strongly the violent action of volcanic forces; and shows that in past time great convulsions of nature have taken place there.

Fig. 112.

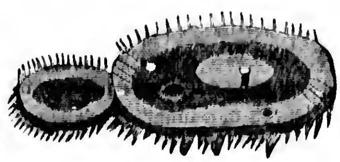


Fig. 113.

Fig. 111 is a telescopic view of the moon. Fig. 112 is a view of the brilliant spot called Aristarchus, which is situated in the north-east quadrant of the moon's surface, where the shadows of some of the circular cavities, and also the shadows of the mountains may be perceived. Fig. 113 is the spot called Hevelius, which contains an annular cavity and a broken elevation, somewhat resembling an egg. Fig. 114 represents a cavity,

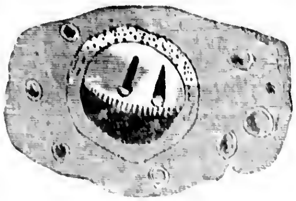


Fig. 114.

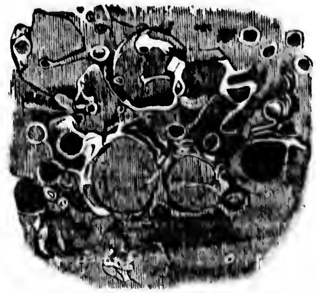


Fig. 115.

surrounded by a circular range of mountains, with two central mountains in the middle of the plain, in which the shadows of one side of the circular range and of the central mountains may be seen. Fig. 115 shows another magnified portion of the moon's disc, exhibiting several circular plains, cavities, and other varieties of the lunar surface.

The telescope also brings to view many level plains on the moon's surface, which were formerly thought to be lunar seas, and which still retain the names that were then given them, though it now appears evident that they are merely dry plains. The Ocean of Storms, the Sea of Clouds, and the Bay of Rainbows are some of these spots. Some astronomers now express the opinion that no water exists on the side of the moon that is turned towards the earth, however it may be as to its existence on the other hemisphere. Some indeed have supposed that its centre of gravity is nearer to the other side, and that hence all the air and water are accumulated there; but this is merely conjecture.

The best time for making observations on the moon is at the time of the quadratures, as at the time of full moon the shadows of the mountains and peaks, which are hitherto conspicuous, disappear, the sun shining upon them vertically. Accurate maps have ere now been drawn of the moon's surface on a large scale, and the principal mountains have received names, usually those of celebrated astronomers.

The following additional particulars respecting the moon may be stated. 1. The length of a lunar day is equal to nearly fifteen of our days, and the length of the night the same, so that a day and night in the moon equal twenty-nine and a half of our days and nights, or one lunar month. On the hemisphere facing the earth there is moonlight, *earthshine*, nearly all the time the sun is absent; but in the other hemisphere in the absence of the sun there is no light but what proceeds from the stars and planets. Were a lunarian to keep travelling at the rate of ten miles an hour, in a direction at right angles to the moon's axis, he might keep pace with the moon's rotation, and be enabled to live in perpetual sunshine. 2. The light of the moon has been computed to be 300,000 times less intense than that of the sun when shining in an unclouded sky; yet its utility is considerable; and when the full moon shines in its splendor it sheds a cheerful though mild radiance over the surrounding landscape. 3. The moon is, according to the opinion of most astronomers, surrounded by an atmosphere, but it is a very limited one, and of great tenuity, and no clouds or vapors appear to exist in it. It is stated as having been distinctly perceived during the annular eclipse of 1836, when just before the edges of the two bodies met, the light of the sun was seen to shoot through the moon's atmosphere, mollified into twilight. Schroter calculated its height at 5742 feet. They also gave it as their opinion that the moon is replenished with inhabitants; for although seas, and rivers, and a dense atmosphere are not found connected with the lunar orb, and some other of its peculiarities are different from those of the earth, yet these circumstances form no valid objection to its being inhabited with a race of sentient and intelligent beings peculiar to itself, and adapted to their habitation. If telescopes of sufficient powers were in use to disclose to us the particulars as to the surface of the moon, there would, doubtless, be found water existing there, and a race of beings perhaps not very dissimilar to mankind, whose thoughts may sometimes be directed to the glorious orb of the earth in the way of adoration.

Appearance of the Heavens as viewed from the Moon.

Although the moon is the nearest body to the earth, and its constant companion, yet its celestial scenery is in a variety of aspects different from ours. The earth appears the most splendid orb in its nocturnal sky, and its various phases and relative positions form, doubtless, an interesting subject of enquiry and contemplation to its inhabitants. It appears in the lunar sky thirteen times larger than the moon does to us, and sheds nearly a corresponding portion of light on the mountains and vales of the lunar surface. As the moon always presents nearly the same side to our view, so the earth is visible from only one half of the lunar surface. The inhabitants of the opposite side of the moon, which is never turned toward the earth, will never see the earth in the sky unless they perform a journey to the opposite hemisphere; and those who dwell near the central parts of that hemisphere, which is turned from our globe, will require to travel more than 1500 miles before they can behold the large globe of the earth in the sky. To all those to whom the earth is visible it appears fixed and immoveable in the same relative point of the sky; or, at least, does not appear to have any circular motion round the heavens. To a spectator situated in the middle of the moon's hemisphere visible from the earth, the earth appears directly in the zenith, or overhead, and always appears fixed very nearly in the same position. To a spectator placed in the extreme parts of that hemisphere, or what seem to us to be the margins of the moon, the earth appears always nearly in the horizon; and to spectators in intermediate positions the earth appears at a higher or lower elevation above the horizon, according to their distance from the extreme or central parts of that hemisphere. But though the earth appears fixed nearly in the same part of the sky the slight variation of the moon, called the libration, causes the earth now and then to appear to shift its position a little by a kind of vibratory motion, so that those at the margins of the hemisphere who see the earth in the horizon sometimes see it dip a little below, and at other times rise a little above, their horizon. This vibratory motion they are probauly disposed at first view to attribute to the earth, which they will naturally consider as a body nearly at rest, but subject to a slight vibratory motion; whereas this apparent vibration proceeds from the actual vibration of the moon itself.

Although the earth seems fixed in nearly the same position, its rotation round its axis is distinctly perceptible, and presents a variety of different appearances. Europe, Asia, Africa, and America present themselves one after another in different shapes nearly as they are represented on our terrestrial globes; and our polar regions, which we have never yet been able to explore, are distinctly seen by the lunarians, who will be enabled to determine whether they chiefly consist of land or water. When the Pacific Ocean, which occupies nearly half the globe, is presented to view, the great body of the earth assumes a dusky or sombre aspect, except toward the north, the north-east, and north-west: and the islands dispersed through this ocean will exhibit the appearance of small lucid spots on a darkish ground. But when the eastern continent turns round to view, especially its northern regions, the earth appears to shine with a greater degree of lustre. These appearances are diversified by the numerous strata of clouds, which are continually wafted by the winds over the different regions of the earth; and must occasionally intercept their view of certain parts of the continents and seas, or render their appearance more obscure at one time than at another.

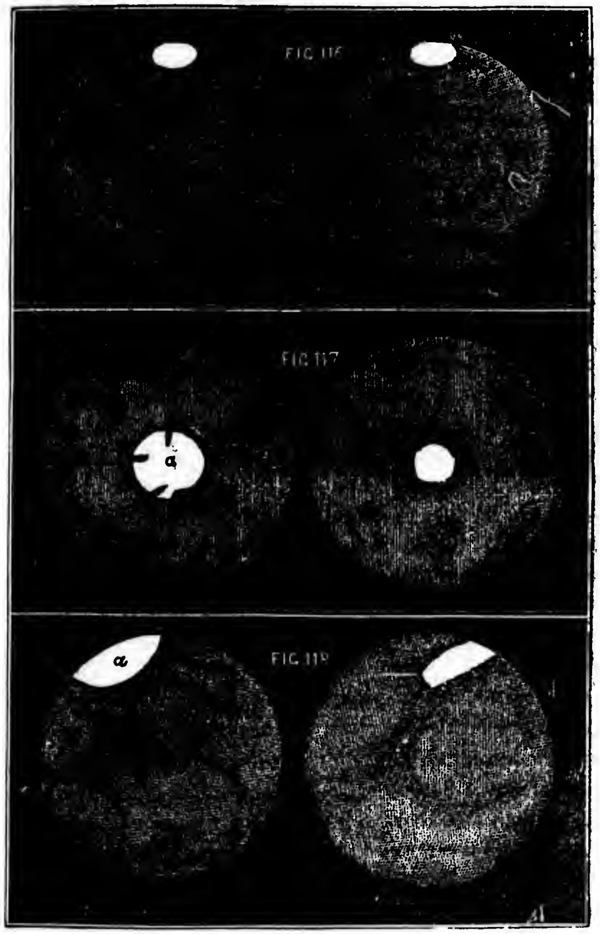
The apparent diurnal motions of the sun, the planets, and the stars appear much slower and somewhat different in several respects from what they do to us. When the sun rises in their eastern horizon, his progress is so slow that it requires more than seven of our days to come to the meridian, and the same time before he has descended to the western horizon: for the days and nights on the moon, as before remarked, are nearly fifteen days each, and they are nearly of an equal length on all parts of its surface, as its axis is nearly perpendicular to the ecliptic, and consequently the sun never removes to any great distance from the equator. During the day the earth appears like a faint, cloudy orb, always in the same position; and during the night the stars and planets are visible without interruption for fifteen days, and are seen moving gradually during that time from the eastern to the western horizon. Though the earth will always be seen in the same point of the sky both by day and night, yet it will appear to be constantly shifting its position with respect to the planets and the stars, which will appear to be regularly moving from the east to the west of it; and some of them will occasionally be hidden or suffer an occultation for three or four hours behind its body. The sun, planets, and fixed stars will appear of the same apparent magnitude as they do from the earth; but as the poles of the moon are directed to points of the heavens different from those to which the poles of the earth are directed, the pole-stars in the lunar firmament, and the stars which mark its equator and parallels, are all different from ours; so that the stars in their apparent diurnal revolutions will appear to describe circles different from those which they appear to describe in our sky. The inferior planets, Mercury and Venus, will generally be seen in the vicinity of the sun as they are seen from the earth; but they will be more distinctly perceived, and are visible for a much longer time, after sunset, than they are from our globe. This is owing, first, to the transparency of the lunar atmosphere, and to the absence of dense vapors near the horizon, which in our case prevent any distinct observations of the heavenly bodies, when at a low altitude; and, secondly, to the slow apparent diurnal revolution of Mercury and Venus. The superior planets, which we are about to consider, will, as with us, be seen in different parts of the heavens, and occasionally in opposition to the sun; but they appear to be continually shifting their positions in relation to the earth, and in the course of fifteen days are seen in the very opposite quarter of the heavens, and in other fifteen days are again seen in conjunction with the earth; and nearly the same appearances are observed in reference to the inferior planets, but the periodic times of their conjunctions with the earth, and their oppositions to it, are somewhat different, owing to the difference of their velocities in their annual revolutions.

The eclipses of the sun which happen to the lunar people are more striking, and total darkness is of much longer continuance than with us. When a total eclipse of the moon happens to us there is a total eclipse of the sun to the lunarians. At that time the dark side of the earth is completely turned toward the moon, and the sun is seen to pass gradually behind the earth until it entirely disappears. The time of the continuance of total darkness in central eclipses is nearly two hours; and, of course, a total eclipse of the sun must be a far more striking and impressive phenomena to the inhabitants of the moon than to us. A complete darkness ensues immediately after the body of the sun is hidden, and the stars and planets appear as at midnight. When a partial eclipse of the moon happens to us, all that portion of the moon's surface, over which the earth's shadow passes, suffers a total eclipse of the sun during the time of its continuance. On the other parts of the moon's surface there is a partial eclipse of the sun; and to those who are beyond the range of the earth's shadow no eclipse appears. When an eclipse of the sun happens to us the lunarians see a dark spot, with a penumbra or fainter shades around it, moving across the disc of the earth, which then appears a full enlightened hemisphere, excepting the part that is obscured by the progress of the shadow. The inhabitants of the other hemisphere of the moon can never experience a solar eclipse, as the earth can never interpose between the sun and any part of that hemisphere; so that they will only know of such phenomena by report, unless they perform a journey for the purpose of observing. The length of the lunar year is about the same as ours, but different as to the number of days, the lunar year having only 12$\frac{7}{10}$ days, each day and night being as long as 29½ of ours; the length of their year, however, will be considerably difficult for the lunarians to determine. The study of the heavens in the moon is more difficult and complex than with us on the earth. The phenomena exhibited by the earth is doubtless the most difficult for the lunar people to understand. They will be apt to imagine, at first view, that the earth is a quiescent body in their firmament, because it appears continually in the same point of the sky, and that the other heavenly orbs all revolve around it. On the other hand they enjoy some advantages in making celestial observations which we do not possess. Those living on the side next the earth, will be enabled to determine the *longitude* of places on the lunar surface with as great facility as we find the *latitude* of places on our globe. For, as the earth keeps constantly over one meridian of the moon, or very nearly so, the east and west distances of places from that meridian may be readily found, by taking the altitude of the earth above their horizon, or its distance from the zenith, on the same principle as we obtain the latitude of a place by taking the altitude of the pole-star, or the height of the equator above the horizon. The lunar astronomers likewise possess a singular advantage over our terrestrial astronomers in the length of their nights, which gives them an opportunity of contemplating the heavenly bodies, especially Mercury and Venus, and tracing their motions and aspects for a long time without intermission. Such are some of the celestial phenomena as seen from the moon. However different these phenomena may appear from those which we are accustomed to behold in our terrestrial firmament, they are all owing to the following circumstances: *that* the moon moves round the earth as the more immediate centre of its motions; *that* it always turns the same side to the earth. These slight differences in the motions and relative positions of the earth and moon are the principal causes of all the peculiar aspects of the lunar firmament. But we shall see, as we proceed, that there is an indefinite variety of celestial scenery throughout the universe, so that no one world, or system of worlds, presents the same scenery and phenomena as another.

THE PLANET MARS.

We now pass on to notice the superior planets, that is, those whose orbits lie without that of the earth, concerning the nearer of which our information is more complete than it is about the inferior planets, as the latter are usually too much hidden by the brightness of the sun's rays to be distinctly observed. But the superior planets, since their orbits are outside that of the earth, are at times in opposition to the sun; at this period too they are in perigee, that is, at their least distance from the earth, and are, therefore, in all respects most favorably situated for observation. The nearest of these bodies to us is Mars, a name which was given by the ancients to this planet, and signifying the "God of War," which appellation appears to have been given the planet on account of its ruddy or fiery appearance, and because the astrologers believed it to be a promoter of war and bloodshed. The diameter of this planet is 4,920 miles; its circumference 15,456 miles; and consequently its superficial area about 76,043,520 square miles, so that it ranks as one of the smaller planets of our system, its bulk being about one-eighth that of the earth. It revolves round the sun at a mean distance of 139,312,000 miles in an orbit of considerable eccentricity, the difference between its greatest and least distance being about 26,000,000 miles. When the planet is in opposition, both it and the earth are on the same side of the sun, and the distance between them then is about 48,000,000 miles. At this time the planet shines with a brilliancy almost rivalling that of Jupiter or Venus; this happens once in two years and fifty days, its *synodic* period being 780 days. When it happens to be in its perihelion at the same time its brilancy is still greater, and consequently this is the most favorable opportunity for telescopic observations upon it. It accomplishes its *periodical* revolution round the sun in 687 days, or about one year and ten months, which is at the rate of about 54,000 miles an hour; but as the Martian day is a little longer than ours there will not be quite this number of days in his year. But before it can return to the same relative position in regard to the earth and sun, or, in other words, from one opposition to another, it occupies a period of 780 days, that is two years and fifty days, as above stated.

When examined at this period with a powerful telescope, Mars is found to exhibit an appearance similar to that which the earth would probably present to the inhabitants of that planet. The surface is diversified with dark portions which represent water, and lighter parts which are the continents. These markings are found to vary a little at times, probably owing to the presence of large masses of clouds in the planet's atmosphere; the main features are, however, sufficiently prominent to enable maps to be constructed showing the configuration of its surface. The annexed figures give a general idea of the appearance of the planet when seen through a large telescope. When its atmosphere is clear the land appears to be of a ruddy hue, while the water is somewhat greenish. Figure 116



Figs. 116, 117, and 118.

represents the southern and northern hemispheres of the planet as drawn by Messrs. Beer and Mädler, who devoted many years to the examination of Mars; Figure 117 is taken from the observations of Secchi, the eminent Roman observer, at the opposition of 1858. The following are the results of Sir John Herschell's observations on this planet made with a powerful reflecting telescope. He states that on account of the clearness of its atmosphere he has been enabled to observe with perfect distinctness the outlines of continents and oceans; that the land on its surface is distinguished by a red hue, which imparts to the planet the ruddy appearance it has when viewed with ordinary telescopes, and which its light exhibits to the naked eye. This redness he ascribes to a quality in the prevailing soil like that which our red-sandstone districts would exhibit to an observer contemplating the earth from the surface of Mars. The seas of this planet, he observes, have a greenish hue, altogether resembling the color of our own. These, spots, however, are not always to be seen equally distinct, because of the varying transparency of the atmosphere ; but when they are distinctly seen they always present the same appearance. Astronomers conclude that this planet is surrounded with an atmosphere of considerable extent, in which clouds at times exist; that the darker spots are water or seas which reflect a much less proportion of the solar light than land, and probably cover about one-third of its surface; that a variety of seasons somewhat similar to ours are experienced on this planet, but of a much longer duration; and that it bears a more striking resemblance to the world in which we dwell than any other planet in the solar system. It was owing to observations taken on this planet by Tycho Brahe having fallen into the hands of Kepler, that the three great laws of planetary motion, commonly termed "Kepler's laws," were discovered. These laws we shall have occasion to notice hereafter. The period of this planet's rotation round its axis has been ascertained to be 24 hours, 37 minutes, 23 seconds. The inclination of its axis to the plane of its orbit is 28° 51′, or a little greater than that of the earth. This is a reason why its seasons should resemble ours to a considerable extent. No moon has as yet been discovered accompanying Mars.

The Scenery of the Heavens as viewed from Mars.

From this planet the earth will at certain periods be distinctly seen, but it presents a different aspect, both in its general appearance and its apparent motions, from what it does to the inhabitants of Mercury or Venus. To Mars the earth is an inferior planet, whose orbit is within the orbit of Mars. It will, therefore, be seen only as a morning and an evening star, as Venus appears to us ; but with a less degree of magnitude and brilliancy, since Mars is at a greater distance from the earth than the latter is from Venus. It will present to Mars successively the form of a *crescent*, a *half-moon*, and a gibbous phase, but will seldom or never be seen as a full enlightened hemisphere, on account of its proximity to the sun, when its enlightened surface is fully turned toward the planet ; nor does it ever appear further removed from the sun, either in the mornings or evenings, than 48°, which is the greatest elongation also of Venus as she appears to the earth, so that the earth never appears in the firmament of Mars about midnight. The earth will likewise be sometimes seen to pass across the sun's disc like a round black spot, as Mercury and Venus at certain periods appear to us ; but the planet Mercury will never be seen from Mars, on account of his smallness and nearness to the sun ; for at its greatest elongation it can appear only a few degrees from the sun's margin, and is consequently immersed in his rays. The only time when it might happen to be detected is when it makes a transit across the sun's disc. Venus will be as seldom seen by the inhabitants of Mars as Mercury is by us. Our moon may likewise be seen from Mars as a small star accompanying the earth, but never at a greater distance from each other than fifteen minutes of a degree, or about half the apparent breadth of the moon ; and with telescopes such as we have all its phases and eclipses may be distinctly perceived. The planets Jupiter and Saturn will appear to Mars nearly as they do to us. At the time of Jupiter's opposition to the sun that planet will appear a slight degree larger, as Mars is then 50,000,000 miles nearer it than we are ; but Saturn will not appear sensibly larger than to us ; and it is likely that the largest of the minor planets and the planet Uranus are not more distinguishable than they are from our globe. The point *Aries* on the ecliptic of Mars, one of the points where its ecliptic and equator intersect each other, corresponds to 19° 28′ of our sign *Sagitarius*. In consequence of this the poles of Mars are directed to points of the heavens considerably different from our polar points, and its equator passes through a different series of stars from that which marks our equator, which will cause the different stars and constellations, in their apparent diurnal revolutions, to present a different aspect from what they do in their apparent movements round our globe.

The Minor Planets or Asteroids.

In the year 1778 Professor Bode, of Berlin, published a very remarkable law, relating to the distances of the planets from the sun, which, though it is said to have been discovered by Titius, is known as " Bode's Law." It was at first merely a bold conjecture, but has since attracted much attention, as it partly led to the discovery of the first of the minor planets or asteroids. Since, however, the dicovery of the last planet, Neptune, it has again fallen to the level of a conjecture. He observed that if we take the numbers 0 3 6 12 24 48 96, each of which, after the second, is double that which precedes it, and add the number 4 to each of them we obtain the following list, which represents approximately the proportional distance of the planets named under them : $\overset{4}{\text{Mercury}}$, $\overset{7}{\text{Venus}}$, $\overset{10}{\text{Earth}}$, $\overset{16}{\text{Mars}}$, $\overset{28}{\text{——}}$ $\overset{52}{\text{Jupiter}}$, $\overset{100}{\text{Saturn}}$. Thus, if we take 10 to represent the distance of the earth, we shall find that 4 represents that of Mercury, 7 that of Venus, and so on. No planet was, however, known to occupy the space intervening between Mars and Jupiter, corresponding to the number 28. There was thus a gap left in the system, and Bode stated his conviction that as the sky was more carefully watched, and better telescopes were employed, such a body would be discovered. Nor was his prediction long unfulfilled, for in the year 1800 six astronomers agreed to establish an association, of twenty-four observers, who should divide the zodiac between them, each taking fifteen degrees, and should search for the supposed planet. This plan soon succeeded, for on January 1st, 1801, Piazzi, an Italian astronomer, discovered a moving body which he at first supposed to be a a comet, but which soon proved to be a planet afterward named Ceres, whose position corresponded very nearly with that pointed out by Bode's law. When this fact became generally known the search was discontinued, as the system appeared now to be complete. In the course of the following year, however, Dr. Olbers discovered a second planet revolving almost in the same period, and at almost the same distance as Ceres. This planet was named Pallas, and its discovery excited great attention among astronomers, such a thing having hitherto been quite unsuspected, as that there should be two planets revolving at almost the same distance from the sun. After some time Olbers ventured a conjecture that these two planets might be the remains of a single one that had by some means become shattered, and suggested that in this case other fragments might probably be discovered. The search was accordingly renewed, and two planets, which they respectively called Juno and Vesta, were discovered in 1804 and 1807. For many years no more were found; accordingly it was believed that all had been discovered, and that these four, Ceres, Pallas, Juno and Vesta, were the four fragments of a large planet, which had once revolved in an orbit nearly resembling theirs.

At the end of the year 1845, the discovery of a new asteroid was announced by Hencke, and again drew the attention of astronomers to the subject. Many more observers now undertook the task of trying to discover some more of those small bodies; and since that time few years have passed without some fresh names of planets being added to the list, which at present contains more than 100, all of whose orbits are situated in the space between Mars and Jupiter. These generally do not present a well-defined disc in the telescope as the larger planets do, but appear like minute stars of about the twelfth magnitude, so that the only way of observing them is by accurately noting down all the stars visible in a given small portion of the heavens, and then carefully watching on successive evenings to ascertain if any of these appear to have changed their positions, or if any fresh points appear among them. Three only of these planets, it is said, have been seen by the naked eye, namely Vesta, Ceres, and Pallas, and it is only under very favorable circumstances that they can be seen. Nothing definite is yet given us as to the dimensions of these small planets, those mentioned as seen by the naked eye being accounted the largest. Their distances from the sun vary considerably. Flora, the nearest of them, being estimated to have a mean distance of 200,000,000 miles, while the farthest is reckoned as distant about 313,000,000 miles. Their times of revolution are also found to be very different, the two planets just named taking respectively 3,266 and 6,413 years to complete their revolutions.

Owing to their small size and great distances very little is known as to the nature or character of these small planets; traces of an atmosphere have, however, been discovered round some of them, that surrounding Pallas appearing to have great density.

The theory of Olbers as to these small planets being fragments of a large planet which had been shattered by the action of some internal force was adopted by some; while others held that they might have resulted from a planet having been shattered by collision with a comet; both of which theories to account for the existence of planets, which are found to be so widely separated from each other, and to revolve round the sun in such widely different periods in their respective orbits, seem as unreasonable as they are groundless. The discovery of so many should, however, be sufficient to incite astronomers to continue their researches for many others which yet remain undiscovered in our system.

The Heavens as seen from the Minor Planets.

To some of these planets, revolving as they do at nearly the same mean distance from the sun, the appearance of the heavens will be very similar. The planet Jupiter will be the most conspicuous object in the firmament of them all, and will appear to most of them at least of three or four times the size and splendor he does to us, so as to exhibit the appearance of a small brilliant moon. Saturn will appear somewhat larger and brighter than to us, but the difference in his appearance will be inconsiderable: nor will Uranus be more distinctly visible than from the earth. At other times, as when near their conjunction with the sun, these planets will appear smaller than to us. Mars will sometimes appear as a morning and an evening star, but he will always appear in the immediate neighborhood of the sun, and will present a surface much less in apparent size than he does to the earth. The earth will rarely be seen on account of its proximity to the sun; and Venus and Mercury will be altogether invisible in all of them unless they may happen to be seen when transiting the solar disc. It is likely that at certain times most or all of these planets will exhibit an uncommon, and occasionally a brilliant, appearance in the firmament of each other. In their revolutions round the sun they may in parts of their orbits approach each other so as to be many times nearer each other in one part of their orbits than in another. These different positions in which they may be placed in relation to each other will doubtless produce a great variety in the appearances they present in their respective firmaments; so that at one time they may present in the visible firmament a surface a hundred or even two hundred times greater than they do in other parts of their orbits. It is probable, therefore, that the diversified aspects of these planets in respect to each other will form the most striking phenomena which diversify their nocturnal heavens. In consequence of the great eccentricity of the orbit of some of them, as Pallas, the sun will appear much larger to them in one part of their course than it does in another.

THE PLANET JUPITER.

Beyond this group of small planets which we have been considering lies the planet Jupiter, the largest known body connected with our system, the sun only excepted. The dimensions of the diameter of this planet are given variously, but, taking the smallest amount we find for his equatorial diameter, this is 85,390 miles, or more than ten times as great as that of the earth. Its circumference, therefore, is 268,261 miles; and its superficial area 22,906,806,790 square miles, about 117 times that of the earth. And as globes are to each other as the cubes of their diameters, and the cube of Jupiter's diameter is 622,617,094,819,000 miles; and the cube of the earth's diameter is 495,476,997,497, dividing the former by the latter the quotient is 1257 nearly, which shows that Jupiter as a solid globe is nearly twelve hundred and fifty-seven times larger than the earth. Conceive for yourself a superficial area, one hundred and seventeen times larger than that of our terraqueous globe; and of twelve hundred and fifty-seven globes of the size of the earth having to be rolled into one in order to make one of the size of Jupiter; its mass as compared with the sun's is estimated as 1 to 160,709.* The mean distance of this planet from the sun is 475,693,000 miles; consequently from the earth 380,693,000 miles; and it performs its orbitual journey round the sun in 4332.58 days, or a few weeks less than twelve of our years. It moves in its orbit at the rate of 29,000 miles an hour, a rate of speed considerably less than half that of the earth. We always find, however, that the farther the planets are removed from the sun, the less is the rate of speed at which they move, and conversely. The axis of this planet being nearly perpendicular to the plane of its orbit, it cannot have the same variety of seasons as the earth and Mars. Its inclination is, however, 3° 5′, which will produce a slight change of seasons both in the polar and equatorial regions. Had the axis

* The proportion of the circumference of a circle to its diameter is nearly as 22 to 7,—more accurately as 3.1416 to 1. Therefore if we multiply the circumference by 7, and divide the product by 22, we obtain the diameter nearly. And by multiplying the diameter by 22, and dividing the product by 7, we obtain the circumference. But we obtain the result more accurately by multiplying the diameter by 3.1416 in order to obtain the circumference; and by dividing the circumference by 3.1416 in order to obtain the diameter. And we obtain the superficial area, nearly, by multiplying the square of the diameter by 3,1416: and the solid contents, nearly, by cubing the diameter.

been as much inclined to the orbit as the earth's axis is, the polar regions would respectively have been deprived of the light of the sun for nearly six years without interruption, or one half of the year of Jupiter. A year on Jupiter corresponds nearly to a month with us. The plane of Jupiter's orbit is inclined very slightly to the plane of the ecliptic, or earth's orbit, and hence it is difficult to determine the exact point at which they intersect, and to ascertain in the usual way the length of its year. This, however, is readily overcome by ascertaining its synodic period, or the time which intervenes from one opposition of the planet to another, and calculating from this its siderial period.

When Jupiter is examined by means of a good telescope the most remarkable feature which strikes the observer is the number of almost parallel belts which characterize its surface, which may be slightly perceived in the accompanying view of the planet. Sometimes frequent and rapid changes take place in the number and appearance of these belts; at other periods, they remain long almost unchanged. It has been a subject of much speculation among astronomers as to the views which should be entertained respecting the nature of these belts, and the causes which operate in producing the changes which frequently take place among them. Whatever opinion may be entertained on this point, it is pretty evident that the dark stripes, or belts, are the real body of the planet, and the bright spaces between them, or scattered among them, are clouds in its atmosphere, or cloudy zones, liable to variation, which surround the body of the planet at a certain distance from its surface. Distinct markings or spots are sometimes visible on these belts, and remain constant sufficiently long to enable the time which the planet takes in rotation on its axis to be ascertained, which, as a result of many observations, has been determined to be 9 hours 55½ minutes. This is, as will be observed, less than half the time occupied by the earth, or any other of the planets, we have yet considered in their diurnal rotation, and is the more remarkable when we consider the vast size of Jupiter. The equatorial regions of the surface of this planet must thus move about 460 miles a minute, while the speed of the corresponding portions of the earth is only about 17 miles in the same time.


Fig. 119.

By observing the attractive influence of the planets on each other, astronomers are enabled to calculate approximately their respective densities; and thus they find the density of Jupiter to be less than a quarter that of the earth, or in other words that Jupiter, taken bulk for bulk, weighs less than a quarter as much as the earth does. The density of the earth is estimated at 5½ times that of water. Jupiter, therefore, has a density a little greater than water. Future observations may, however, give somewhat different results as to the time of axial rotation and the density of this planet. The intensity of the solar light on Jupiter is 27 times less than on the earth; this, however, will produce a large degree of illumination, if that planet has an atmosphere and surface anything like ours, to reflect the light. An observer situated on Jupiter would have no suspicion that such a globe as the earth has an existence in the universe; all its fancied grandeur and its proud inhabitants are as much unnoticed and unknown there, as is the smallest animalcule in the drop of water by the unaided eye.

The telescope also discloses to us the fact that Jupiter is accompanied by four satellites, or moons. Three of these were discovered by Galileo on January 7th, 1610, when he first directed his newly-invented telescope toward the planet; and the fourth a few evenings later. A comparatively low power, such as that afforded by an ordinary opera-glass, suffices to show them all distinctly. Three of these satellites revolve round Jupiter in orbits which are almost circular, and very slightly inclined to the plane of the planet's equator. Owing to this circumstance the three nearer ones to the planet are eclipsed every revolution, and the outer one in nearly every revolution, so that the phenomena of eclipses are far from rare to the inhabitants of Jupiter, there being about 4,500 lunar eclipses in one Jovian year, about twelve of our years. It has been deduced from the observations of Sir W. Herschell and others that the moons of Jupiter always present the same side toward the planet, and make one rotation on their axis during one revolution round their primary, which corresponds with what we find in the case of our moon, which, as before shown, always presents the same hemisphere toward the earth, and makes one rotation on its axis while making one revolution round the earth. The eclipses and transits of these bodies are very interesting phenomena, and may be easily observed with an ordinary telescope. A full list of these is given in the "Nautical Almanac" for each year, and scarcely a day passes without some of them being observed. They are frequently used in determining the longitude of any station of observation at sea. When any of the satellites passes between the earth and the planet, it is seen in transit as a bright spot on its face; its shadow is also seen as a dark spot at a little distance from it, presenting the appearance of two satellites in transit.

The annexed table gives in a concise mumner the most important facts concerning these satellites.

Name	Mean Distance from Planet	Siderial Period	Diameter
Io	267,380 miles	1 day 18 hours 27 minutes	2,252 miles.
Europa	425,160 "	3 " 13 " 14 "	2,099 "
Ganymede	678,390 "	7 " 3 " 43 "	3,436 "
Callisto..............	1,192,820 "	16 " 16 " 32 "	2,929 "

The first of these satellites is considerably larger than our moon: the second very nearly of the same size: the third is nearly seven times the bulk of our moon: the fourth is about three times the bulk of our moon—so that the whole of Jupiter's satellites are equal to about a dozen of our moon. The circumference of the first satellite is 7,074 miles; of the second 6,594 miles; of the third 10,794; and of the fourth 9,201 miles. The superficial contents of the first satellite would consequently be 15,930,648 square miles; that of the second 13,840,806 square miles; that of the third 37,088,184 square miles; and that of the fourth 26,949,924 square miles. The number of square miles, therefore, on Jupiter's four satellites would be nearly 93,809,562 square miles, or nearly ninety-four millions of square miles, which is about double the extent of surface on all the habitable parts of our globe. Doubtless they are replenished with a large number of inhabitants for which they possess such ample capacity. The first satellite, it is seen, revolves at a little further distance from the planet than the moon does from the earth; the second at nearly double that distance; the third at ncavly treble that distance; and the fourth at nearly six times that distance.

The Heavens as viewed from the Satellites and from Jupiter.

From his satellites, Jupiter will appear as a large and resplendent moon in their firmament: sometimes appearing in the zenith; sometimes in the horizon; and in other positions, according to the positions the spectators occupy on the surface of the satellites. From the first satellite the globe of Jupiter will appear about 1,000 times larger than the moon does to us, and will exhibit in the course of 21 hours all the diversified phases of the moon, a crescent, a gibbous phase, a half-moon, and a full enlightened hemisphere. Besides, the appearance of the other three moons in its firmament will be highly interesting and sublime. At certain times one of these moons will come so near the first satellite as to appear three times larger than our moon does to us; and at other times it will appear six times smaller than in its former position; and a variety of other phenomena will be presented to it, from the complex motions of this system of bodies, which it would be too tedious here to describe, all of which will present to view objects of surpassing grandeur and sublimity, incomparably superior to what we are accustomed to behold in our nocturnal sky. What has been now stated with reference to the first satellite will also apply in general to the other three satellites, with this difference, that Jupiter will appear of a different magnitude from each satellite; and the magnitudes, motions, and aspects of the other satellites will likewise be somewhat different. In each satellite the great globe of Jupiter, appearing motionless in the sky, will be the most conspicuous object in their firmament. To the second this globe will appear about four hundred and seventy times larger than our moon does to us; to the third about one hundred and eighty times; and to the fourth about eighty times the apparent size of the full moon. Each satellite too will have a variety of other phenomena peculiar to itself. To each of them the occultations of the other satellites by the body of Jupiter: their eclipses by falling into his shadow; the varieties of the surface of Jupiter caused by his diurnal rotation; the shadows of the satellites passing like dark spots across his disc; the transits of the satellites them selves like full moons crossing the orb of Jupiter; the diversified phenomena of eclipses, some of them happening when the satellite is like a crescent, or half-moon, and some of them when it appears as a full enlightened hemisphere; and scarcely a single day will pass without some of these phenomena, and many others being observed. The length of the day, as has been shown, is different in each satellite.

The only planet which will be conspicuous in the firmament of Jupiter is the planet Saturn, which will appear larger than either Jupiter or Venus does to us, especially at the time of its opposition to the sun. The planet Uranus which is scarcely distinguishable to our unassisted sight, will not be much more distinguishable at Jupiter than with us, even at the time of its opposition. Mars will scarcely be seen from Jupiter, both on account of its smallness, and of its proximity to the sun; for at his greatest elongation he can never be seen more than 18° from that luminary. The earth also will be invisible from Jupiter both on account of its small size, its distance, and its being in the immediate vicinity of the sun, immersed in his rays. But although so few of the primary planets are seen in the nocturnal sky of this planet, yet his firmament will present a remarkable appearance by the number of his own satellites, especially as they all perform their journeys round the planet in such short periods of time, and hence their changes occur in rapid succession. These four moons will exhibit many curious and sublime phenomena to the inhabitants of Jupiter, as they run their nocturnal courses through his sky: sometimes they will be seen eclipsing each other; sometimes eclipsing the sun, and other times the stars; sometimes two, three, and even the whole four will be seen shining in the heavens, in one bright galaxy; one perhaps in the form of a crescent, one with a gibbous phase, one like a half-moon, and the other with a full enlightened hemisphere. One will be seen moving comparatively slow, and another moving rapidly through the sky, and leaving all the rest behind it.

One will be seen under an eclipse, another entering into it, and another emerging from it. One of the satellites will cast the shadows of objects toward the north, another toward the south, another toward the east, another toward the west, and in all directions upon the surface of Jupiter. These and many other celestial phenomena must be highly interesting to the astronomers and all others connected with this far distant world. On the whole, the planet Jupiter, accompanied by his satellites, presents to our view an object of inexpressible grandeur and sublimity, when we contemplate the vast magnitude of this magnificent globe and the velocity with which it moves, accompanied by its moons, through the regions of space.

The Planet Saturn.

The intervals between the planets are now becoming wider and wider, and we have to pass nearly 400 millions of miles beyond the orbit of Jupiter before we reach that of Saturn. This planet may justly be considered as in almost every respect the most magnificent and interesting body within the limits of the planetary system, so far as yet discovered. Viewed in connection with its satellites and rings, it comprehends a greater extent of surface than even the system of Jupiter; and its majestic rings constitute the most singular and wonderful phenomena that have yet been discovered. The mean distance of this planet from the sun is 872,135,000 miles; but, owing to the eccentricity of his orbit, the real distance may be greater or less than this by nearly 50,000,000 miles. His mean distance from the earth is 780,705,000 miles, an interval which a cannon ball, flying with its utmost velocity without intermission, could not travel in less than 178 years, and a steam carriage, moving at the rate of twenty miles an hour, could not traverse in less than 4,448 years. Saturn accomplishes his orbitual journey round the sun in 10,729.2 days, or nearly 29½ of our years, its motion being over 20,000 miles an hour, or less than one third that of the earth. In point of size it is next to Jupiter in our system, having an equatorial diameter of 71,904 miles. Here we may observe that astronomers determine the polar diameter of this planet, as well as that of Jupiter, the earth and others, to be somewhat shorter than the equatorial diameter. The difference, however, in any of these cases is very slight, in some of them scarcely at all noticeable. And even these differences are determined variously by different astronomers, and continued observations with more perfect instruments may eventually show all these bodies to be perfect spheres, or that their diameters are equal, excepting so far as they may differ on account of the natural elevations and depressions of the surfaces of the planets. The circumference of Saturn measures 225,893 miles, and its superficial area 16,242,610,272, or over sixteen thousand millions of square miles, an extent of surface over 82½ times that of our terraqueous globe.

The motion of this planet being slow as compared with that of the other planets, if it be once recognized in the heavens near any large fixed star it will be found from year to year making a slow progress to the eastwards from that point. Its apparent motion in that direction in the course of a year is little more than twelve degrees, or less than the moon moves in twenty-four hours. Hence if we perceive this planet in any particular point of the heavens this year, at the same time next year it will appear only about 12° farther to the east.

Notwithstanding the dull appearance Saturn presents to the naked eye, when viewed through a powerful telescope, it presents a more regular and magnificent appearance than any other body connected with our system; and were it as near us as Mars, or even Jupiter, it would present a splendid appearance even to the naked eye. The ancients who first traced the motions of the planet could form no adequate idea of the grandeur of Saturn, and of the system of which it is the centre; and their astrologers, on account of his pale leaden hue, accounted him a cheerless impropitious planet, and as shedding a malign influence upon the inhabitants of the earth. But after ages of darkness and superstition had rolled away the telescope was invented, and by the aid of this noble instrument, which has unfolded to us the wonders of the heavens, a system of revolving bodies were discovered connected with this planet, more wonderful and magnificent than any other object with which we are acquainted. With powerful telescopes four or five belts have been discovered on his surface, which seem broader and less strongly marked than those of Jupiter, and do not appear subject to the variations which are seen in Jupiter's belts, and, therefore, they are thought most probably to form permanent portions of the globe of Saturn, indicating that there is a diversity of surface on this

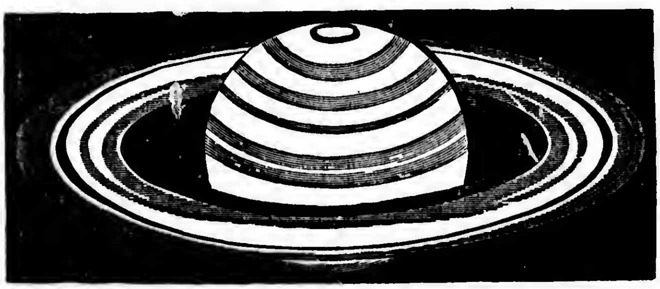


Fig. 120.

planet, but whether land or water, or any other particular substance, is not yet clearly determined. The quantity of light this planet receives from the sun is only the $\frac{1}{90}$th part of what we receive; for Saturn is about

9½ times the distance from the sun that the earth is, the square of which is 90¼, and the quantity of light the planets receive is in inverse proportion to the squares of their distances from the sun. But that quantity of light is estimated as equal in effect to the light which would be reflected by a thousand full moons such as that connected with our earth. As we have remarked before, however, upon the nature of the atmosphere which surrounds a planet, as well as upon the nature and character of its surface, much depends as to the degree of illumination which will be enjoyed on it. If the atmosphere of Saturn be as dense and its surface as rough as those of the earth that planet will enjoy a good degree of light. The density of this planet is estimated as less than that of any other planet in our system. The true period of Saturn's rotation on its axis has been difficult to determine; it is, however, set down as at a few seconds short of 10½ hours. It is remarkable that La Place, from physical considerations, had calculated the time of rotation of Saturn to be nearly that stated, before Sir W. Herschel, had determined it by direct observation. Future observations with improved instruments may probably disclose something different as to the time of its axial rotation and density. The eccentricity of Saturn's orbit is 49,000,000 miles, which is about the $\frac{1}{37}$th part of the diameter of its orbit. Its inclination to the ecliptic is 2° 29½′.

Saturn is attended with a more numerous train of satellites than any other planet in the solar system that has yet been discovered. Eight large moons have been discovered moving around it in solemn grandeur, diffusing light over its surface in the absence of the sun, and greatly diversifying the scenery of its firmament. Two of these, the second and seventh, can only be seen with the most powerful telescopes, and several of the others require a good instrument in order to show them well. Owing to their great distance and small sizes our information concerning them is quite limited. The annexed table exhibits in a concise form the most important facts known concerning them. The diameters, however, with the exception of that of the sixth, are doubtful :

[illegible]	Mean distance from planet.	Siderial Period.	Diameter.
1st	120,800 miles	0 days 27 hours 37 minutes	1,000 miles
2nd	155,000 "	1 " 8 " 53 "	2 "
3rd	191,000 "	1 " 21 " 18 "	500 "
4th	246,000 "	2 " 17 " 41 "	500 "
5th	343,000 "	4 " 12 " 25 "	1,200 "
6th	796,000 "	15 " 22 " 41 "	3,300 "
7th	1,007,000 "	21 " 7 " 8 "	2 "
8th	2,314,000 "	79 " 7 " 55 "	1,800 "

Astronomers differ considerably as to the diameters of these satellites; and we incline to think them in general much larger bodies than the diameters given would indicate them to be. The orbits of the three first mentioned of these are much nearer to the planet than that of the moon s to the earth; that of the fourth is a little over that distance; that of the fifth nearly 1½ times that distance; that of the sixth somewhat over 3¼ times that distance; that of the seventh four times, and of the eighth over nine times that distance. The orbits of the six interior satellites are found to be nearly circular, and very nearly in the plane of the planet's ring, which we shall soon consider; that of the seventh approaches nearer in coincidence with the ecliptic.

Some phenomena of the Satellites as viewed from the surface of Saturn. Description of the rings and scenery of the heavens as viewed from Saturn his satellites and rings.

These satellites, like those of Jupiter, undergo frequent eclipses; but on account of their great distance from the earth these eclipses are not often observed. It is evident that such a numerous assemblage of moons revolving round this planet at different distances, and in different periods of time, will present a most beautiful diversified and sublime appearance in the heavens of Saturn, especially when all the eight satellites appear at the same time above the horizon. Then one will appear as a full moon, another as a crescent, another as a half-moon or with a gibbous phase; one entering into an eclipse, another emerging from it; the inner satellites, on account of their proximity to the planet, presenting the largest discs and the most splendid appearance, and moving with great velocity in their orbits, rapidly passing the other satellites at different rates of motion, and leaving them behind in their course.

On the surface of Saturn a curious effect will be produced, and a diversified scene presented. The shadows of all objects will be projected in different directions by the different satellites, according to their varying positions in the heavens. One satellite will project the shadow of an elevated object towards the east, another toward the west, a third will cast it toward the north, a fourth toward the south, and the shadows will be cast in a variety of directions according to the number of satellites above the horizon, and the positions they occupy in the firmament; and the swift motions of the first three satellites will cause the direction of their shadows rapidly to change. In addition to all this diversity of sublime scenery, there is the grand spectacle produced by the magnificent rings encircling the planet, which we shall now endeavor to describe.

This ring surrounding the planet being compound, that is, made up of two or more concentric rings, is the most remarkable peculiarity of Saturn, and, as before remarked, appears to be quite unique in the whole system. To the early observers it caused considerable of curiosity and wonder. Galileo, when he first directed his telescope to the planet, observed that it was somewhat elongated, as if it were oval in shape instead of round, the power of the early telescopes not being sufficient, nor their definitions good enough, to show the real cause of the appearance. After some time he advanced an opinion that the planet was really triple, having a small satellite on each side of it. This theory obtained for some time, till gradually the ring began to be presented edgewise to the earth, and then disappeared altogether. This the astronomers of that time were unable to explain, and were, on that account, very much perplexed; but, after the lapse of about half a century, Huygens discovered the real cause of these appearances, and announced that Saturn was surrounded with a slender flat ring, nowhere touching it. He also predicted the period when it would again become invisible, and proved to be very near correct in his dates. After a short time it was discovered that, instead of one ring, there were two concentric ones; and numerous recent observations go to show that these again are divided, so that we may look upon the whole as a compound or multiple ring, made up of several distinct and separate ones. Three of these are well marked, the innermost of which is commonly known as the *dusky ring*, and seems partially transparent, probably from an accumulation of water near its edge. See figure 120.) From several phenomena which have been observed, there is thought to be ground for supposing that one or more of these rings may be fluid rather than solid; and most probably they are partially fluid. The diameter of the outer bright ring is estimated at nearly 170,000 miles, and its breadth at upwards of 10,000. The interval between this and the inner bright ring is given by Sir W. Herschell at 2839 miles, which is 700 miles more than the diameter of our moon; so that a body as large as our moon would have place to move between the rings. The breadth of the inner bright ring is 17,000 miles, and that of the dusky ring about half that amount, so that the united breadth of the whole would be about 36,000 miles. Their thickness is, however, but small, being variously estimated at from 40 to 250 miles. Astronomers differ somewhat as to the dimensions of these rings, some having them larger than as here given. The superficial contents of these rings, reckoning both their sides and edges, are computed at over 120 times the area of the whole earth; so that they possess ample space for the accommodation of vast numbers of inhabitants, with which, doubtless, they are abundantly replenished. From the observations of Sir W. Herschell, and others, it has been concluded that there are irregularities on the surface of the rings analogous perhaps to mountains and vales of vast extent; and that the occasional disappearance of the *ansae* may possibly arise from a curvature in their surfaces. Herschell was also of the opinion that the edge of the exterior ring, (or that edge which he could observe best with his telescope,) is not flat but curved. This would lead us reasonably to infer that the rings may be inhabited on all their sides and edges, just as our globe is inhabited on all its opposite sides. This astronomer considered, too, that the rings are not less solid than the body of the planet, which consideration was doubtless in the main correct, and which bespeaks a solid uneven surface, at least in part, for the rings.

By means of several protuberant points connected with the rings Sir W. Herschell discovered that it has a swift rotation round the globe of Saturn, which it accomplishes in 10 hours 32½ minutes. Secchi, however, sets it down at 14 hours 23⅓ minutes. The ring is everywhere distant from the surface of the planet over 20,000 miles; so that two or three globes of the size of the earth might be interposed between them. This magnificent appendage keeps always the same position with respect to the planet; is incessantly revolving round it; and at the same time moving along with the planet in its revolution round the sun. When viewed through a good telescope the appearance of the system of Saturn is very beautiful. At times the ring is presented with its edge toward us, and is then almost invisible, being just discernible as a thread of light along which some of the satellites appear to be moving. As the earth moves out of the plane of the planet's equator the ring opens out wider and wider, the projecting sides having the appearance of handles, whence their technical name *ansae*. The opening of the ring attained its maximum in August, 1869, and now appears slowly closing up again. Its edge, therefore, will be directed toward the earth again about the close of the year 1876. The phenomenon of the disappearance of the rings takes place at intervals of fourteen years and nine months, and happens when the planet is in 170° and 350° of longitude, or in the 20th degree of Virgo, and the 20th degree of Pisces. Sometimes the sun is on one side of the plan of the rings, and the earth on the other. The dark side is then turned toward us, and the ring is invisible. In Figure 120 is a good view of the rings as seen in 1852 by Mr. Dawes.

Saturn and his rings would present a more splendid and interesting appearance through our telescopes could we view the rings not obliquely, but as at right angles to our line of vision; but as we view them our eye is never more elevated than 30° above the plane of the rings. The sun shines on one side of this compound ring during a period of fifteen years, and the regions of Saturn which lie under the dark side suffer a solar eclipse under its shadow during this period. But doubtless this loss of light is amply compensated by the light of the satellites.

Recent observations reveal the fact that the planet is not situated exactly in the centre of the rings, one of the *ansae* being longer than the other; another fact is that the dimensions of the rings appear to vary from day to day in a way that is explained by supposing the rings to be elliptical, and that they would thus present this appearance in their rotation round the planet. This oscillation of the rings about the planet is believed to be necessary to the maintenance of permanent equilibrium in the system of Saturn; for astronomers demonstrate from physical considerations that were they mathematically perfect as to their circular form, and exactly concentric with the planet, " they would form a system in a state of unstable equilibrium, which the slighest external power," (such as the attraction of the satellites,) "might completely subvert by precipitating them unbroken on the body of the planet." "The observed oscillation," says Sir J. Herschell, "of the centre of the rings about that of the planet is in itself the evidence of a perpetual contest between conservative and destructive powers, both extremely feeble, but so antagonizing one another as to prevent the latter from ever gaining an uncontrollable ascendancy, and rushing to a catastrophe." It appears, too, that the ring rotates on its axis in exactly the same time that the planet does, for he goes on to say: "The smallest difference of velocity between the body and rings must infallibly precipitate the latter on the former, never more to separate; consequently, either their motion in their common orbit round the sun must have been adjusted to each other by an external power with the minutest precision, or the rings must have been formed about the planet while subject to their common orbitual motion, and under the full, free influence of all the acting forces." At the rate of axial motion given to the planet and rings by the Herschells, the parts about the planet's equator must move 22,476 miles an hour, and the exterior circumference of the outer ring 53,176 miles an hour, 886 miles a minute, or fifteen miles during every beat of the clock. We cannot, therefore, possibly conceive of any external power as adjusting their motions to each other in their common orbit round the sun "with the minutest precision," nor of the rings being formed about the planet "while subject to their common orbitual motion" with such a velocity, "and under the full, free influence of all the acting forces," such as the centripetal and centrifugal forces of gravity, and the various forces of attraction from different directions in full operation. Such a thing, as we have had occasion to remark before, in a former part of this book, is altogether unreasonable, inconceivable, and never has taken place. That system is as eternal as the earth on which we live.

In consequence of the vast dimensions of these rings, and the large space they occupy in the firmament of the planet, they will present a magnificent spectacle from the regions of Saturn which lie under their enlightened sides, especially those places which are situated not far from the planet's equator. They will appear as vast shining arches spanning the heavens from one side of the horizon to the other, and holding an invariable position among the stars. Toward the poles of the planet the rings will be quite invisible on account of the convexity of the globe of Saturn interposing between them and the observer; but near the polar regions a segment of the rings will appear, presenting a brilliant appearance in the horizon. Advancing from those regions toward the equator they will appear to span the heavens like brilliant arches of different degrees of magnitude, until at the equator they will appear a complete semicircle.

During the space of fourteen years and nine months, which is half of the year of this planet, the sun shines on one side of these rings without intermission, and during a like period he shines on the other side. During nearly fifteen years, therefore, the dwellers on one side of the equator will be enlightened by the sun in the day-time and the rings by night, while those on the other hemisphere, who live under the dark side of the ring, suffer a total eclipse of fifteen years continuance, during which they never see the sun. As the sun ceases to shine upon one side of the ring and is about to shine on the other, the rings will be invisible for a few days or weeks to all the inhabitants of Saturn. The prominent parts of the celestial scenery of Saturn may be considered as belonging to his own system of rings and satellites, and the views which will occasionally be opened of the firmament of the fixed stars, for but few of the other planets will appear in its sky. Jupiter will appear alternately as a morning and an evening star with about the same degree of brilliancy it exhibits to us, but it will never be conspicuous except near the period of its greatest elongation, and it will never appear removed from the sun further than thirty-seven degrees, and consequently will not appear so conspicuous, or for such a length of time, as Venus does to us. Uranus is the only other planet which will be visible from Saturn, and it will be distinctly perceptible as a star of the third magnitude when near the time of its opposition to the sun. All the other planets, such as Mars, the Earth, Venus, Mercury, and our Moon, will be far removed from the view of the inhabitants of Saturn, being all in the immediate vicinity of the sun, and immersed in his rays.

But notwithstanding all this the sky of Saturn will present a most diversified and interesting appearance. No pictorial representation, however ample the scale, can convey even an approximate idea of the august and splendid objects which adorn his nocturnal firmament; for besides the rings, which form the most striking and magnificent spectacle, there are the eight moons, three or four of which generally diversify his celestial hemisphere, appearing in different positions and with different phases, and sometimes the whole eight satellites in one bright galaxy may be seen pursuing their different courses among the stars, and rapidly shifting their positions and aspects. Let us picture to ourselves one moon four times as large in apparent size as ours shining in the canopy of heaven; another three times the apparent size of ours in another quarter of the sky; a third apparently thrice as large; a fourth about the apparent size of our moon; and a fifth, sixth, seventh and eighth of different apparent magnitudes; some of them appearing as a crescent, some with a gibbous phase, and others with a full enlightened hemisphere; some rising, some setting, one entering into an eclipse, and another emerging from it; let us conceive such scenes as these, and we may acquire some general idea of the phenomena presented in the heavens of Saturn.

Also, each of the satellites of Saturn will have celestial scenery peculiar to itself. To each of them the globe of Saturn, surrounded by the immense rings, will appear the most conspicuous object in the firmament. From the first satellite, the globe of Saturn will appear about 5000 times larger than the moon does to us. The moon occupies only the $\frac{1}{90}$th part of our firmament, but the globe of Saturn will fill the $\frac{1}{12}$th of the firmament of his first satellite, and the rings will occupy an extent two or three times greater; so that the planet with his rings will appear the most grand and magnificent objects in their sky. In some positions on this satellite it will appear in their zenith, or above their heads; in others in the horizon, and in other positions in the sky, according to the position which the spectator occupies upon the satellite. It is not likely that more than half of the globe of Saturn will be visible from this satellite, on account of the interposition of the rings, and as its orbit is very nearly parallel with the plane of the rings, the surfaces of these rings will be seen in a very *oblique direction*, but still they will exhibit a very resplendent appearance. When the edge of the outer ring is opposite to the satellite, and enlightened by the sun, it will present a large arch of light in the heavens on each side of the planet, above which will appear half the hemisphere of Saturn. If the satellite turn round its axis in the same time it takes to revolve around its primary, as is most probable, Saturn and his rings will appear stationary in the heavens, and the planet will present to the inhabitants of the satellite a variety of phases, as a crescent, a half-moon, a gibbous phase, and a full enlightened hemisphere. The rings will likewise appear to vary their aspect during every revolution, beside the variety of scenery they will present during their rotation. At one time, they will exhibit large and broad luminous arches; at another time they will appear as narrow streaks of light; and at another like dark belts across the disc of Saturn. And as this satellite moves round the planet in the course of 27½ hours these appearances will be changing almost every hour. The appearances of the seven other satellites continually varying their phases, their apparent magnitudes, and relative aspects; their positions in respect to the body of Saturn, and its rings; their occultations by the interposition both of the rings, and the planet, and the eclipses to which they are often subjected, will produce a diversity of phenomena, and a grandeur unexampled in the case of any other moving bodies in our system. The second satellite when in opposition, or in its nearest position to the first, will be only 35,000 miles distant; and although it is not believed to be larger than our moon, will present a surface sixty times larger than the full moon does in our sky. It will present all the phases of the moon in the course of 45 hours, and will be continually changing its apparent magnitude, on account of its removing farther from or being nearer to the first satellite. The third satellite will appear nearly half as large, and will present nearly the same variety of phases as the other. All the other satellites will appear smaller in proportion to their distances from the orbit of the first; but they will probably all appear larger than or as large as our moon, except the seventh and eighth, which will appear much smaller.

The eighth satellite, which is reckoned among the largest, will have a scenery in its firmament somewhat different from that of the first. As its orbit is considerably inclined to the plane of the rings, its inhabitants will have a more extensive prospect of the rings than those of the six interior satellites whose orbits are in the plane of the rings, although these objects are beheld at a greater distance, and consequently do not fill so large a portion of its sky. Their apperance, however, will not be without splendor; for although the orbit of this planet is more than nine times the distance between the earth and the moon, yet the body of Saturn will appear sixteen times larger than the moon does to us, and the rings will occupy a space proportionately more expansive. The phases of Saturn and his rings, and the various changes of aspect which they assume, will be more distinctly seen, though on a smaller scale, than from some of the inner satellites; for the whole body of the planet as well as the rings will in most cases appear full in view. The intermediate six satellites will appear in all the different phases and aspects above described, and they will never appear to remove to any great distance from the globe of Saturn; but will appear first on one side, then on another, and sometimes either above or below the planet, as the inferior planets appear to us in respect to the sun; and consequently that part of the firmament in which Saturn appears will present a most splendid aspect. In this respect the relative positions of the satellites as seen from the outermost, will be different from their positions as seen from the innermost satellite, when they will sometimes be seen in regions of the sky directly opposite to Saturn. All the other satellites of this planet will have phenomena peculiar to themselves in their respective firmaments, and to each the globe and rings of Saturn will appear of a size in proportion to the distance at which it is from it; and in all of them similar phenomena, as in the case of the first, are exhibited on a scale of grandeur and magnificence.

Conceive then a firmament in which is shining a globe five thousand times larger than the apparent size of our moon; conceive luminous arches still more expansive surrounding this globe; conceive seven moons of different apparent magnitudes, some of them sixty times larger in apparent size than our moon; conceive, further, all these bodies sometimes appearing in one part of the heavens, sometimes in another, changing their phases and apparent magnitudes, and distance from each other, every hour; appearing sometimes like a large crescent, sometimes like a small one; sometimes shining with a full enlightened face, and sometimes undergoing a total eclipse; sometimes hidden behind the large body of the planet, and sometimes crossing its disc with a rapid motion, like a circular shadow. Suppose these and many other diversified phenomena presenting themselves with increasing variety in the canopy of heaven, and you will have some slight idea of the grandeur of the firmament as seen from some of the satellites of Saturn.

On the rings there will be a greater diversity of celestial scenery than any we have yet described. There will be at least ten varieties of celestial scenery, according as the spectator is situated on different parts of the rings. Two opposite varieties of scenery will be exhibited from what appear to us the upper and lower sides of the rings; one variety of scenery will be exhibited from the exterior edge of the outer ring; another from its interior edge; one variety of scenery from the exterior edge of the second ring, another from its interior edge: one variety of scenery will appear from the exterior edge of the interior bright ring, another from its interior edge; one from the exterior edge of the dusky ring, another from its interior edge. By referring to the figure, the reader will perceive there are four rings distinctly marked. To describe all these varieties in minute detail would fill a large volume. We shall have to confine ourself to a brief description of one of these celestial views. Those who dwell on the sides of the rings will behold the one half of the hemisphere of Saturn, which will fill perhaps the one-fifth or the one-sixth of their celestial hemisphere, while the other portions of the planet will be hidden by the interposition of the rings. Those who are near the interior and dusky rings are only some 25,000 miles from the surface of Saturn, and consequently the varieties on its surface will be perceived. Those near the outer edge of the exterior ring are about 60,000 miles from the surface of the planet, which will consequently appear to them four times less in size than to the former. But being only 18,000 miles from the first satellite at the time of its opposition to Saturn that satellite will appear more than 350 times larger than our moon, will rapidly assume different phases, and will be continually varying in its apparent magnitude; and at its greatest distance beyond the opposite side of therings itwill appear at least 170 times less than when in the nearest point of its orbit; and will exhibit all the intermediate varieties of aspect within a little over a day; so that this satellite will be continually varying its apparent size from an object two or three times the apparent dimensions of our moon to one 350 times greater. The same may be said with respect to the other seven satellites, with this exception, that they will appear of smaller magnitudes, and the periodic times of their phases and their changes in apparent magnitude will be different.

Another object which will diversify the firmament of those who are on one of the sides of the rings is the opposite portions of the rings themselves. These will appear rising up from each side of the planet like broad luminous arches, each of them somewhat less than a quadrant, and will fill a very large portion of the sky, so that the inhabitants of the rings will behold a portion of their own habitation forming a very conspicuous part of their firmament, and, at first view, may imagine that it forms a celestial object with which they have no immediate connection. Were they to journey to the opposite side of the ring they would see the habitation they had left suspended in the firmament without being aware that the place they had left forms a part of the phenomena they behold. As the rings rotate round the planet, and the planet rotates round its axis, the different parts of the surface of the planet will present a different aspect, and its variety of scenery will be successively presented to the view. The eclipses of the sun and of the satellites by the interposition of the body of Saturn, and of the opposite sides of the rings, will produce a variety of striking phenomena, which will be diversified almost every hour.

From the dark sides of the rings which are turned away from the sun for fifteen years a great variety of interesting phenomena will likewise be presented; and during this period the aspect of the firmament will most probably be very varied and striking. This half of the rings will not be in total darkness during the absence of the sun, for some of the eight satellites will always be shining upon it; sometimes three, sometimes four, and sometimes all the eight in one bright assemblage. It is probable too that Saturn,like a large, slender crescent, will occasionally diffuse a mild light, and in the occasional absence of these the fixed stars will display their radiance in the heavens, which will be the principal opportunity afforded the astronomers of the rings for studying and contemplating those remote luminaries. Those who occupy the exterior rings will behold the interior rings and the opposite segments of their own like vast arches in the heavens; and although only 2,500 miles intervene between the two bright rings, that space is doubtless as impassible as the space which intervenes between us and the moon. The celestial scenery as viewed from these rings will afford a grand and diversified field for telescopic observations, surpassing in variety and sublimity whatever is beheld in any other region of the solar system, by which some of the objects could be contemplated, as if they were placed within the distance of forty or fifty miles.

Thus the planet itself, with all the moving bodies connected with it, presents to the mind a scene of surpassing grandeur and sublimity. Let us suppose ourselves stationed within a few thousand miles of this system; from such a position the globe of Saturn, the rings and moons would appear to fill the greater portion of the visible heavens. Let us conceive this planet nearly a thousand times larger than the earth,moving through space at the rate of over 20,000 miles an hour, accompanied by his stupendous rings 500,000 miles in circumference; and these rings revolving round the planet, with a velocity of nine hundred miles every minute, and eight other spacious globes, while in their rapid courses at different distances round the planet and his rings; let us endeavor to stretch our imagination to the utmost to represent to ourselves this scene as near as possible to the reality. Supposing ourselves spectators, how grand and terrific and almost overwhelming would be the amazing spectacle! Amidst the emotions which such a sight would excite in us we would exclaim: Who can understand the operations of the Lord? Great is the Lord; great is his power; and his wisdom is infinite! His power is irresistible; his wisdom is unsearchable; and his agency, as his presence, pervades immensity!

The Planet Uranus.

Of the planets which have been discovered beyond the orbit of Saturn comparatively little is known, owing to their great distance from us. The nearest of these, Uranus, is only faintly visible to the naked eye. It was discovered on March 13th, 1781, by Sir W. Herschell, though it was some few months afterwards before its planetary nature was recognized. While engaged in examining some small stars, he was struck with the appearance of one in particular, and on applying higher powers he found that it seemed to increase in size and presented a faint disc; it also exhibited a proper motion. Herschell accordingly considered it to be a comet, and announced its discovery as such, but it was soon found to be impossible to assign to the wanderer a parabolic orbit, which would account for its movements, and it was then ascertained to be a planet moving in an elliptical orbit at a mean distance from the sun of 1,753,851,000 miles. Some time was spent in deciding on a name for the stranger. The name of the discoverer was suggested. He himself, however, proposed to call it *Georgium Sidus*, the Georgian Star, out of respect to his patron, George III; but as the names of other planets were derived from the Heathen Mythology, it was finally decided to select a name from this source for it, and Uranus was at length fixed upon. The other names will, however, be occasionally met with in astronomical writings. The diameter of Uranus is a trifle more than 33,000 miles; consequently its circumference is over 103,672 miles; and its superficial area more than 3,421,176,000 square miles, or about 17½ times the land and water area of our globe. Its mass of matter is estimated at about twenty times greater as to bulk than what is contained in Mercury, Venus, the Earth, the Moon, Mars, Juno, Vesta, Ceres, and Pallas; and, if the mass of its system of satellites were counted in, it would be much greater. Its distance from the sun is about double that of Saturn; and to reach the nearest point of its orbit, a cannon ball flying from the earth thitherward with a velocity of 500 miles an hour would require a period of 389 years; and a steam carriage travelling at the rate of 20 miles an hour without intermission would require more than 9,730 years before it could reach the planet Uranus. The period of this planet's rotation on its axis is as yet unknown; its great distance from the earth preventing us from observing any spots or changes on its surface by which this might be determined. La Place concludes from physical considerations that it rotates about an axis very little inclined to the ecliptic; and that the time of its diurnal rotation cannot be much less than that of Jupiter and Saturn. It moves in its orbit round the sun in a little more than 84 of our years, its period being 30,686.82 days, at the rate of 15,000 miles an hour.

One remarkable feature in connection with this member of our system is the great inclination of its equator to the plane of its orbit, the poles being very nearly in the plane. As a result of this the sun is at different times vertical to nearly all parts of the planet's surface. Its orbit is inclined to the ecliptic at an angle of 46′26″ so that it is never much more than $\frac{3}{4}$ ths of a degree from the ecliptic. This inclination is less than that of any of the other planetary orbits. The eccentricity of its orbit is 85,000,000 of miles, which is about the $\frac{1}{42}$nd part of its diameter. Its mean apparent diameter as seen from the earth is about 4″. The quantity of light this planet receives from the sun is 360 times less than what the earth receives; for the quantity of light received on any planet is inversely proportional to the square of its distance from the sun. Uranus is about 19 times the distance of the earth from the sun, and the square of 19 is 361, which is the number of times the quantity of light which he receives will be less than what we receive. But this quantity of light is estimated as equal to what we should have were 348 full moons all continually shining on our globe. If the atmosphere of that planet be has dense as ours, and its surface considerably rough, it will enjoy a good share of illumination. The sensible heat may not entirely depend upon the distance of a planetary body from the sun, but partly upon the nature of its atmosphere and the substances on its surface on which the rays of light and heat fall. Light and heat seem only to be required where there are sensitive and intelligent beings existing, and we may rest assured that in all the regions of the universe the nature and constitutions of the inhabitants are adapted to their respective habitations. This immense globe is doubtless replenished with large numbers of sensitive and intelligent creatures.

Several satellites have been discovered revolving round Uranus; but the number that accompany that planet do not appear to be definitely ascertained. Sir W. Herschell stated that he discovered six, and two within these have been discovered by Lassell and Struve, so that the number is by many astronomers set down at eight, and their periods of rotation vary from $2\frac{1}{2}$ to $10\frac{1}{2}$ days. Lassell, however, expresses his belief that the total number yet discovered is only four. They all, instead of revolving, as the other planets do, from west to east, have their orbits nearly at right angles to the ecliptic, and move in a direction from east to west. It is reasonable to suppose, however, considering the immense distance and the probable small size (their diameters are not yet ascertained) of these bodies, that the acutest astronomers may possibly make mistakes in their observations of them, and therefore, it is better to wait till future observations confirm their statements, or reveal something different as to the motions of these satellites. If it be confirmed that this apparent anomaly do exist, as we may say almost at the confines of the Solar system, it will indicate that in other systems different states of things exist as to the planets and their satellites besides what we experience in the system to which we belong.

We append a list of the satellites of Uranus. Those given here are numbered 1, 2, 4, 6 in the fuller list.

	Mean Distance from Planet.	Siderial Period.	Diameter.
1st	123,000 miles.	2 d. 12 h. 28 m.	?
2nd	171,000 "	4 " 3 " 27 "	?
3rd	281,000 "	8 " 16 " 25 "	?
4th	376,000 "	13 " 11 " 6 "	?

The satellites of Uranus seldom are eclipsed; but as the plane in which they move must pass twice in the year through the sun there may be eclipses of them at these times; but they can be perceived only when the planet is near its opposition. Some eclipses were seen in 1799 and 1818 when the satellites appeared to *ascend through the shadow of the planet in a direction almost perpendicular to the plane of its orbit.* All these satellites, with perhaps several others that revolve about this planet, will not only shed a flood of light on its surface, but exhibit a splendid and variegated appearance in its nocturnal firmament.

The Heavens as seen from Uranus.

The only one of the planets which will be distinctly visible from Uranus is Saturn, which will appear occasionally as a morning and an evening star, and will appear nearly of the same size as to us; but as it will always be seen near the sun it will only be visible at certain periods or intervals of fifteen years, and will appear about as near to the sun as Mercury does when seen from the earth. It is not probable that Jupiter will be at all visible to this planet on account of its proximity to the sun. If ever it be visible it will only be for a very short time at intervals of six or eight years. The most splendid and interesting phenomena in the firmament of this planet will be produced by the phases, eclipses, revolutions, and various aspects of his moons. Four of these are given in our list, but it is highly probable that several others are connected with this planet.

Let us suppose then one satellite presenting a surface in the sky eight or ten times larger than our moon; a second six times as large; a third four times as large; a fourth twice as large; a fifth about the same size as the moon; a sixth somewhat smaller; and, perhaps, two or three others of different apparent magnitudes; let us suppose two or three of these, of different phases, moving along the concave of the sky; at one time four or five of them displayed through the firmament; one rising above the horizon, one setting, one on the meridian, one toward the north, and another toward the south; let us suppose them at another time all shining in the firmament with full enlightened hemispheres, or with different phases; and we shall have a faint idea of the beauty, variety, and sublimity of the heavens of Uranus. What is deficient in respect to the invisibility of the other planets is amply compensated by his assemblage of satellites, which diversify and illuminate its nocturnal sky.

The sun from this planet appears only about 2½ times the apparent diameter of Jupiter* as seen from the earth; notwithstanding all this the light it receives is considerable, as is evident from the brightness it exhibits when viewed with a telescope in the night time, and likewise from the well-known phenomena, that when the sun is eclipsed to us, so as to have only the $\frac{1}{14}$th part of its disc left uncovered by the moon, the diminution of light is not very sensible; and it has been frequently noticed that at the end of the darkness in total eclipses, when the sun's western limb begins to be visible and seems no bigger than a thread of silver wire, the increase of light is so considerable, and so quickly illustrates all surrounding objects, as strikes the spectators with surprise.

The scenery of the heavens from the satellites of Uranus will bear a striking analogy to that observed from the moons of Jupiter; but if there are six or a greater number of satellites connected with this planet the firmament of each of its satellites will be more diversified than that of any of the satellites of Jupiter. From its first satellite the globe of Uranus will appear nearly three hundred times larger than the moon appears to us, and consequently will appear a very grand and magnificent object in its sky, while all the other moons in different phases will serve both to illuminate its surface, and to diversify the scenery of its firmament. To the second satellite Uranus will appear about one hundred and eighty times as large as the moon to us; and to the other satellites it will present a smaller surface in proportion to their distance. Each of these satellites will have its own peculiar celestial phenomena; but after what has been said in the preceding descriptions, and especially with reference to the celestial phenomena from the satellites of Jupiter, it is unnecessary to enter into details with respect to these. These satellites, however, probably move in contrary directions to those of Jupiter and the others; and, therefore, their celestial phenomena will be exhibited differently.

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* Jupiter's *mean* apparent diameter is 38″.

We may remark that in the preceding descriptions the apparent magnitudes of Jupiter, Saturn, and Uranus, as seen from their satellites; and the apparent magnitudes of the satellites as seen from their primaries, and from each other, are only approximations to the truth, so as to convey a general idea of the scenes presented in their nocturnal firmaments; perfect accuracy not being absolutely required in such descriptions. The variety of celestial phenomena in the firmaments of these bodies is much greater than we have described. Were we to enter into minute details in relation to such phenomena it would require a volume of considerable size to contain their varieties; for in the system of Saturn alone there is more diversity of phenomena than in all the other known parts of the planetary system. And were we to consider all the varieties of scenery which characterize *the surfaces* of all these distant worlds, since the colors exhibited on all of them are the same as, or similar to, those exhibited on our globe, we should have a voluminous work.

The satellites of Jupiter, Saturn, and Uranus, of which we have endeavored to give a brief description in the preceding pages, form, as it were, so many planetary systems in connection with the grand system of the sun. The same laws of motion and gravitation which apply to the primary planets are also applicable to the secondary planets or moons. The squares of their periodical times are in proportion to the cubes of their mean distances from their primaries. They are subject to the attraction of their primaries as all the primary planets are attracted by the sun; and as the sun in all probability with his whole system moves round some reciprocal centre of gravity, so the satellites move round their respective primaries, partly by the attractive influence of these planets, and partly by that of the great central luminary. Each of these secondary systems is far more grand and extensive than the whole planetary system was conceived to be in ancient times. Even the system of Saturn, including its rings and satellites, contains a mass of matter much more than a thousand times larger than the earth and moon. The system of Jupiter comprises a mass of matter nearly fifteen hundred times as great as these two bodies; and even that of Uranus is more than eighty times the dimensions of our terraqueous globe.

The Planet Neptune.

The history of the discovery of this planet is one of the most remarkable pages in the whole history of astronomy. Uranus, as we have seen, was discovered by accident, and some time elapsed before it was admitted to be a planet. With Neptune the case was very different. About half a century ago M. Bouvard attempted to calculate accurately the movements of Uranus, but found unexpected irregularities which he could not then account for. If the planet alone were revolving round the sun its place could be easily assigned, but each of the other planets exerts an influence upon it, and these influences are continually varying. All these, however, were allowed for, and yet there remained some disturbing cause which drew it out of its assigned place. Accordingly, in the beginning of 1843, Mr. Adams began to investigate the matter for the purpose of ascertaining the place which the exterior planet (should there be one) ought to occupy, and its elements. After nearly two years of diligent enquiry he announced to the professor of Astronomy at Greenwich Observatory the results of his investigations. Nothing further was done at the time; but soon after, Le Verrier, a French astronomer, independently applied himself to the same enquiry, and obtained results closely resembling those arrived at by Mr. Adams. Upon this a search in the locality indicated was resolved upon, but some time was occupied in commencing it, as the star maps of that part of the zodiac were only imperfect.

Le Verrier then published a revised computation, and on September 18th, 1846, M. Galle, of Berlin, directed his telescope to the spot thus indicated by Adams and Le Verrier. A small star, not mentioned on the maps, was at once seen, and on careful watching proved to be the suspected planet, which had thus by purely theoretical computations had its place marked out among the stars. The problem thus solved almost simultaneously by two different astronomers in England and France was one of the greatest ever solved by the human mind, and reflects honor on both astronomers.

Of the planet itself not much can be said. It revolves around the sun at the mean distance of 2,746,271,000 miles, which is considerably less than that which would be assigned to it by Bode's law. It completes its journey round the sun in 60,126.7 days, or nearly 164$\frac{3}{4}$ years. The eccentricity of its orbit is but small. Its diameter is ascertained to be about 36,620 miles; its circumference is, therefore, 115,045 miles, and its superficial contents 4,212,947,900 square miles, or about 21$\frac{1}{2}$ times the area of our terraqueous globe.

One satellite has been discovered by Lassel revolving round Neptune in a period of 5 days, 21 hours, 8 minutes, at a distance from the primary of 220,000 miles. It is evident this satellite must be a body of very considerable size, otherwise it could not be visible at such an immense distance. It is probably much larger than any of the satellites of Jupiter and Saturn, and may far exceed our globe in magnitude. It is not altogether improbable that some of these far distant planets may be surrounded with a ring similar or analogous to that of Saturn.

The discovery of this remote planet constitutes a new era in the progress of celestial science, and evinces the certainty and uniformity of these physical laws by which the bodies of the planetary system are directed. The law enunciated by Newton, that "every particle of matter in the universe attracts every other particle with a force proportional to the quantity of matter in each, and decreasing inversely as the squares of their distances." has obtained here a new confirmation. This law is thus shown to be extensive in its influence, reaching far beyond what was once considered the boundaries of the solar system, and exerting its energies on every particle of matter throughout the boundless universe.

The first step in the exhibition of that law was the discovery made by Newton that the earth attracts the moon. The principle was also found to explain the revolutions of the planets round the sun ; besides it was found that the revolutions of the secondary planets, or moons, round their primaries, were owing to the same cause. The application of this law also explained certain anomalies in the motions of the moon and planets which were otherwise difficult to account for. A great inequality in the movements of Jupiter and Saturn, which was long unaccounted for, was at length traced to their reciprocal action on one another by the operation of this law. The effects of the attraction of planets that could be observed, and whose names were known, were thereby calculated. In respect to Neptune the mean distance and position of the planet, its mass, and the form of its orbit, were all unknown. But by its observed effects they were all so well determined as to guide the observer almost to the very point of the heavens where it was first descried. This fact stands almost alone in the records of astronomy ; there has been no discovery of the same kind before it in the annals of astronomy, and it may lead to other discoveries of a similar kind. Astronomers have now no reason to conclude that they have yet explored the utmost boundaries of the solar system, a body of so great magnitude having been ascertained to exist, and prosecute its journey round the sun at over three times the distance of Saturn. The observations of future years may bring to view many other orbs which have hitherto existed concealed from view in these distant regions, and in other regions, also, of our system. Thus, the Creator crowns with success the exertions of human genius in the investigation of his dominions by opening up to our view a more expansive prospect of his boundless and eternal empire.

If we except the satellites of Uranus all the bodies of the solar system, so far as discovered, revolve in the same direction round the sun, and all move within a narrow belt. The planets, however, cannot strictly be said to revolve round the sun, but the sun and the planets revolve about the centre of gravity of the system, which, owing to the preponderating bulk of the sun, lies not far from his own centre. Some idea of the immense magnitude of the sun may be gathered from the fact that if he were a hollow shell, and the earth placed at the centre, there would be sufficient room for the moon to revolve as she now does at 240,000 miles from the earth, and still there would be some 200,000 miles beyond the moon before the shell of the sun could be reached.

The Attraction of Gravitation explained.

As the sun is called the centre of light and heat to all the bodies revolving around it, so it may also be called the centre of attraction; and the influences of light and heat are invariably distributed to all the planets in the same ratio as the power of attraction, which keeps them revolving in their orbits, that is, in the inverse ratio of the squares of their distances; or, to express it more clearly, the power of the attraction, the light, and heat of the sun on one planet is to that on another planet as the square of the distance of the latter from the sun is to the square of the distance of the former. But as some of our readers may not understand this from the bare statement of the fact we will endeavor to simplify the law of attraction by a familiar illustration.

Suppose two persons, A and B, sitting at the same distance from the fire, both in front of it, at least the one as much as the other; it is plain they will both feel the same degree of heat; for whatever reason may be given to show that A receives more heat than B, the same reason might be assigned to show that B received more heat than A; therefore they must both receive the same amount of heat each. Now suppose that B removes to double the distance from the fire that he was at when alongside of A, and that A remains in the same place; it might then be supposed that B would receive *only half* as much heat as he did before; or that A would now enjoy double the heat which B would receive in his new position. Such, however, is not the case, for the degree of heat does not diminish at the same rate as the distance increases, as one might expect at first thought; but it diminishes at a much greater rate, and the question is, how much greater? Now well conducted and careful experiments in Natural Philosophy have proved that the heat received at the distance of 2, 3, 4, 5, 6, 7, 8, 9, etc., feet is not $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6}, \frac{1}{7}, \frac{1}{8}, \frac{1}{32}$, etc., of the heat received at one foot; but it is $\frac{1}{4}, \frac{1}{9}, \frac{1}{16}, \frac{1}{25}, \frac{1}{36}, \frac{1}{49}, \frac{1}{64}, \frac{1}{81}$-th, etc., of the heat received at one foot. Thus B will receive at *double* the distance of A only one-fourth of the heat which A receives; at triple the distance only one-ninth; at four times the distance one-sixteenth, etc. The law of expansive progression is then as follows: Let the heat received at the distance of one foot be denoted by 1; then the heat received at the distance of 2 feet will be denoted by $\frac{1}{4}$, or 1 divided by 2 times 2; the heat received at the distance of 3 feet will be $\frac{1}{9}$, or 1 divided by 3 times 3; the heat received at the distance of 4 feet will be $\frac{1}{16}$ or 1 divided by 4 times 4, and so on. Now dividing 1 by any number gives a result which mathematically is called the *reciprocal* or *inverse* of that number; and multiplying any number by itself gives a result which is likewise called the *square* of that number. But the numbers 1, 4, 9, 16, 25, 36, 49, 64, 81, etc., are the squares of the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, etc., because they are obtained by multiplying the latter numbers each by itself; and the fractions $\frac{1}{4}$, $\frac{1}{9}$, $\frac{1}{16}$, $\frac{1}{25}$, $\frac{1}{36}$, $\frac{1}{49}$, $\frac{1}{64}$, $\frac{1}{81}$, etc., are called the reciprocals or inverses of the squares; and *ratio* means the rate at which anything increases or decreases; hence the force of the heat or amount of heat received from a common fire is in the ratio of the *inverses* of the *squares* of the distances; or, more shortly, in the inverse ratio of the squares of the distances. This may be explained in still another way. Suppose A to be placed at 2 feet distance from the fire, and B at 3 feet distance; then B will receive less heat than A; not in the ratio of 2 to 3, the numbers which represent their distances, but in the ratio of 2 times 2 to 3 times 3, that is, of 4 to 9; in other words, as 4 is received $2\frac{1}{4}$ times in 9, so A will receive $2\frac{1}{4}$ times more heat than B; and this is what is really meant by the phrase *the inverse ratio of the squares of the distances.*

Thus, having explained the law of the influence of heat on two bodies, or on any number of bodies at different distances from the source of heat in the case of a common fire, we again observe that the law is equally true of the influence of light and of the influence of attraction, upon bodies at different distances from the source of light and of attraction. Thus, we feel and experience that the sun is the great source of light and of heat to this world in which we live; and astronomy teaches us that it is the great centre of attraction; that power which operates upon the earth and the other planets, and causes them to revolve in elliptical orbits around that luminary as the centre of their motions. This power of the sun arises from his great preponderance in weight; for, as stated above, every particle of matter in the universe attracts every other particle with a force proportioned to the amount of matter they contain. This law, which by long and accurate observation is known to be true, at once conveys to the mind the idea of permanent equilibrium in the universe.

KEPLER AND HIS LAWS.

From the earliest ages of astronomy up to the time of Kepler the planets were reckoned to be only six in number; and this number being mathematically perfect, that is, equal to the sum of all its factors 1, 2, 3, it was imagined that no more planets existed, or might be expected to be found. Kepler, however, earnestly enquired why they should be only six in number; and from his long and careful observations on the motions of the planets deduced certain laws, which are considered as lying at the foundations of astronomical science, which have prepared the way for many new discoveries, and did away with many old and incorrect theories and ideas. This famous astronomer was a pupil of Tycho Brahe, who lived in the latter part of the 16th century. He acquired from his preceptor the habit of accurate observation, and was far more successful than he in the theories which he formed. He was naturally possessed of a quick and lively imagination. He commenced with careful observations, and then formed his theories in accordance with facts; and, proceeding thus, he soon made many and important discoveries. The task to which he devoted his time and energies was to discover the nature of the paths described by the planets. Starting with the hypothesis of the sun being in the centre of the system he began to watch attentively their places, and to simplify matters he confined himself at first to observing the motions of the planet Mars. He calculated the place it should occupy according to the theory of its revolving in a circular orbit, and soon found that the place it really occupied in the sky differed considerably from that assigned to it. This theory was thus at once shown to be incorrect, and he had, therefore, to form a new one by the combination of several circular movements; and again he carefully calculated its position till, just as he seemed to be on the verge of success, the planet once more wandered from the path which he had assigned to it; and once more he had to commence his observations anew from the beginning. In this way he continued to try one hypothesis after another, submitting each to the test of most careful observation, till at length no fewer than nineteen different theories had been proposed, and the movements of the planets compared with those which were calculated by those theories; and still the true solution of the problem remained undiscovered. His perseverance, however, never failed, and he toiled on, though eight long years had been occupied in the task. One important negative result he had, however, arrived at, and this was that whatever was the nature of the curve the planets described, it was not a circle or a combination of circles. This was one great step toward the solution of the problem. From the earliest ages it had been assumed that, as the circle seemed the perfection of form, all the heavenly bodies must move in circles; but Kepler now untrammelled himself of this theory, and then applied himself afresh to the task. In looking at the greatness of his work we must remember that the difficulty is much increased by the fact that our station of observation is itself in rapid motion. Could we view the planets from the sun we should easily see their courses, but as we cannot do this allowance has to be made in every calculation for the motion of our standpoint; and this motion was not then clearly understood.

Having discarded the theory of motion in circles Kepler now proceeded to try other forms, testing them as before; and the first that occurred to him was the ellipse. He accordingly went through the same series of calculations again, and this time the motion of the planet was found to orrespond with that assigned to it by the theory. The great problem of the heavens was now solved, and the joy with which Kepler enunciated the first of the laws which bear his name can scarcely be imagined. This law may be stated as follows : 1. " That the planets revolve in elliptical orbits, situated in planes passing through the centre of the sun ; the sun itself being in one of the foci of the ellipse." As to the *foci* : In every circle there is a point, called the centre, such that all straight lines drawn from it to the circumference are equal. No such point is to be found in an ellipse ; but in the longest diameter, or the major axis as it is called, two points can be found so situated, that if straight lines be drawn from one to any point in the circumference, and thence to the other, the sum of these lines will always be equal. These points are called the foci. Thus, in the figure, A B is the longest diameter, major axis, C D the shortest diameter, minor axis, and F′ and F are the focal points.

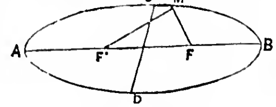


Fig. 121.

A second law enunciated by Kepler is : 2. " That the radius vector drawn from the centre of the planet to the centre of the sun passes over equal areas in equal times in every part of the orbit ; " that is, whether the planet be in its aphelion or farthest from the sun, in its perihelion or nearest the sun, or at its mean distance from the sun. Thus, when in the month of December the earth is nearest the sun it is moving much faster than it moves in summer, when it is farthest from the sun ; for the radius vector describes equal areas in equal times ; and hence we find that the farther the planets are removed from the sun the slower they move, although their radii vectores may describe equal areas with those of the planets that are situated nearer the sun, and moving faster. Another law Kepler enunciated is as follows ; 3rd. " That the squares of the periodic times of the planets, that is, of the times of a complete revolution in their orbits, are proportional to the cubes of their mean distances from the sun " ; or, in other words, that the square of the periodic time of one planet is to the square of the periodic time of another planet, as the cube of the mean distance of the former from the sun is to the cube of the mean distance of the latter from it. Thus, if we know the distance of a planet we can calculate approximately its time of revolution round the sun ; and, on the other hand, if we know its periodic time we can ascertain its distance. As an illustration, the distances and periods of Venus and the Earth may be taken, which may be set down in round numbers as follows ;

	Period	Distance from the sun.	
Venus	224 days,	68,000,000	The proportion between the periods here is $\frac{224}{365}$;
Earth	365 "	95,000,000	And the proportion between the distances $\frac{68}{95}$.

If now we take the square of the former quantity, we shall find it to be nearly equal to the cube of the latter. It will be noticed that the numbers here given for the purpose of illustration are merely approximations. These laws, deduced and proposed by Kepler, at the close of the sixteenth and in the beginning of the seventeenth century, and afterwards mathematically demonstrated by Sir Isaac Newton, are, together with Newton's law of gravitation, accounted the fundamental and invariable laws of the science of astronomy. It will, of course, be observed in what sense they are to be understood as laws; in the common acceptation of the term law has reference to man, and to the moral world; but neither Kepler nor Newton made these laws; they are simply their deductions, from long observation and experiment, as to how nature is and acts universally.

SIR ISAAC NEWTON AND HIS DISCOVERIES.

The name of Newton stands before Kepler as the discoverer of the law upon which all those of Kepler depend. Kepler seems to have suspected that some such law did exist, but failed to discover it. He seems likewise to have been aware of the fact that the tides were, in some way, influenced by the moon, and that the other heavenly bodies were in some way connected so as to influence each other; but he did not discover what this mysterious bond of union was, and, therefore, it was with him a mere conjecture. But Newton applied himself strenuously to clear up this difficulty, and accomplished his task nobly. This great man was born in 1642, the same year in which Galileo died. It is said that his attention was first drawn to the subject of gravitation by observing an apple fall from a tree one day while sitting in a summer-house in his garden. There was nothing remarkable in such a circumstance, for it was an event which might be seen every day. But it set him thinking, and he began to enquire why the apple should fall downwards or towards the ground instead of upwards, or to one side. To most men such a question might have appeared vain and frivolous; to him, however, it seemed an important event towards very great results; and such in reality it proved to be. After careful enquiry he found that all bodies are attracted towards the centre of the earth, and this attraction he called gravitation. The question then arose to him, whether this action was confined to the surface of the earth, or whether distant bodies were attracted in a similar way. The intensity of this force he also believed to diminish with the square of the distance; but the difficulty presented itself, how this was to be tested. Even if a body could have been raised several miles from the earth's surface, this distance would have been so trifling when compared with the earth's radius (4000 miles) that no appreciable difference would have been manifested.

No way, therefore, appeared to him practicable of putting this theory to the test, till at last the idea occurred to him, why he should not use the moon as the falling body, and ascertain the distance through which it falls in any given time, say, for instance, in one minute. This idea, at first, appears absurd, but the annexed figure will enable our readers to understand it. It is known that the moon revolves round the earth in an orbit, almost circular, as G B D. Now, suppose the moon to be at D, its tendency at that moment is to move along in the tangent line D C, and in this direction it would go on moving did not some other force deflect it out of that course; for every body tends to continue in the state in which it is if not acted upon by forces external to itself; if it is at rest it tends to remain at rest; if in motion to go on continuously moving in a straight line. This force, which acted upon the moon so as to draw it out of that straight line and make it describe a curve, Newton supposed to be the attraction of the earth, and determined to calculate whether the amount it deviated from a straight line was such as would arise from the earth's attraction. When the moon has moved into the position B, it is easily seen that the distance it has deviated from its true path is equal to A B. He accordingly calculated what this distance would become after the lapse of one minute, that is, how far the moon would fall toward the earth in that time. He next computed the space through which a body removed to the distance of the moon ought to fall in the same period under the action of the earth's gravitation, and compared these results together. Though this calculation seems simple enough, it really occupied him for many years; and when at length he had completed it, he found a considerable resemblance between the amounts, but not a sufficiently close one to satisfy him, and he, therefore, laid the work aside for a time. After some time, however, he heard that a more accurate determination of the earth's diameter had been effected, and he accordingly repeated his calculations, substituting the new figures; and when at length he had completed his bewildering task, he found the result to agree most accurately. In order to fully satisfy himself of the accuracy of his theory, he went through the same calculations again in reference to some of the planets, and obtained like results; he then announced his general fundamental law before mentioned, that "every particle of matter in the universe attracts every other particle with a force proportioned to the quantity of matter in each, and decreasing inversely as the squares of their distances."

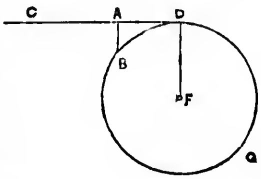


Fig. 122.

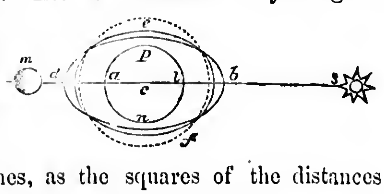
The motion of the planets is thus seen to be compounded of two, the one the motion which the body has in a straight line continuously, the other that which arises from the attraction of the body around which they move.

Having attained this result Newton set himself one more task; and that was, to ascertain, on mathematical principles, the curve in which the planets ought, in these conditions, to move. This was a calculation requiring the greatest amount of mathematical skill. Newton, however, possessed this, and set about the work fully expecting that the curve must be an ellipse. But he found when the work was completed one which represented not only this, but any of the "Conic Sections," that is, of the curves which may be obtained by cutting a cone. These are the *circle*, which is the curve obtained when the cone is cut parallel to the base; the *ellipse* when it is cut a little inclined to this; the *parabola* when the line passes parallel to one side of the cone; and the *hyperbola* when it passes parallel to the axis. In any one of these curves then a planet may move under the influence of these general laws; the satellites of Saturn move in the first; the planets generally in the second, while the comets pursue their courses in parabolas and hyperbolas. This grand discovery of Newton seems to have completed our knowledge of the fundamental laws of motion of the worlds around us. By this we find that all their motions depend upon the two simple laws of *inertia* and *mutual attraction*, and that all their variations can be fully explained by these. And further, deeper investigations show us that though all the stars are in ceaseless motion, yet their motions run through fixed and certain cycles, so that the very fluctuations of the heavenly bodies are certain indications of the stability of the universe.

Great as Newton's work was he did not live to accomplish all his task. He discovered the mutual attraction of the heavenly bodies for one another, but left it to succeeding astronomers to calculate the effects this attraction would produce on the movements of each. That this was a work involving some difficulty will readily be seen if we consider the case of only a single planet. For illustration, let us take Venus; suppose now for a moment that only that planet and the sun existed, we could then easily mark out the exact position of the planet for every moment, if we knew its mean distance and the eccentricity of its orbit. Now add the earth to the system, and we shall find that a disturbing influence is at once introduced by its attraction. As Venus comes into that part of its orbit nearest the earth, it is attracted by the latter, and thus drawn out of its path; its motion is likewise accelerated as it approaches the earth, and retarded as it recedes from it; and the calculation of the amount of this disturbance is rendered more difficult by the fact that the earth is itself moving with a velocity different from that of Venus. When we have made due allowance for this disturbance we have to consider the effects produced by each of the other planets in turn, keeping in mind that they too are all in motion. We thus get some idea of the complication of the problem. It has, however, been completely worked out by modern astronomers, the due allowance being made for each of these disturbing forces; and this has been done with such wonderful accuracy that when certain minute irregularities were perceived in the motions of one of the planets, (Uranus), which could not be accounted for by the influence of any of the known ones, it was conjectured that another planet must exist beyond Uranus. Two astronomers accordingly, as we have seen, set about the calculation quite independently of each other, and determined the spot in which a planet should be, if it existed at all; and on turning a telescope to that spot the planet Neptune was discovered, though at no point of its orbit could it come within 130,000,000 miles of the planet whose course it had been disturbing by its attraction. One fact may be particularly noticed as the result of these investigations; and that is, the absolute stability of the universal system, it being so equally balanced that all these perturbations exactly compensate for one another, and, after a cycle of prodigious length, all return to their original places.

THE TIDES.

The tides, as most readers know, are the alternate risings and fallings of the waters of the seas and oceans, and of bays, friths and rivers connected with them. This alternate rising and falling of the water is distinguished as the "flow" and "ebb" of the tides. They are caused by the attraction of the sun and moon upon the waters of the earth, but especially by that of the latter. Let us illustrate this by a figure. Suppose *a p l n* to be the earth, *c* its centre of gravity; let the dotted circle represent a mass of water covering the earth; let *m* be the moon in its orbit, and *s* the sun.



Since the force of gravity diminishes, as the squares of the distances increase, it is evident that the waters will rise at *d* by the direct attraction of the moon *m*, and will rise at *b* by the centre of gravity *c* being drawn away from it, and leaving the waters on the opposite regions of the earth from the moon to accumulate in like manner in order to maintain equilibrium. Of course when the sun is on the side *b* of the earth its attraction tends to elevate it still more. It is evident, the quantity of water remaining the same, that a rise cannot take place at *b* and *d* without the parts at *e* and *f* being at the same time depressed. In this situation the waters of the earth may be considered in somewhat of an oval form. Were the earth and moon without motion, and the earth covered all over with water, the attraction of the moon would raise it up in a heap in that part of the ocean to which the moon would in such a case be vertical; but by the rotation of the earth on its axis each part of its surface to which the moon s vertical is presented twice in a little more than a day to the attraction of the moon; and thus are produced two floods and two ebbs. If the moon were stationary there would be two tides in one day; but because that body is proceeding every day more than 12° in her orbit from west to east, the earth must make more than one rotation on its axis before the same meridian comes again into conjunction with the moon; and hence two tides take place in about 24 hours and fifty minutes. In the position of the earth and moon, as given in the figure, the waters are raised at *d* by the direct attraction of the moon, and a tide is accordingly produced; but when by the earth's rotation *a* comes, in twelve hours afterwards, into the position of *l*, another tide is occasioned by the receding of the waters there from the centre. In those parts of the earth to which the moon is vertical the tides rise highest; in all other parts, the effect is less, because the force of the attraction acts in a direction more oblique. You will readily understand that the tides are dependent upon fixed and determinate laws which are known; for if you refer to an Ephemeris, or an Almanac of a certain kind, you will see that the exact time of high water at certain places, say at London Bridge, the port of New York, New Orleans, or Canton, or any other place that may be mentioned in this connection, on the morning and afternoon of every day in the year, is set down.

Those men who are accustomed to work in the harbors, and along the coasts, although they are generally ignorant of the causes which produce the tides, yet know by experience that the time of high water differs on each day about three quarters of an hour, or a little more or less; and, therefore, if it be high water to day at six o'clock, they will at a guess promptly tell you that to-morrow the water will not be up till a quarter to seven.

The attraction of the sun, owing to the immense distance at which he is placed from the earth, produces but a small effect in comparison with that produced by the attraction of the moon. Sir Isaac Newton computed that the attractive force of the moon raised the waters in the ocean ten feet, and that of the sun raised it only two feet. When the moon is in her first and last quarters, the attraction of one of these bodies raises the water while that of the other depresses it, and in order to learn the height to which the water now rises, the attractive force of the sun has to be *subtracted* from that of the moon; these tides consequently are the lowest, and are called *Neap-tides*. The tides which happen at new or full moon, owing to the direct attraction of the sun and moon, are highest, and are called *Spring tides*. The height of the tides at these times is found by *adding together* the attractions of the sun and moon. It is evident that at new moon the sun and moon attract the earth on the same side, and that the attractive force of the sun has to be added to that of the moon in order to find the height to which the waters now rise; and the waters receding from the centre to the side of the earth opposite to the sun and moon, has to heap up there equally in order that the equilibrium of the earth be maintained. And at full moon the powerful attraction of the moon draws the waters towards itself on the side next to it; in consequence of which, and to maintain equilibrium, the water accumulates equally on the opposite side of the earth. The sun now exerting his attraction on this latter side increases the height of the water about one-fifth; and, of course, an equal recession of the waters from the central regions of the earth have to take place towards the side next the moon, in order to counterbalance and to have the height of the waters on the opposite sides of the earth the same, or, at least, so that there will be equilibrium. Consequently, at the full moon, as well as at the new, the height to which the tides rise is found by adding together the attractive forces of the sun and moon.

The tides rise higher at some times than at others, owing to the fact that the moon revolves round the earth in an elliptical orbit, or an orbit which is slightly elliptical, and, therefore, approaches nearer the earth in some parts of her course than in others. When she is nearest the attraction is strongest, and, therefore, the tides rise highest; and when she is farthest from the earth the attraction is the least, and the tides are lowest. They rise also to different heights in different places; in the Mediterranean and Black Sea the tides are scarcely perceptible. At the mouth of the Indus the water rises about 30 feet. The tides are remarkably high on the coasts of Malay, in the Straits of Sunda, in the Red Sea, along the coasts of China, Japan, and in the Bay of Fundy, etc. In general the tides rise highest and with greatest force in those places which are narrowest. When the sun and moon are both vertical to our equator, and the moon in *perigee*, then the tides are highest. Speaking strictly, however, these tides do not happen at the equinoxes, but a little before and after them; for in this, as in other cases, the actions do not produce the greatest effects when they are at the strongest, but some time afterwards. Thus, the hottest time of the day is not when the sun is on the meridian, but usually between one and four o'clock in the afternoon. Another circumstance is to be taken into account: the sun being nearer the earth in winter than in summer, it is of course nearer to it in October and February than in September and March; and therefore, all these things being considered, sufficient cause may be found why the highest tides happen a little before the *vernal* and a little after the *autumnal* equinoxes. The moon's attraction having more effect upon the tides than that of the sun, their height varies with the distance of the moon from the earth; and as they are highest when she is in *perigee*, or nearest the earth, so they are lowest when she is in *apogee*, or farthest from the earth. All these effects are, however, known, and their causes accounted for; and the times of the tides and the heights to which they rise at certain places are calculated long before, so that all may know these facts.

It is plain from what has been said on this subject that the phenomena of the tides depend entirely upon two counteracting principles,—that of the attraction of the sun and moon disturbing the waters, displacing the centre of gravity, and destroying the equilibrium of the globe of the earth—and the tendency of the waters themselves to maintain equilibrium about their proper centre of gravity. All these effects are produced by His agency who is everywhere present, and in whom we live and move.

ON COMETS.

THE planets and their satellites were for some time considered to be the only proper members of our system. This view, however, has been found to be erroneous, as many bodies called comets have had their orbits calculated, and been found to revolve round the sun in regular periods. Comets have from the earliest ages of their discovery attracted a large share of attention from their great size and brilliancy, as well as from the suddenness with which they appeared, and the rapidity with which they extended these long tails which usually distinguish them. These vast streams of light sometimes extend to the distance of eighty and a hundred millions of miles in length. In past ages and among most peoples they have been objects of superstitious dread, their appearance being usually considered as portentous of war, famine, pestilence, the death of monarchs, the subversion of kingdoms, or other great evils. On account of this apprehension the periods of their appearance have usually been carefully recorded, and in calculating their orbits considerable assistance is at times derived from these ancient records. The appearance in the year 1066 of a brilliant comet having three tails was considered by many as a sign of the invasion and conquest of William of Normandy. In some of the ancient chronicles it is referred to as furnishing a proof of his divine right to the kingdom of England. But not only were comets considered as harbingers of evil, but fears were often entertained that they should in their course come into collision with the earth and thereby cause terrible results. This feeling still exists to a limited extent, considerable alarm having been manifested by many on the appearance of the comet in 1858, which in one part of its course passed across the earth's orbit. The utter groundlessness of these fears will be seen when people learn something of the physical constitution of these bodies. In ancient times comets were generally supposed to be meteors, or exhalations, generated by inflammable vapors in the earth's atmosphere; but now it is ascertained beyond a doubt, that comets move in regions far beyond the limits of our atmosphere, and form a portion of the solar system. But they differ in many respects from the planetary bodies before described. The planets revolve round the sun in orbits of small eccentricity, which for the most part approach nearly to circles.

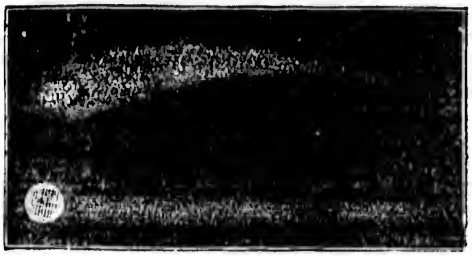
Comets, on the other hand, move in extremely elongated ellipses, parabolas or hyperbolas, the sun being situated almost at one extremity of their orbits; so that often, at their perihelion, they approach within less than a million of miles of it, and they swiftly dash away for a considerable period from his light and heat. It is clearly only those which move in elliptical orbits which can be periodical, as the parabola does not return again upon itself. About 300 comets have already had their orbits calculated, and of these more than one half are known to be parabolas; so that no second return of these latter can occur, unless, by the attraction of other heavenly bodies, their orbits should be considerably altered. Only five or six have been found to move in hyperbolic orbits. The number of known periodic, elliptic, comets, whose orbits and periods have been ascertained, is about 20.

Fig. 123, COMET OF 1811.

Elliptic orbits have, however, been assigned to many others, but no second returns of them have yet been seen, so as to verify the calculations. In by-gone days, before the invention of the telescope, but few comets were observed. But now scarcely a year passes without four or five being observed; and frequently the number is greater. For the most part, however, they are so small as only to be visible by the aid of a good telescope. It is only at rare intervals that those large ones which are at once discerned by the naked eye become visible to us. The periods of these, likewise, are as a rule very much longer than those of the telescopic comets, so that the orbits of only a few of them have been determined. The first indication of a comet is usually a faint luminous speck visible with a telescope. This appears gradually but slowly to increase, as the comet approaches the sun; and soon a bright spot, known as the *nucleus*, is discerned in it. This is usually of a circular form, and situated nearer to the side that is directed towards the sun. In telescopic comets this nucleus is not always discernible. As the comet approaches the sun it becomes larger and brighter; the coma, or cloudy mass around the nucleus also becomes less regular; and soon a tail begins to be extended on the side remote from the sun. It is this which forms the most remarkable feature in the appearance of a comet. The tail is usually more or less curved, and points away from the sun; so that when receding from that body the comet travels with his tail foremost. The annexed figure 123 representing the comet of 1811, gives a good idea of the general appearance of these bodies, the nucleus, coma, and tail being all distinctly marked. A period of 3,065 years was assign-

Fig. 124.

Fig. 125.



ed to this comet. On their return, after completing their orbits, comets seldom present the same appearance as before; hence they cannot be

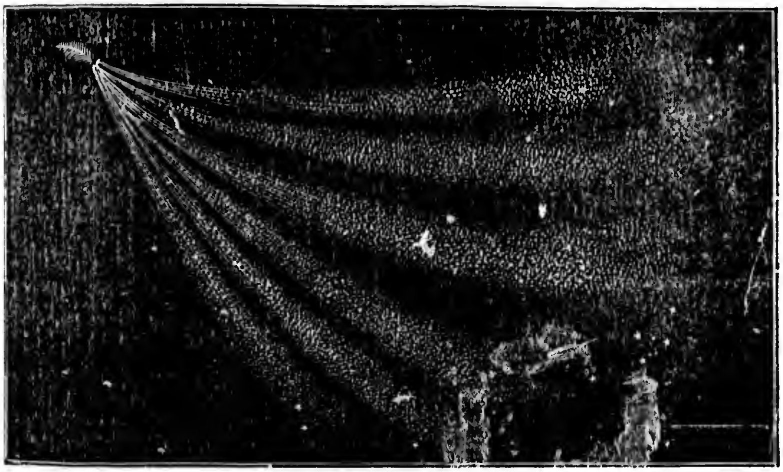


Fig. 126.

identified by their form, but by the calculation of their orbits. According to many old illustrations some comets have presented very remarkable shapes, sometimes closely resembling swords or sabres. But allowance should be made by us in such cases for the imagination of the artist, excited by the terror occasioned by the approach of the comet. A few comets that have been observed had more than one tail. One, that appeared at the end of 1823, had, in addition to the usual tail, a second one directed toward the sun. The comet of 1774 is, however, the most remarkable, as it is stated that when it approached the sun, the tail was divided into six distinct branches, all curved in the same direction and extending 30° or 40° in length.

That called Halley's comet is one that has attracted a greater degree of attention than almost any other, as it was the first whose orbit was calculated, and its period is the longest of all those whose orbits are fully ascertained, and verified by subsequent returns. On its appearance in 1682, just after attention had been excited by the appearance, two years before, of a brilliant one whose motions Newton had investigated, Halley carefully examined its movements, so as to ascertain whether those of any which had previously been noted would in any way accord with them. He soon found that in several respects it seemed to resemble those of 1531

Fig. 127.

Fig. 128.

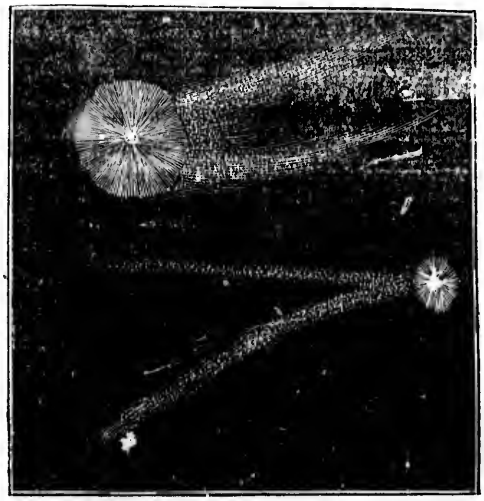


Fig. 124 is a view of a comet as seen on October 21st, 1807, by Schroeter ; figure 125 is a view of the same comet as seen on the following evening, October 22. Figure 126 represents the tail of the splendid comet of 1744, which was divided into six branches. Fig. 127 represents the comet of 1661 as seen by Hevelius ; the atmosphere or nebulosity surrounding the nucleus of this when viewed at different times varied in its extent, as likewise the tail in the length and breadth. Fig. 128 represents a class of comets which have their tails somewhat bent, which some suppose to be owing to the resistance of the ethereal fluids through which they move.

and 1607, and imagined that all three might be in reality appearances of the same body, its period being somewhere about seventy-five and a-half years. This conjecture proved to be correct, and Halley's comet is now reckoned as one of the members of our system, revolving round the sun in a period of seventy-six to seventy-eight years, its greatest and least distances from the sun being 3,200 and 56 millions of miles respectively. The return of this and all other comets is frequently retarded or accelerated by the attraction of the planets which happen to lie near their course. The period given above is, however, the mean period of Halley's comet; and on its last return, in 1835, the allowances to be made for the influences of the planets were so carefully calculated, that the date of its perihelion passage was predicted within four days. The next return of this body is to occur in the year 1912. By searching back through the list of comets which have been seen, very many appearances of this body can be traced; one as far back as 11 B. C.; and the comet of 1066, already referred to, was, it is believed, an appearance of the same body. It made its appearance in 1456 with a very long tail, considerably curved; and an eclipse of the moon occurred when the comet was in close proximity to it, creating intense alarm.

The comet known as Donati's, which appeared in 1858, will perhaps be remembered by some. It was first seen on the 2nd of June, at Florence,

DONATI'S COMET.

by Dr. Donati, after whom it was named. Its movements for the next two months were very slow. Towards the end of August, faint traces of a tail began to appear, and it soon became visible to the naked eye. It accomplished its passage round the sun on the 29th of September, its tail vastly increasing in length, being on the 10th of October upwards of 50,000,000 miles long. On the 5th of October the comet passed in front of the star Arcturus, and though a portion of the tail, at its densest part, having a thickness of several thousand miles, intervened between the observers and the star, its light was not so much enfeebled as it would have been by the faintest fog on the earth's surface. While the tail of this comet was being thrown out the nucleus was watched, and presented the appearance of a series of coverings being thrown off, and passing into the tail. As many as seven of these envelopes were distinctly observed. The tail appeared much brighter at the edges, and a dark band passed down the middle as if it consisted of a hollow cane. The observations on this comet were very numerous, and there is little doubt but that it revolves in an elliptic orbit, completing its journey in about 2000 years. The comet that appeared in 1861, was also a very remarkable one from the suddenness with which it came to view. It was discovered in the Southern hemisphere about the middle of May; and in the latter part of

COMET OF 1861.

June it was seen in the Northern hemisphere, only a portion of the tail being above the horizon in England, the 29th of this month. Its brightness was very remarkable, being greater than that of the one seen in 1858. Its tail, when at its greatest length, extended over nearly 80°, and was perfectly straight. It was, however, somewhat fan-like in shape. The annexed figure represents it, and shows the appearance of the nucleus when the tail was a throwing off. Mr. Hind states that it is probable that on the 30th of June, the earth actually passed through the tail of the comet: and it is remarked in connection with this that on that day Mr. Lowe, and one or two other observers, noticed a peculiar phosphorescent glare in the sky.

M. Biela, in 1826, discovered a comet which has since been known by his name, and has become remarkable. Observations made at different times soon showed that it moved in an elliptical orbit, and its period was found to be about 6½ years. Its return, in 1832, took place within a few hours of the predicted time. On its next visit to the sun it was invisible, owing to the position of the earth with respect to it and the sun being such that the comet was lost in the sun's light. Towards the close of 1845, when it again returned, a strange phenomenon was seen. The comet, which at first appeared almost circular, gradually became lengthened out, and at length divided into two parts, which continued to travel separately until lost sight of. Both parts reappeared in 1852, the distance between them having somewhat increased in the meantime. In 1859 it was again in an unfavorable position for observation, and so was not seen; and in 1866, from some unknown cause, it could not be found. Whether it has been altogether thrown out of its course by the attraction of some planet near which it passed, or what has become of it is a matter that astronomers are at a loss to ascertain. There are several other comets which have a strange history; but we can only refer to one, Encke's, which performs its revolution in a period of about 3¼ years. More appearances of this comet have been carefully observed than of any other, and by a comparison of these different observations Encke found that on each return it accomplished its passage round the sun in 2½ or 3 hours earlier than he expected. Its period thus appears to be diminishing by this amount, in each revolution. He conjectured that this might be accounted for by supposing that all space is occupied by an extremely rare medium, but yet one sufficiently dense to retard the comet to this extent, and thus to cause it gradually to be falling in towards the sun. Other conjectures have been made, but the matter is still a moot point among astronomers.

Of the physical constitution of these bodies comparatively little is as yet known. They are believed to be self-luminous masses of vapor revolving round the sun. Some have supposed that in a few comets a solid nucleus exists; but the evidence on this point does not appear to be very strong, and if one does exist it evidently is very small. The general opinion, however, is against its existence at all, and the great majority of comets are known to be devoid of one. That the mass of these bodies is extremely minute is seen by the way in which they are affected by many of the heavenly bodies which they approach. Lexell's comet, for instance, when approaching the sun in 1770, passed so near to the planet Jupiter that it was entangled for several months among his satellites. Its orbit was completely changed by this contact, but no effect whatever could be discerned upon the satellites ; whereas, had the comet's mass been at all appreciable, their times of revolution might have been slightly modified. So also the comets of 1858 and 1861, though they both passed near the earth, did not alter the length of our year by a single second. The fact that the light of even faint stars is scarcely at all diminished by passing through the tail of a comet has frequently been observed. It is known that the whole mass of a comet is so small that even though one should come into full collision with the earth no injurious effects would follow from the blow. Several large comets have at times passed so close to the sun as almost to graze his surface. The heat, therefore, to which they were exposed must have been extremely great, but they appeared not to be at all affected by it. The number of comets connected with our system has hitherto been found impossible to enumerate. Some have imagined that it must, indeed, be very great. But this fact is certain that there may be many which from their position are altogether hidden from our view. The following is a list of the principal comets recognized as belonging to the solar system :

Name.	Period.	Date of next appearance.
De Vico's	5·469 years	Oct., 1872.
Winnecke's	5·541 "	Feb., 1875.
Brorsen's	5·581 "	Jan., 1874.
Biela's	6·617 "	May, 1872.
Faye's	7·44 "	June, 1873.
Vestphal's	67·8 "	1920.
De Vico's	73·25 "	1919.
[illegible]	75· "	1922.
Halley's	76·78 "	1912.

There are many others whose periods and dates have been calculated, but some need confirmation. As some of these latter closely agree in period it has been conjectured that they have originally formed part of one large comet, which divided in a similar way to Biela's.

Shooting Stars : Meteorites.

We shall on a clear night be almost certain to see falling or shooting stars. These are much more common at certain seasons of the year than at others, but scarcely a night passes without some being visible. For a long period there appears to have been little or no notice taken of them by astronomers, it being believed that they owed their origin merely to gaseous exhalations from the earth, which became ignited in the atmosphere. But it was found that at some times the number seen was immensely greater than at others, and instances are recorded in which they outnumbered the ordinary stars, so that the display was termed a star or meteoric shower. Humboldt speaks of one of these which he witnessed on the 13th of November, 1799, when travelling in South America, and says: "Towards morning we witnessed a most extraordinary scene of shooting meteors. Thousands of bodies and falling stars succeeded each other during four hours. From the beginning of the phenomena there was not a space in the firmament equal in extent to three diameters of the moon, which was not filled every instant with bodies of falling stars." On the 13th of November, 1831, another grand meteoric shower was witnessed, which was followed by others on the same date in 1832 and 1833. The last of these seems to have been the most brilliant and splendid that has been recorded. It was observed with peculiar effect in some of the cities of the United States. The whole of the sky appeared to be on fire, and in many places the utmost terror and alarm was caused by the sight. Thus writes one of the papers of that date in the Eastern States: "From a point in the heavens about 15° south-easterly from our zenith the meteors darted to the horizon in every point of the compass. Their paths were described in curve lines similar to those of the circles of longitude on an artificial globe. They were generally short in their course, resembling much an interrupted line — — — — thus. They ceased to appear when within 10° of the horizon. I did not see a single meteor pass the meteoric pole I have described, nor one pass in a horizontal direction. Several of them afforded as much light as faint lightning. One in the north-east was heard to explode with a sound like that of the rush of the distant sky-rocket. Millions of these meteors must have been darted in this shower. The singularity of this meteoric shower consisted in the countless numbers of the celestial rockets, and more especially in their constant uniform divergence from near the zenith."

Fig. 129.

The annexed cut represents the appearance of these meteors for several hours as seen at Boston, New York, Philadelphia, and other places in the eastern parts of the United States. It is copied from one of the periodicals published in the Eastern States about the time when these phenomena appeared.

Another observer wrote: "The scene was truly awful, for never did rain fall much thicker than the meteors fell toward the earth." Many of the meteors were observed to leave behind them luminous trains, which were visible for a greater or less period. These have obtained the name of the November meteors, from the fact that at this period especially they fell in great numbers on three consecutive years. One remarkable fact was observed during the shower, and this was, that all the shooting stars appeared to radiate from a single point in the constellation Leo. According to the concurrent testimony of the observers this radiant point was stationary among the stars during the whole period of observation, that is, it did not move along with the earth in its diurnal revolution eastward but accompanied the stars in their apparent progress westward—which tends to show the elevation of the meteors to have been beyond our atmosphere. Continued observations have shown that in the month of November there is always a much greater display of these bodies than at other times of the year. By examining likewise the records of these showers it was noticed that the grand displays seem to take place about every thirty-three years, sometimes being seen for two or three consecutive years. It was accordingly suggested that not improbably a brilliant display might be seen in 1866; and though the numbers seen were not nearly so great as in 1833, the display was very grand and beautiful, so that those who watched through the night felt amply repaid for their trouble. Nearly all, as in previous instances, appeared to radiate from the star in Leo, and close to this spot many faint ones were seen, some seeming just to appear and vanish again, without having changed their position perceptibly. These were evidently travelling directly towards the earth, and hence their trains were so foreshortened as to be invisible.

These then are the main facts in connection with the phenomena of these meteors; and our task now is to find what we are to learn from them as to the nature and movements of these bodies. As we have observed, several facts seem to show that they had their origin beyond the surface of the earth; and the annual periodicity, it is supposed, may indicate that in certain parts of its orbit the earth is passing through a portion of space which is especially crowded with them. By noting the position of the spot whence they appear to radiate we learn the direction whence they are coming, and we find that the earth seems actually to be in the midst of a stream of them. There is an opinion now prevailing that there is a *ring* of those bodies revolving round the sun. This ring is about the dimension of the orbit of the earth; it is inclined to the plane of the ecliptic at an angle of about 17°, cutting it just in the part in which the earth is situated on the 13th of November, so that at this period the earth is just passing through the ring. When the earth then at this time meets the stream of meteors they will, of course, seem to radiate from one point. Their uneven distribution in the stream may account for their constant fluctuation in number, and at any period they will only be visible to that part of the earth which is directed toward them. This explanation is, however, not deemed sufficient to account for the star shower being so much more brilliant one year than another, nor for the periodical interval of 33 years. It is thought moreover that, if we suppose that in one part of the ring they are clustered together more thickly than in the rest of it—that there is, in fact, in one part, a rich assemblage of these bodies, and that this group revolves in its orbit in about eleven days less than the earth does,—the whole will be explained. This assemblage, it is thought, extends over some small portion of the ring, so that at times the earth may for two or three successive years pass through or near the dense portion. It gains about 12° annually, so that for some thirty years the earth only passes through the portion where they are less crowded.

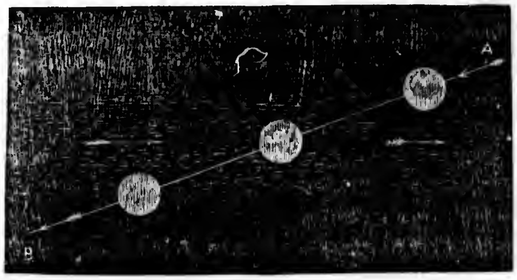


Fig. 130.

Thus, in the figure, we suppose the dotted lines to represent the zone of meteorites distributed unevenly, but still for the most part kept within narrow limits. These are moving along from left to right. About the 13th of November the earth is moving along the part A B of its orbit in the direction indicated by the small arrows. It, therefore, meets the stream of meteors, which will, of course, all appear to radiate from one point. Their constant fluctuations in number will be accounted for by their uneven distribution in the ring; and at any period they will only be visible to that part of the earth which is directed toward them.

Besides the 13th of November there are other periods at which large numbers of these bodies are seen. The 9th–11th of August is such a period; and though the numbers then seen are usually less than in November, the display is more certain and more uniform. There appear to be several of these rings of meteorites through which the earth passes at different periods; and a considerable number of radiant centres from which they diverge have been noted. Some astronomers suppose that the August and November meteors are parts of the same ring, which therefore cuts the earth's orbit in two points. The opinion that they are two separate rings is, however, more generally received. M. Arago, the French astronomer, is of opinion that we cannot account for such extraordinary phenomena unless we suppose that beside the planetary bodies which revolve around the sun there are myriads of smaller bodies, which only become visible at the moment when they come within our atmosphere, and assume a meteoric appearance: and that they move in groups and also singly: all of which opinions are in support of the "ring theory." Dr. Olmsted, of Yale College, who particularly investigated the meteoric showers of 1833, deduces the following among other conclusions; *that* the distance of the body whence they emanated was about 2238 miles: that they entered the earth's atmosphere with a velocity of four miles per second: *that* some of the larger meteors must have been bodies of great size, not less than a mile in diameter; and *that* they consisted of portions of a nebulous body which revolves around the sun in 182 days; all of which is in favor of the "ring theory."

As to the nature or constitution of these bodies not much yet is known. It is believed, however, that they are for the most part small solid bodies revolving round the sun as already described. If they are moving in a contrary direction to the earth, the velocity with which they enter the earth's atmosphere must be very great. The resistance of the air soon checks this motion, but by the friction thus produced the body is so intensely heated that it becomes luminous, and ultimately is entirely consumed. The average height at which they become visible is seventy miles, and their course is about thirty miles. The weight of most of them is believed to be very small, possibly not more than a few grains. There are, however, a few which are much larger, and owing to their size pass unconsumed through the atmosphere, and fall to the earth's surface. These are usually distinguished as *meteorites*, and are sometimes divided into aerolite, or meteoric stones, aerosiderites, or pieces of meteoric iron. It is not known whether these bodies, like those already described, move in elliptical orbits, though it as been observed that they too are somewhat periodical.

The fall of many of these has been recorded, and in many instances the masses themselves are carefully preserved. When the body has been seen to fall a loud report has frequently been heard, accompanying it, and sometimes fragments have been scattered over a large area, indicating that while falling the meteorite exploded. Mr. Barham relates that when riding in Jamaica one evening, he beheld a ball of fire apparently about the bigness of a bomb swiftly falling down with a great blaze. Approaching the place where it fell he found the ground strangely broken up, and ploughed, and several holes appeared of the bigness of a man's head, and all the green herbage burned up near the holes; at the same time he experienced a strong smell of sulphur.

In the year 1676 a great globe of fire was seen at Bononia, in Italy, about forty minutes after sunset. It passed with a rapid course, at the rate of not less than 160 miles a minute, and at last stood over the Adriatic Sea. It crossed all Italy in its course, and by computation it was found that it could not have been less than thirty-eight miles above the earth's surface. Wherever it approached, the inhabitants below could distinctly hear it with a hissing noise resembling that of a firework. It was heard to go off with a violent explosion. Its magnitude, when over Bononia, appeared twice as long as the moon one way and about as broad the other.

It was estimated to be a mile long, and about a half a mile broad. One of the most striking and extraordinary of this kind of meteors made its appearance in Britain on the 18th of August, 1783, about nine o'clock in the evening. It was seen in all parts of the island, from the Shetland Isles to the English Channel, over all France, and a great part of Italy, and is supposed to have described a tract of at least 1000 miles over the surface of the earth. It appeared to have burst and re-united several times, and the first bursting which was noticed was somewhere over Lincolnshire, in England. Its appearance created universal wonder and alarm. When it was observed at Brussels the moon appeared quite red, and the illumination was so great as totally to obliterate the stars. A report was heard sometime after it disappeared, which was very loud in the south-eastern counties of England. A hissing sound was said also to accompany its progress. At Greenwich two bright balls, parallel to one another, led the way, and were followed by the expulsion of eight others. The balls seemed tinted first with a pure bright light, then followed a yellow mixed with azure, red and green, which, with a coalition of bolder tints, and a reflection from the other balls, gave the most beautiful rotundity and variation of color with which the eye could be charmed. The height of this fire-ball was reckoned at from seventy to ninety miles; its diameter was estimated at nearly two miles, and its velocity at 1000 miles a minute. The same year, on October 4th, at forty-three minutes past six in the evening, another meteor appeared nearly of the same description, but much smaller and of shorter duration. It was first perceived to the northward, as a stream of fire, like the common shooting stars, but large; and presently burst out into that intensely bright bluish flame, which is peculiar to such meteors. It was nearly globular, but left behind it a dusky red streak of fire. After moving ten degrees in this state it became suddenly extinct without any explosion. Its height was estimated at between forty and fifty miles. The celebrated Gassendi relates that a meteor fell at Vaison, in France, of the size and shape of the human head; it was mainly composed of iron. In April, 1803, a brilliant fire-ball was seen in Normandy, travelling very rapidly; shortly after which a loud explosion was heard, and a great number of pieces of stone fell to the ground, nearly 3000 being collected. When picked up soon after they have fallen these bodies are usually found to be intensely hot. On chemical examination no new elements have been discovered in them. The greater number of them are found to contain iron, usually in a very large proportion: and nickel is nearly always found associated with it.

Some of these meteors, especially the large fiery ones, doubtless owe their origin to gaseous exhalations from the earth, which, assuming different forms in the atmosphere, under a variety of combination, descend to the earth again with the manifestation of light; and, as for the rest, (the star showers), the theory of small bodies revolving round the sun in an orbit which intersects the plane of the earth's orbit, whence they would come within the sphere of the earth's attraction, does not appear unreasonable, and may be sufficient to account for their appearance. The idea of any of the heavenly bodies, by explosive action of any internal or external force, sending any of their constituent parts beyond their spheres of attraction, appears as unreasonable as it is impossible.

The Aurora Borealis, or Northern Lights.

For beauty there is none of the luminous meteors that surpass the Aurora Borealis or Northern Lights. This is not unfrequently seen in our latitudes, but less frequently and with far less splendor than it appears in the polar regions. Its form varies greatly: when perfectly developed an arch of light appears to cross the sky a little way above the horizon, and from this quivering streamers dart upward continually towards the zenith, giving rise to the name of "the merry dancers," by which this phenomenon is sometimes known. Frequently several auroral arches are seen at once, and the effect is then very grand and sublime. At other times the

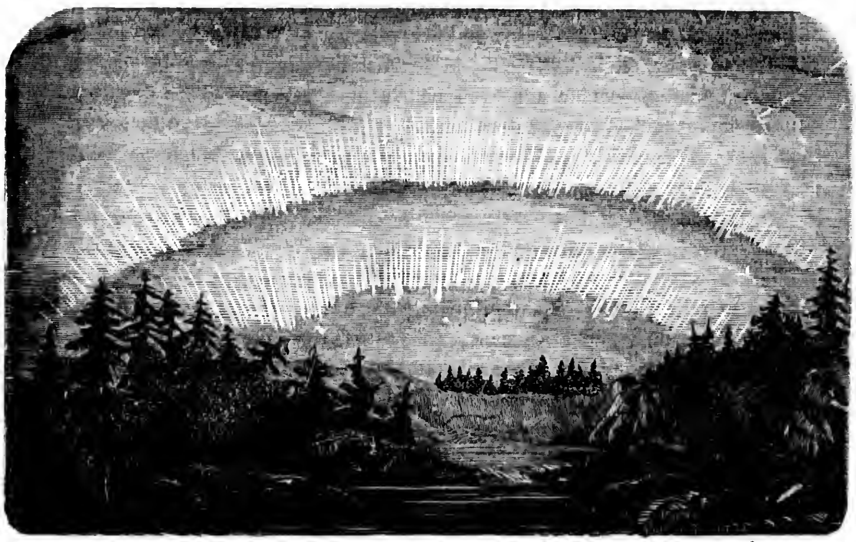


Fig. 131.—THE AURORA BOREALIS OR NORTHERN LIGHTS.

streamers appear to shoot up from behind distant hills. It has also been known to assume the form of a huge curtain suspended in massive folds, which reflect various colors. The Aurora in our latitudes appears almost always far less distinct and perfect than any of these; at times its ruddy glow has been mistaken for that of a distant fire.

Various hypotheses have been started to account for these appearances. The fluctuations of the magnetic needle, which occur during their continuance, indicate strongly an electrical origin; and this is further confirmed by the fact that telegraphic messages have been interrupted and the alarms rung by the auroral currents. Earth currents are also much stronger during the continuance of the Aurora, and hence this phenomenon is now generally attributed to the discharge of electricity in the upper regions of the air.

The Mariner's Lights.

The Mariner's Lights, sometimes called St. Elmo's Fire, is another of the electrical meteors. A bright flame-like light is seen at the top of the masts and sometimes at the ends of the spars. This flame often points towards an approaching cloud, increasing in length as the cloud passes over it; at times it has been seen as much as two or three feet long. The appearance is easily accounted for, and a good illustration of the same effect is seen by holding a sharp point near the conductor of an electrical machine. The electricity from the cloud, instead of passing off in the form of a flash of lightning, is in this way silently carried off by induction. In mountainous regions travellers have occasionally noticed a somewhat similar appearance at the end of their sticks or umbrellas, and a faint hissing sound usually accompanies it. The air in this case is highly electrical; and the pointed ends of the sticks have served to attract the fluid and discharge it. Both the Aurora and the Mariner's Lights are merely manifestations, as light, of a substance which we may call electricity.

THE FIXED STARS.

Let us now turn our attention for a little from the solar system to the fixed stars which appear in such vast profusion in the sky; and before we begin to contemplate these remote luminaries it may be well for the reader to form some idea of the distances at which they are from us, and as to the magnitudes of some of them. Great as the sun and his surrounding planets are they dwindle into a point when we wing our way to the regions of the stars. Before we could arrive at the *nearest* star that is visible from our globe we behooved to pass over a space of at least twenty billions of miles in extent, a space which a cannon ball flying with its utmost velocity would not pass over in less than *four millions of years.* Here every eye on a clear winter's night may behold a thousand shining orbs, most of them emitting their splendor from spaces immeasurably distant; and bodies visible to us at such distances must necessarily be of immense magnitudes. There is reason to believe that the least twinkling

star which our eyes can discern is not less than the sun in magnitude and splendor; and that many of them are a hundred or even a thousand times superior in magnitude to that stupendous luminary. Sir W. Herschell, when speaking in reference to Dr. Wollaston's photometrical experiments on the light of Sirius, (the brightest star), says, "Dr. Wollaston assuming, as we think he was perfectly justified in doing, a much lower limit of possible parallax in Sirius than we have adopted in the text, has concluded the intrinsic light of Sirius to be *nearly that of fourteen suns.*" Sir W. Herschell informs us that with a magnifying power of 6450, and by means of his new micrometer, he found the apparent diameter of *Vega* or *a Lyræ* to be 0′, 355; this will give the real diameter of the star about 38 times that of the sun, or 33,440,000 miles, supposing its parallax to be one second. Were this its true estimate its solid contents would be 19,579,357,857,382,400,000,000, or above nineteen thousand, five hundred and seventy-nine trillions of cubic miles; which is fifty-four thousand, eight hundred and seventy-two times larger than the solid contents of the sun.

It is very difficult from mere inspection to form any estimate of the number of these bodies; it appears, however, from catalogues which have been compiled, that the total number of stars visible to the naked eye is about 6000. One half of the sky only can be seen at one time, and the number visible on a clear night may therefore be set down approximately at 3000. These stars vary greatly in brilliancy and apparent size, and have accordingly been divided into six classes, the brightest being classed as of the first magnitude, while the faintest visible to the naked eye are set down as of the sixth; the rest being divided into the intermediate four magnitudes. As a general rule it is computed that stars of the first magnitude are about 100 times as brilliant as those of the sixth. The light of Sirius is estimated, however, to be equal to that of 324 of the latter. Though the number of stars seen by the naked eye is thus limited it must not be supposed that these are all that exist. If we direct a telescope to any part of the sky we shall at once perceive that the field of view is covered with points of light, and the number of these telescopic stars is found to be infinitely greater than that of those visible to the naked eye. These telescopic stars are classed into magnitudes down to the fifteenth and sixteenth, or even lower, according to the power of the telescope employed for bringing them into view. The stars are especially numerous in the regions of the Milky Way, that starry belt that encircles the sky, with which every common observer is familiar. The ancients seem to have believed that the brightness of this zone was owing to a confluence of stars, for Ovid writes: "Its groundwork is of stars." Soon after the invention of the telescope, when astronomers were enabled to penetrate the stellar regions, they were astonished at the number of stars that appeared in this shining zone of the heavens; and their numbers appeared to increase in proportion to the magnifying powers of their telescopes. It was not, however, till Sir W. Herschell applied his powerful instruments to this region of the heavens that its profundities were explored, and all its minute nebulous parts shown to consist of countless myriads of stars, of every apparent magnitude stretching onward to infinity, until they appeared to be lost to the eye, even when it was assisted by the largest telescopes. In several fields of view of this zone, occupying a space not much more than twice the breadth of the moon, one perceives through a good telescope more of those twinkling luminaries than all the stars visible to the naked eye throughout the whole canopy of heaven. In certain places in it every slight motion of the telescope presents new groups and new configurations; and the diversified and wondrous scene is continued over many degrees in succession. The variety and the beautiful configurations of the stars strikes the observer with amazement, and makes him feel as if he were lost in penetrating the immensity of the universe. Sir W. Herschell explored this region of the heavens with a Newtonian reflecting telescope of twenty feet focal length, and an aperture of eighteen inches. He found that this telescope completely *resolved all the whitish appearances into stars*, which the telescopes he had formerly used had not light enough to do. The portion he first observed was that about the hand and club of Orion; and he found in this space an astonishing number of stars, the number of which he endeavored to estimate by counting many fields; that is, the apparent spaces in the heavens he could see at once through his telescope, without moving it, and computing from a mean of these the number that may be contained in a given portion of the Milky Way. In the most vacant space to be met with in that region he found 63 stars; other six fields contained 100, 60, 70, 90, 70, and 74 stars; a mean of all which gave 79 for the number of stars in each field; and then he found that, by allowing 15′ for the diameter of his field of view, a belt of 15° long and 2° broad, which he had often seen pass through his telescope in an hour's time, could not contain less than 50,000 stars, large enough to be distinctly enumerated; beside which he suspected twice as many more which he could see only now and then by faint glimpses for want of sufficient light. The reader may remember that these stars extended onwards to infinity, that is, that there is *no end* to them in that one or in any direction; and the small place occupied by those now mentioned is only the $\frac{1}{1375}$th part of the visible canopy of the heavens; so that if every part of the firmament were equally rich in stars, there would be *within the reach* of such a telescope as Herschell's no less than sixty-eight millions, seven hundred and fifty thousand stars. And it may be further considered that it was only in the comparatively "vacant spaces" of this zone that the number of stars stated above were perceived.

In exploring some other parts of this zone, Sir W. Herschell informs us that he descried a much greater number of these luminaries in a similar extent of space. "In the most crowded parts of the Milky Way," he says, "I have had fields of view that contained no fewer than 588 stars, and these were continued for many minutes, so that in one quarter of an hour's time there passed no less than 116,000 stars through the field of view of my telescope." In order to understand this description, we are to understand the telescope to have been fixed in one position at the time of observation; and that, by the diurnal motion of the earth, or the apparent motion of the heavens, the first field of stars gradually passed out of view, and other fields appeared in succession; until, in the space of fifteen minutes of time, one hundred and sixteen thousand stars passed over the field of vision. Now the field of view taken in by the telescope was only 15′ of a degree less than the one-half of the apparent size of the moon. In this narrow field were seen about as many stars as observers generally behold throughout the whole firmament by the naked eye in a clear winter's night. At another time, this indefatigable astronomer perceived no less than 258,000 stars pass before his view in the course of forty-one minutes. In the space between β (Beta) and γ (Gamma) of the Swan the stars are found clustering with a kind of division between them, so that they may be considered as clustering toward two different regions. In this space, taking an average breadth of about 5°, he found from observation that it contains more than 331,000 stars, which gives above one hundred and sixty-five thousand for each clustering collection. If we suppose every part of this starry belt equally full of stars as this space now referred to, it will contain no less than 20,191,000 stars; for, supposing the Milky Way to be, on an average, 12° broad, the whole of it will contain an area of $4320° = 12° \times 360°$, for this belt extends clear round the heavens. Now if the space examined by Herschell between Beta and Gamma of the Swan be about 14° in length, and 5° in breadth, it will contain an area of 70°, which is somewhat less than the $\frac{1}{61}$st part of the space occupied by the Milky Way. The whole visible heavens considered as a concave spherical plane contains an area of 41,253 degrees. Now could we suppose every portion of the firmament to be equally well replenished with stars as the Milky Way, there would be more than 195,000,000, or more than one hundred and ninety-five millions of stars in the heavens *discernible* by such a telescope as that of Herschell; but as there are comparatively few other regions of the heavens which are open to our view so densely crowded with stars as the Milky Zone, we must make a certain reduction from this estimate of *discernible* stars, though it is most probable there are more than one hundred millions of stars within the reach of our best telescope, were all the spaces of our firmament moderately well explored; and future generations with more perfect instruments will probably add indefinitely to the number.

Had we taken the most crowded field of stars which Herschell perceived through his telescope, namely, 588, as our standard for estimating their number, the number of stars in the Milky Way would have been forty millions, and in the whole firmament three hundred and eighty-eight millions. In short, to use the words of Sir John Herschell: "This remarkable belt, when examined through powerful telescopes, *is found* (wonderful to relate!) *to consist entirely of stars scattered by millions like glittering dust on the black ground of the general heavens.*" Now in regard to the distances of some of these discernible stars, we may easily conceive that they are immense, and far beyond our distinct comprehension. Sir W. Herschell, in endeavoring to determine a "sounding line," as he terms it, to fathom the depth of the stratum of stars in the Milky Way, undertakes to prove by pretty conclusive reasoning that his *twenty-feet* telescope penetrated to distances not less than 497 times the distance of Sirius; so that a stratum of stars amounting to 497 in thickness, each of them as far distant from each other in a direct line beyond Sirius as the star Sirius is distant from our sun, was within the reach of his vision, when looking through that telescope. Now the least distance at which we can conceive Sirius to be distant from the earth or sun is 20,000,000,000,000 or twenty billions of miles, and consequently the most distant stars visible in his telescope must be four hundred and ninety-seven times this distance, that is, 9,940,000,000,-000,000, or nearly ten thousand billions of miles. Such immense distances are already infinitely beyond the power of our conception; a cannon ball moving at the rate of 500 miles an hour would occupy more than 2,267,-855,068, or two thousand two hundred and sixty-seven millions, eight hundred and fifty-five thousand years in traversing that amazing interval.

On our first excursions into the celestial regions we are almost terrified at the idea of the distance of Saturn, which a cannon-ball projected from the earth and flying with its utmost velocity would not reach in 180 years. We are astonished at the size of such a globe as Jupiter, which could contain within its circumference over thirteen hundred globes of the size of the earth. We are justly amazed at the stupendous magnitude of the sun, which is more than a thousand times the size of Jupiter, and which illuminates with his splendor a sphere of more than five thousand millions of miles in circumference. But what are all such distances and dimensions, vast and amazing as they are, when compared with the astounding grandeur of the scene before us? They sink into comparative insignificance, and are almost lost sight of amidst the myriads of splendid suns which occupy the profundities of the Milky Way. What is one sun and one planetary system, in the presence of ten millions of suns, perhaps immensely more resplendent, and vastly more magnificent; and of hundreds of times this number of spacious worlds, which beyond all doubt revolve around them! Yet this scene, stupendous as it is, is not the universe. It is indeed only a comparatively small corner of it, which beings at an immensely greater distance will behold as an obscure and scarcely discernible spot on the outskirts of their firmament, and infinite numbers will not be able to behold at all, being situated at infinite distances from it. So that amidst this vast assemblage of material existence we may say in the language of the prophet, when speaking of the Almighty: "Even here is but the hiding of His power." Now what is man and the globe on which he dwells, amidst this sublime scene of immensity and magnificence! An atom in the infinite space, an infinitely small particle of vapor compared to the ocean, a being who in respect to the magnificence of the universe and the grandeur of his Creator, is as nothing, and is counted to Him as less than nothing, and vanity.

Double Stars.

When we observe the heavens on a clear night we see here and there two stars in very close proximity; the telescope further reveals to us the fact that very many of those which appear to the naked eye as single stars consist in reality of two or more so close together that they appear as one. Sir W. Herschell was the first to direct special attention to these, of which he compiled a list. He hoped that by accurate measurements of the apparent distance between them, he might be able in some instance to detect a variation, and thus ascertain their parallax, and by this their distances. The idea, then, was that these stars merely appeared close together because they happened to be in a straight line directed almost towards the earth: that they were in fact merely optical couples, one being at an immense distance behind the other. After long continued observations, Herschell found that their distances and relative positions did vary, but instead of it being, as he expected, an annual fluctuation caused by the earth's motion, it was a progressive change. He thus found that in some cases the stars were revolving round one another in elliptic orbits, and that they were physical couples, the two forming one system. These he called binary stars, or couples, to distinguish them from optical pairs. Other observers have followed up these investigations, and there are now upwards of 600 binary stars known and noted, and in many cases their times of revolution are thought to have been calculated. Of course these results will have to remain subject to future modifications, for we know that, considering the immense distances of the stars, accuracy in these respects can only be approximated to.

One of the best examples of double stars is afforded by ε Lyrae, which is sometimes called the double-double star. To the naked eye it appears a somewhat faint star, but a telescope of very moderate power will show it to be double. But when a more powerful instrument is employed, each of these components is in turn found to consist of two smaller ones. The lower pair, it is said, revolves in about 2000 years, and the upper in about half that time, while the two couples take a very long period to revolve around their common centre of gravity. See the annexed figure. It is but lately that the attention of astronomers has been directed to such observations; and on account of the very minute distances of the revolving stars from each other, and the slight variations in the angle of position which can be traced for a series of years, an age or two is requisite in order to determine with precision the degree of progress of their revolutionary movements. In the course of time, and by means of improvement in optical instruments, we may believe many important discoveries will be made in reference to the bodies in question, and that what is at present doubtful and obscure will be rendered definite and precise. But as the most powerful instruments which can be invented can carry our view only a very small distance comparatively beyond the outward boundaries of those mighty visible heavens which surround us, millions of those systems may still exist in those remote regions which will forever remain inexplorable by the inhabitants of the earth.

Colored Stars.

One remarkable feature in connection with those binary stars is the fact that in some instances the component stars are of different colors. In ρ Leporis, for example, one is white, while the other is deep red. In β Cygni again the colors are yellow and blue. And in γ Andromedæ they are orange and green. "Many of the double stars," Sir John Herschell remarks, "exhibit the beautiful and curious phenomena of contrasted or complementary colors. In such instances the larger one is usually of a ruddy or orange hue, while the smaller one appears blue or green; probably in virtue of that general law of optics which provides that when the retina is under the influence of excitement by any bright colored light, feebler lights, which seen alone would produce no sensation but of whiteness shall for the time appear colored with the tint complementary to that of the brighter. Thus a yellow color predominating in the light of the brighter star, that of the less bright one in the same field of view will appear blue; while if the tint of the brighter star verge to crimson, that of the other will exhibit a tendency to green, or even appear as a vivid green under favorable circumstances. The former contrast is beautifully exhibited by *Iota Cancri*, the latter by *Gamma Andromedæ*, both fine double stars. If, however, the colored star be much the less bright of the two it will not materially affect the other. Thus, for instance, Eta Cassiopeiæ exhibits the beautiful combination of a large white star and a small one of a rich ruddy purple. It is by no means, however, intended to say that in all such cases one of the colors is a mere effect of contrast ; and it may be easier suggested in words than conceived in imagination what variety of illumination two suns, a red and a green, or a yellow and a blue one, must afford a planet circulating about either, and what charming contrasts and grateful vicissitudes, a red and green day, for instance, alternating with a white one and with darkness, might arise from the presence or absence of one or other or both above the horizon. Insulated stars of a red color almost as deep as that of blood, occur in many parts of the heavens, but no green or blue star of any decided hue has we believe ever been noticed unassociated with a companion brighter than itself." This variety of colors in the double stars arises doubtless for the most part, if not altogether, from complementary colors ; and as to the stars that appear insulated, and exhibit a red color, we know there are different degrees of whiteness in light ; the light of a candle, for example, or that which arises from the incandescence of some of the elementary substances is not as clear a white as the solar light ; and, further, when we come to note the color of different stars, and compare it with former records, we find that in a few instances a change has taken place. Thus, Sirius, which now shines with a pure bright light, is spoken of by old observers as a ruddy star. There are also many others which exhibit changes in brilliancy ; and these changes seem in most cases to be periodical. The star on which this discovery was made is *Omiron Ceti*, called also Mira, or the wonderful star, a name that is very appropriately given to it. At the time of its greatest brightness it is usually of the first or second magnitude, it then decreases for two or three months till it becomes invisible, and remains so for about five months, its minimum brightness being about equal to that of a star of the twelfth magnitude. It then again appears, and the whole period occupied in these changes is about 331 days. Algol or *Beta* Persei is another variable star, remarkable for its short period and rapid changes. It ordinarily appears a star of the second magnitude, but in a period of three and a-half hours it diminishes in brightness to the fourth magnitude, and after a few minutes begins again to increase, and attains its former brilliancy in another period of three and a half hours. At this it remains two days thirteen hours, and then the same series of changes recurs.

We have mentioned that the telescopic stars are classed into magnitudes, according to their apparent brightness through the telescope. The question naturally suggests itself whether these different degrees of brightness result from differences in the size of the stars, or in their distances. To this it cannot be answered with certainty, as there are only a few stars whose distances have been approximately measured. There appears, however, to be little doubt that the difference is chiefly in their distances. The distances of the stars are ascertained in the same manner as those of the sun and planets, that is, by parallax. Instead, however, of taking two stations at different parts of the earth's surface, and having the distance of the earth's diameter or semi-diameter as a base line between them, the diameter of the earth's orbit is taken as a base line which is 183,000,000 miles, the observations being taken at intervals of six months, or when the earth is in the two opposite points of her orbit. But even with this immense line the parallax is so small, that it can only be detected by the most careful observations, and accurate instruments. In no case has it been found to be greater than 1″, and if this be its value the distance of the star must be 206,000 times as great as that of the sun. The parallax of about a dozen of stars is now believed to be ascertained, and is found to vary between 0·919″ and 0·046″. The star *Alpha Centauri* is the nearest to the earth, and its distance is estimated at 20,496,000,000,000, or twenty billions four hundred and ninety-six thousand millions of miles: while the average distance of stars of the first magnitude is probably three or four times as great as this. These figures, however, fail to convey to the mind any definite idea as to the real distances.

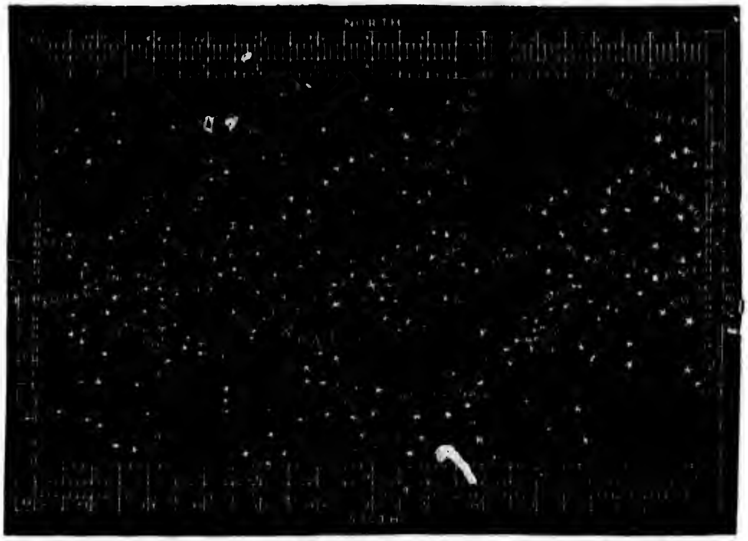
In studying the stars we need some mode of distinguishing them, and in this there is some little difficulty. The heavens were divided by the ancients into twelve constellations or assemblages of stars, which they designated by different names, as before mentioned; and many new ones have been added to this number in modern times, so as to make in all 109. Several of these are, however, but small and unimportant, and hence are rejected by some astronomers. Special names, too, have been assigned to many of the most brilliant stars, but these have a tendency to confuse. In 1604 a German astronomer, named Bayer, published a celestial atlas, in which he designated the stars in each constellation by the letters of the Greek alphabet, the brightest being called α, the next β, and so on. This plan was found to answer so well that it has been continued to the present time. In some constellations, however, the number of stars now catalogued is so great that more letters are required to denote them: the English alphabet, therefore, follows the Greek; and if both prove insufficient the remaining stars are denoted by numbers. In a few instances in Bayer's catalogue the stars are not arranged quite in their order of brightness, either from want of accuracy in Bayer's observations, or from a change in the light of the star since his time; but it is considered better not to attempt to amend this, as it would only produce confusion. The best plan for one to follow who wishes to become acquainted with the different constellations is to study the sky itself with the aid of some maps, or of a celestial globe. Several of the constellations, as the Pleiades, the V-shaped Hyades; and Orion, with the three stars in the belt, commonly known as the Yard Measure, also the Great and the Little Bear, and the Pole Star, are familiar to almost every one: these will serve as a guide in determining others.

The stars are all of them bright, self-luminous bodies, like our sun, which, indeed, appears to other worlds to be one of the stars. Delicate observations show that they have proper motions, but it is very difficult and requires long-continued observations to determine them. We can however, ascertain the motion of the sun by observing the relative distances of the stars. The stars in one part of the sky are seen gradually opening out, and getting further apart, while in the opposite quarter they are as gradually closing up; evidently showing that we are moving towards the former part of the heavens, just as when we are travelling in a forest the trees in front seem opening out, while those we have passed appear to be getting closer together. Now Sir W. Herschell found that the apparent proper motion of 44 stars out of 56 are very nearly in the direction which should result from a motion of the sun toward the constellation Hercules, or to a point of the heavens whose right ascension is 250° 52½′, and north declination 49° 38′. "No one," says Sir J. Herschell, "who reflects with due attention on the subject will be inclined to deny the high probability, nay *certainty*, that the sun has a proper motion in some direction." If the sun then have a proper motion in space, as it is more than probable it has, all the planets with their satellites, along with the comets, must partake of it; so that beside their own proper motions around this luminary, they likewise move along with the sun through the depths of infinite space with a velocity perhaps approaching to that with which they move around in their orbits. The earth will, therefore, partake of three motions, one around her circumference, one round the sun, and another in the direction in which the sun is moving; and consequently it is probable we shall never again occupy that position in infinite space through which we are now passing.

The sun, with his system of planets, &c., is found to occupy a position in a nebulæ or cluster of stars, of which the Milky Way forms the main part. This Milky Way in one part of its course round the celestial sphere divides

SECTION OF THE MILKY WAY.

into two branches, which after separating a little way, and passing about a third round the sky, again unite into one. This may be illustrated by taking a flat circular body, as, for example, a cheese, and splitting it in the centre of the circumference, by passing a knife one third of the way through, the two parts being made to diverge a little as shown at a b in the figure. The sun s is situated somewhere near the centre, and the split side causes the divided appearance of the Milky Way. Of course if the sun is moving through the regions of space, as beyond doubt it is, though at a slow rate of motion compared with the orbitual motions of the planets, all the other stars of this nebular cluster are also moving relatively; for the fixed stars



MINIATURE MAP OF THE HEAVENS ON MERCATOR'S PROJECTION, SHOWING THE COURSE OF THE MILKY WAY.

always maintain the same relative positions to each other. The sun with his system, doubtless, revolves in a cycle to which thousands of years are as nothing, in an elliptical or circular orbit, round some reciprocal centre of gravity.

Temporary Stars.

Closely allied to the variable stars are the new or temporary stars which have at times attracted much attention. Several appearances of such stars have been recorded; one of the most remarkable is that observed by Tycho Brahe, in November, 1572. This star seems to have burst forth very suddenly, as it is said the constellation Cassiopeia, in which it appeared, had been carefully observed by an astronomer only two days before the star was seen, and that then no trace of it was observed. Also, Tycho Brahe himself did not see it at half-past five when going from his house to his laboratory; but returning to his house about ten, he came to a crowd of country people who were staring at something behind him. Looking round he saw this wonderful object. It was so bright that his staff cast a shadow; it was of a dazzling white, with a little of a bluish tinge. It had no hair or tail around it, similar to comets, but shone with the same kind of lustre as the other fixed stars. It was even seen by those who had good eyes at noonday. Its phenomena, it is said, were so striking as to determine the celebrated Tycho Brahe to become an astronomer. This star continued visible for about sixteen months, gradually becoming fainter till it disappeared. In 945 and 1264 stars had appeared in the same constellation in a somewhat similar manner, and as the intervals between the three dates are almost equal, it has been conjectured that they might be three appearances of the same object. If this be the case this star in the course of a few years,(in 1891 or 1892, as thus its period would be about 319 years), may make its appearance again, and thus we might have an opportunity of gazing upon this object, which in former times attracted so much attention. Another temporary star of considerable brilliancy appeared in the year 1604, and was also carefully observed by Brahe. Modern times, however, have furnished us with several instances of this kind. In 1848 Mr. Hind observed a new star in Ophiuncus. It increased in brilliancy to the fourth magnitude, but subsequently decreased to the 11th or 12th, at which it now remains. In 1866 a new star appeared in the Northern crown, and was very minutely examined. It had been previously noted as of the sixth magnitude, but it suddenly shone out as a star of the second magnitude; its light, however, diminished very rapidly for some time. Attention was at once directed to it, the spectroscope being now available for observation. This instrument exhibited, in addition to the ordinary spectrum of the star, a second spectrum of bright lines, prominent among which were those indicative of burning hydrogen; so that it appears as if in this instance a sudden blaze was produced by incandescent *hydrogen*, and other substances.

When old star catalogues are compared with those of the present day, it is found that, in addition to many changes of magnitude, several stars, whose places are there recorded, are now no longer to be seen; and, on the other hand, that some of those now known are not recorded in the old lists, although their brilliancy is considerable, and would probably have insured their insertion had they been visible. In many other cases doubtless the discrepancy may have arisen from errors in observation; but there is no doubt that many stars have altogether disappeared, and it is not improbable that some of these may be variable stars, which, after a more or less prolonged absence, may again become visible. Different explanations have been offered to account for these phenomena. Some imagine that it revolves in an immense orbit, and that when it is visible it is in the part of that orbit nearest the earth, gradually increasing in brilliancy as it approaches to its nearest point, and gradually diminishing as it departs from it, which is not at all a reasonable supposition in the case of the stars. Some imagine the star to rotate, and one part of its surface to be more luminous than another, which is a very reasonable supposition; others suppose that a planet of large dimensions may revolve around the star and thus eclipse its light, which may or not be a reasonable supposition; but there is *no known* instance to us of a larger body revolving round a smaller one. If the telescope had been in use in the time of Brahe, he might have learned more about the star which he saw. Astronomers now are only waiting, in the hope that future researches aided by the spectroscope and by more powerful and refined instruments may throw fresh light on the whole subject. All the variable stars are being closely watched with this object in view.

Clusters and Nebulæ.

Besides the stars and planets we easily distinguish in the sky various groups called clusters or nebulæ. These are usually divided into *Irregular Groups*, more or less visible to the naked eye; *Clusters*, resolvable by good telescopes; and Nebulæ, many of which on account of their immense distance are irresolvable with the most powerful telescopes yet made. There are many examples of the first class, among which may be mentioned Præsepe or the Beehive, and the sword handle in Perseus, both of which are very beautiful telescopic objects. Very many objects of the second class have also been noted. In ordinary telescopes they appear

Fig. 132. The Great Nebula in Orion.

for the most part as faint cloudy masses; but as more powerful instruments are directed to them they begin to resolve into stars, apparently placed very close together. Every increase yet made in the power of the telescope has had the effect of resolving more of these clusters. As to shape and appearance these objects vary greatly, some being globular or elliptical masses, while others present very strange forms. The great nebula in Orion, and the Dumb-bell nebula in Vulpecula, are examples of this. See an illustration of the nebula in Orion in Figure 132; and of Dumbbell nebulæ, Figures 133 and 134. Many, however, can only be partially resolved, parts of misty matter gradually fading away in the distance being distinguishable apart from the stars. No definite line can indeed be drawn to distinguish between clusters and nebulæ. So great is the

Fig. 133.

number of these objects that a catalogue of them compiled by Sir J. Herschell contains no less than 5,079. As to their character and distance

Fig. 134.

we may derive some information from the observations of Sir W. Herschell. Most of the nebulæ *yielded* to his Newtonian reflector of twenty feet focal distance, and twelve inches aperture, which plainly discovered them to be composed of stars, or at least to contain stars, and show every other indication of their consisting of them entirely. "The nebulæ," says he, "are arranged into strata, and run on to a great length; and some of them I have been able to pursue, and to guess pretty well at their form and direction. It is probable enough that they may surround the whole starry sphere of the heavens, not unlike the Milky Way, which undoubtedly, is nothing but a stratum of fixed stars. And as this latter immense starry bed is not of equal breadth or lustre in every part, nor runs on in one straight direction, but is curved and even divided into two streams along a very considerable portion of it, we may likewise expect the greatest variety in the strata of the clusters of the stars and nebulæ. One of these nebulous beds is so rich that in passing through a section of it in the time of only thirty-six minutes, I have detected no less than thirty-one nebulæ, all distinctly visible upon a fine blue sky. Their situation and shape, as well as condition, seem to denote the greatest variety imaginable. In another stratum, or perhaps a different branch of the former, I have seen double and treble nebulæ variously arranged; large ones with small seeming attendants; narrow but much extended lucid nebulæ, or bright dashes; some of the shape of a fan, resembling an electric brush issuing from a lucid point; others of the cometic shape, with a seeming nucleus in the centre, or like cloudy stars surrounded with a nebulous atmosphere. A different sort again contains a nebulosity of the milky kind, like that wonderful, inexplicable phenomenon about Theta Orionis; while others shine with a fainter mottled kind of light which denotes their being resolvable into stars." "In my late observations on nebulæ," says Sir W. Herschell, on another occasion, "I have found that I generally detected them in certain directions rather than in others; that the spaces preceding them were generally quite deprived of their stars, so as often to afford many fields without a single star in it; that the nebulæ generally appeared some time after among stars of a considerable size, and but seldom among very small stars; and when I came to one nebula I generally found several more in the neighborhood; that afterward a considerable time passed before I came to another parcel. These events being often repeated in different altitudes of my instrument, and some of them at considerable distances from each other, it occurred to me that the intermediate spaces between the sweeps might also contain nebulæ, and finding this to hold good more than once, I ventured to give notice to my assistant at the clock that I found myself on nebulous ground." The discoveries of the Herschells support the view that all the stars in the universe, so far at least as discernible by the telescope, are arranged into systems, which revolve round their respective centres; and that the stars are not dispersed at random in a kind of magnificent confusion through boundless space; and may likewise exist systematically in immense clusters throughout the regions of infinitude. Of course, we may certainly believe that each of these stars that appear in space or in the far distant nebulæ by the telescope, is itself, as our sun, the centre of a planetary system. The very object of a sun is to give light and heat to surrounding worlds, as well as to be their bond of attraction. All space is replenished at certain intervals with opaque globes, although they may never appear to our naked eye, nor yet happen within the view of our telescopes; the very idea of stable equilibrium in the universe teaches this; there is not a globe too many in one region of space, nor a globe less than enough in another region ; nor does the law of gravitation allow us to suppose that even the smallest amount of matter can be in excess or in deficiency in the systems of the universe without having the universal order disarranged and the balance of equilibrium destroyed. Astronomers have descried the self-luminous globes, because they are of immense size and of great brilliancy ; but the investigation of opaque globes which exist in infinite numbers and of various sizes throughout space, and on which the sensitive and rational creatures of God exist, presents a noble field of labor for their eternal employment.

The nebulæ have great variety of forms; some are comparatively bright, and others so obscure as to render it difficult to detect them in the field of view of the telescope, or to ascertain their shape. Some of them appear round, some oval, and others of a long elliptic shape ; some exhibit an annular form like luminous rings, and others appear like an ellipsis with a dark space in the centre ; but the greater number approximate to a roundish form. Of the 103 nebulæ inserted in Messer's catalogue eighteen were known at the time to consist of small stars ; but Sir W. Herschell afterward found twenty-six more of them to consist purely of clusters of stars, eighteen of small stars accompanied with nebulosity, and the remainder not resolvable into stars by the highest powers of his telescopes. But it is evident that these objects, though apparently small and obscure, must be systems of immense magnitude, when we take into consideration the vast distances at which they must be situated from our globe. As to this point

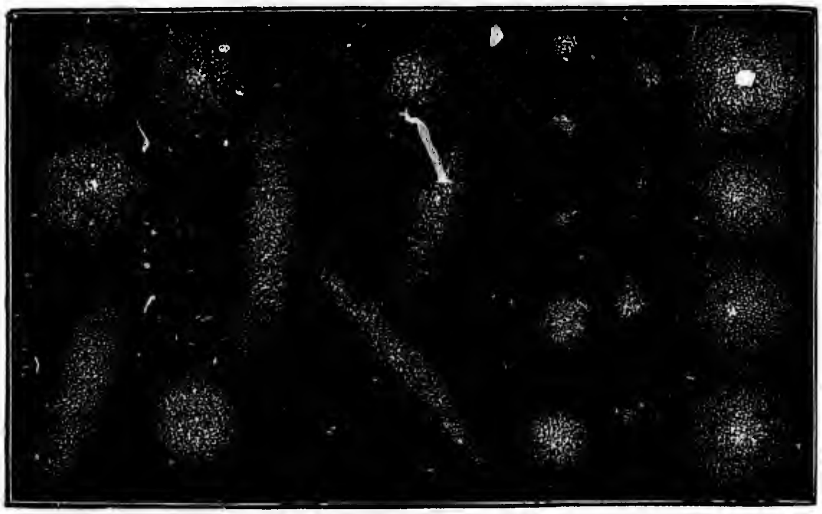


Fig. 135.

Sir W. Herschell speaks as follows : " My opinion of their size is grounded on the following observations : There are many round nebulæ of about five or six minutes in diameter, the stars of which I can see very distinctly ;

and on comparing them with the visual ray calculated from some of my long gauges, I suppose by the appearances of the small stars in these gauges that the centres of these round nebulæ may be 600 times the distance of Sirius from us." He then goes on to show that the stars in such nebulæ are probably twice as much condensed as those of the cluster in which we are placed; otherwise the centre of it would not be less than 6000 times the distance of Sirius; and that it is possibly much underrated by supposing it only 600 times the distance of that star. "Some of these round nebulæ have others near them perfectly similar in form, color, and the distribution of stars, but of only half the diameter; and the stars in

Fig. 136.

These are Specimens of Nebulæ of various descriptions: Dumb-bell nebulæ; nebulæ resembling the cluster to which our system belongs; diffused nebulæ; and nebulous stars.

them seem to be doubly crowded, and only at about half the distance from each other. They are indeed so small as not to be visible without the utmost attention. I suppose these miniature nebulæ to be at double the distance from the first. An instance equally remarkable and instructive, is a case where, in the neighborhood of two such nebulæ as have been mentioned, I met with a third similar resolvable, but much smaller and fainter, nebula. The stars of it are no longer to be perceived; but a resemblance of color to the former two, and its diminished size and light, may well permit us to place it at full twice the distance of the second, or about four or five times the distance of the first; and yet the nebulosity is not of the milky kind, nor is it so much as difficultly resolvable or colorless. Now, in a few of the extended nebulæ the light changes gradually, so as from the resolvable to approach the milky kind, which appears to me an indication that the milky light of nebulæ is owing to their much greater distance. A nebula, therefore, whose light is perfectly milky, cannot well be supposed to be at less than six or eight thousand times the distance of Sirius; and though the numbers here assumed are not to be taken otherwise than as very coarse estimates, yet an extended nebula which, in an oblique situation where it is possibly foreshortened by one half, two-thirds, or three-fourths of its length, subtends a degree or more in diameter cannot be otherwise than of a wonderful magnitude, *and may well outvie our Milky Way in grandeur*." It seems to be a very natural conclusion that the nebulæ which are perfectly similar in form, color, and the distribution of stars, but of only half the diameter of the other, and the stars doubly crowded, are about double the distance from the first. And if the distance of the larger nebulæ, whose stars are distinctly seen, be at least 600 times the distance of Sirius, as there seems reason to believe, then the distance of those which are only half the diameter must be 1200 times the distance of that star, that is at the very least 24,000,000,000,000,000, or twenty-four thousand billions of miles. But the nebulæ whose light is "perfectly milky," or so far removed from us that the stars of which they are composed cannot be separately distinguished, may ' reasonably considered as at seven thousand times the distance of Sirius, or in number 168,000,000,000,000,000, or one hundred and sixty-eight thousand billions of miles; a distance indeed of which we cannot by any means form a distinct conception. A cannon ball flying with its utmost velocity would require more than thirty-eight thousand millions of years before it could move over an equal space. Since the distances of these nebulæ are so immensely great, and since those that are nearest us are found by actual observation to be composed of countless numbers of stars, leaving us no room to doubt that the most distant are also immense systems of the same character, how vast must be the magnitude, and how inexpressible the grandeur, of the numerous luminaries of which they are made up; and how immensely great the number of planetary bodies which revolve around them through boundless space!! From all the observations of Sir W. Herschell, he is of opinion that our Nebula, or the Milky Way, as it may be termed, is not the most considerable within the range of vision; and he points out some very remarkable nebulæ, which in his opinion cannot be less, but are probably *much larger*, than that of which our sun and system form a part.

Some idea of the extreme faintness of some of the distant nebulæ may be formed from the estimate which has been made that their light varies from $\frac{1}{1500}$ to $\frac{1}{20000}$ of that of a sperm candle a quarter of a mile distant. The nebulæ, as has been seen, are not distributed by any means uniformly over the surface of the sky, the greater number of them being situated in a zone crossing at right angles the Milky Way. In the constellation Virgo there is the greatest aggregation of them, one portion of it being known as the nebulous region of Virgo; and in the southern hemisphere, not far distant from the pole, are two brilliant cloud-like patches, called the Magellanic clouds, or Nubeculæ. These, when examined by the telescope, are found to be composed of stars, clusters, and nebulæ, collected together seemingly, but most probably in their order of distance. In appearance they somewhat resemble a portion of the Milky Way; but they are quite distinct from it.

One of the most remarkable and extensive nebulæ in the heavens is that which is found in the constellation of Orion.* In looking at that constellation, which makes a splendid appearance in the southern sky during the winter months, the first object which arrests one's attention is the three brilliant stars equidistant from each other in a straight line, which is called the belt of Orion. Immediately below these, hanging down as it were from the middle of the belt, three small stars at nearly equal distances are perceived, which are termed the sword of Orion. On directing the naked eye to the middle star of these three, the observer perceives something which has the appearance of a small star, but not well defined; this is the great nebula of Orion, of which, however, one can form no definite conception without the aid of a good telescope. With a common pocket achromatic telescope, of a foot in length, the nebulosity may be plainly perceived; but the higher the magnifying power, and the larger the aperture of the object-glass, the more brilliant and distinct does this phenomena appear, along with a number of small stars connected with it, which are quite invisible to the unassisted eye. Huygens was the first to discover this phenomena, and he gives the following description of it in his *Systema Saturnium:* "Astronomers place three stars close to each other in the sword of Orion; and when I viewed the middlemost with a telescope, in the year 1656, there appeared in the place of that one twelve other stars among these three, that almost touch each other, and four

* See Fig on page 385.

more beside appeared twinkling as through a cloud, so that the space about them seemed much brighter than the rest of the heavens, which, appearing wholly blackish by reason of the fair weather, was seen as through a certain opening through which one had a free view into another region which was more enlightened. I have frequently observed the same appearance in the same place without any alteration; so that it is likely that this wonder, whatever it may be in itself, has been there from all time; but I never took notice to anything like it among the rest of the fixed stars." The reader will easily recognize the description in the figure of this nebula here presented which has been obtained, however, by means of a more perfect telescope than any that were in use in the time of Huygens. The following is Sir J. Herschell's description of this phenomenon: "I know not how to describe it better than by comparing it with a curdling liquid, or a surface strewed over with flocks of wool, or the breaking up of a mackerel sky, when the clouds of which it consists begin to assume a curious appearance. It is not very unlike the mottling of the sun's disc, only, if I may so express myself, the grain is much coarser and the intervals darker, and the flocculi, instead of being generally round, are drawn into little wisps. They present, however, an appearance of having been composed of stars, and their aspect is altogether different from that of resolvable nebulæ. In the latter we fancy by glimpses that we see stars, or that could we strain our sight a little more we could see them; but the former suggests no idea of stars, but rather something quite distinct from them." It is calculated that this wonderful nebula would fill a space twenty-nine millions of times larger than that contained within the orbit of Uranus; so that compared with it the whole solar system is but an imperceptible point. It is also calculated that there are many nebulæ within the reach of the telescope which altogether surpass in extent, in grandeur, and magnificence the cluster to which our system belongs, or the Milky Way. And what of those that extend *in every direction in endless succession!!*

Variable Nebulæ.

Some of the nebulæ, like some of the stars already referred to, are found to be variable. In October, 1852, Mr. Hind discovered a very small one with a star of the tenth magnitude near to it. This was afterwards observed, and its position noted, by other astronomers, but in 1861 it had entirely disappeared. Another nebula, which had frequently been observed as a well-defined compact cluster, was found in May, 1860, to be replaced by a seventh magnitude star. After a few weeks the stellar appearance had ceased, and the cluster seemed to be resuming its usual form. The question as to the real constitution of the nebulæ is one which has given rise to much speculation. There is now little or no doubt expressed as to many of them being starry systems somewhat resembling our own cluster, but immensely removed from it. This belief rapidly gained ground as one after another of the nebulæ was resolved, by the application of more powerful telescopes; and it is very generally believed that all the telescopic nebulæ will ultimately be thus resolved. The hypothesis previously received was that they consisted merely of masses of cloud-like matter. When the spectroscope was first directed to one of those objects, owing perhaps to the faintness of the light, no spectrum could be obtained, but merely a short luminous band. A second and third fainter bands were afterward made out, and these lines were found to correspond with those indicative of nitrogen, hydrogen, and barium. These facts seem to point strongly to the conclusion that the light emanated from incandescent gaseous matter.

The Nebular Hypothesis.

Before the invention of the telescope, and for some time after its invention, while it was yet comparatively imperfect, the nebulæ were supposed to be vast, formless masses of vapory matter scattered here and there throughout space. Hence arose the "nebular hypothesis," as it is termed, according to which the sun and our whole system of planets originally existed in the form of a mass of nebulous matter filling a space greatly exceeding that contained within the orbit of Uranus. This vast mass the theory supposed was set in rotation, and, as it gradually cooled, became more and more condensed, until at length some part assumed the liquid form, and would then form a ring surrounding the central mass. This ring would, of course, be in rotation, and as it would scarcely be of uniform thickness throughout would soon break up; the matter composing it would then be collected into a ball still rotating round the centre, and at the same time revolving on its own axis. In this way the hypothesis had it that all the planets were in turn formed, and they by centrifugal force threw off their satellites and rings, till at length the system became complete, and the planets cooled down into solid masses.

Such is the "nebular hypothesis," and in it is seen what absurd and groundless theories ignorance gives rise to among men. With all the telescopic nebulæ that have been resolved into stars, and with the fact patent that only distance prevents any of them from being thus resolved into stars and all other revolving bodies, men henceforth will have no need of forming such groundless theories with respect to an origin for the visible world; nor, with all the light which is now afforded them of its eternal existence, will people have an excuse for any more believing the groundless theories of hasty speculators with respect to it.

SKETCH OF THE HISTORY OF ASTRONOMY.

We think it proper here, and of interest to our readers, to give them a sketch of the history of astronomy. This science was cultivated in very early times. The question, however, as to what nations first cultivated this science, cannot be definitely answered. But it seems probable that the Chaldæans were the first who, within the range of history, made systematic observations of the stars. The path of the sun among the fixed stars was very early discovered, and these stars were arranged into the twelve constellations known as the Signs of the Zodiac, long before the historical era. Many of the other constellations were also named, but some were afterwards altered by the Greeks and Romans; and even in modern times, a few additions have been made, as, for instance, the Shield of Sobieski and the Heart of Charles I. The zodiacal signs are sometimes supposed to have been connected with the rural occupations of the ancients. Thus, the cluster of stars through which the sun seemed to pass in spring, was called Aries, or the Ram. Leo, the lion, had been considered symbolical of the rays of the summer sun. Libra, the balance, tells of the period of equal day and night; Scorpio, the scorpion, of unhealthiness, of autumn; while Aquarius, the waterman, and Pisces, the fishes, betoken the rains and floods of winter. The names given to these zodiacal constellations in the order of the signs, are as follows: Aries, the ram; Taurus, the bull; Gemini, the twins; Cancer, the crab; Leo, the lion; Virgo, the virgin; Libra, the balance; Scorpio, the scorpion; Sagittarius, the bowman; Capricornus, the goat's-horn, Aquarius, the waterman; Pisces, the fishes. It must not be supposed that any resemblance can be traced between the shape marked out by the stars and the figures they are supposed to represent. The original idea seems to have been to map out the sky into convenient portions for examination, and at the same time to immortalize certain real or mythical heroes; but as the system became adopted universally, it has been retained to the present day, and serves as a ready means for distinguishing and registering the stars. Among the most noticeable of celestial phenomena are solar and lunar eclipses, and these, of course, attracted the attention of early astronomers, and at length the true cause of them was discovered. A careful record appears to have been kept of them, so that the *Saros*, or Chaldæan period was discovered. This is a period of 18 years and 11 days, or 223 lunar months, at the expiration of which the moon enters again upon its former track in the heavens, and thus the same eclipses are, as it were, repeated. The Egyptians seem to have made some progress in astronomy at as early a period as the Chaldæans. Their pyramids indicate their skill in practical astronomy, as they are all so situated that their several sides point very exactly to the four cardinal points, east, west, north, and south. The system adopted by the Egyptians was the following: They conceived that the planets Mercury and Venus revolved like satellites round the sun, their orbits being carried along with him in his revolution round the earth. They supposed the earth immovable, as the centre of the system, and the other celestial bodies to turn round the same centre ; first the moon ; then the sun, about which they supposed Mercury and Venus to revolve ; next the planet Mars ; then Jupiter ; next Saturn ; and lastly the sphere of the fixed stars.

The Chinese date their astronomical knowledge from Fohi, who they say was the first of their kings ; and supposed by some of the Moderns, erroneously enough, to be Noah, who, tradition says, journeyed with his children in the direction of China, about the time of the building of Babel's tower.

The wonder and anxiety with which eclipses were witnessed by the Ancients, may be easily imagined, and when an astronomer ventured to predict an eclipse, and his prediction was verified, he must have been looked upon as little short of divine. The first instance we have on record in which this was actually done, was in the year 610 B. C., when Thales a Milesian, the father of astronomical science among the Greeks, foretold an eclipse of the sun. It is probable, however, that the same thing had been done repeatedly before by the Chaldæans and others. With Thales the true history of astronomy begins. But the Greeks were not distinguished for any great proficiency in the natural sciences. We find here and there shrewd guesses and faint gleams of truth ; but it is generally mixed up with fanciful speculations, instead of being supported by careful observation and reasoning. They seem, for the most part, to have started with certain principles which had no existence but in their imagination ; as, for example, that the earth must be in the centre of the universe, and that, since the circle was the perfection of shape, all the motions of the heavenly bodies must be in circles. Observing the phenomena of the sky, and the apparent motions of the sun and stars, they formed cumbrous and complicated theoretical systems, endeavoring to reconcile these appearances with their theories. Hence we find all the involved mysteries of transparent wheels, revolving one within the other, and carrying with them the planets and stars of cycles, and epicycles, and of crystal spheres in ceaseless rotation, which Plotemy and his followers were ever planning, and ever altering. We must, however, glance at a few of the names which stand prominently forward in the history of the science. Anaxagoras and Pythagoras were two of the Greek philosophers who succeeded Thales, and they appear to have had much more accurate views than most of their day. They taught *that* the sun is in the centre of the universe; *that* the earth is globular and moves round the sun ; *that* Venus is the morning as well as the evening star; *that* the moon reflects the sun's rays and is inhabited ; *that* the stars are worlds, and *that* comets are wandering stars. These celebrated philosophers flourished about 500 B. C., and their system is nearly the same that was adopted or restored by Coperni cus in the 15th century A. D., or about 2000 years after them. Their doctrines do not appear to have been at all generally received in their time, and were condemned by those in power as being impious. Anaxagoras was sentenced to death on account of his philosophical views; but his sentence was afterwards, through the influence of a friend, commuted to banishment for life.

Hipparchus, born at Nice in Bythinia, in the second century B. C., appears to have made considerable advances in the cultivation of every branch of astronomy. He gave up all attempts at framing a system for the universe, and occupied himself in carefully watching and recording the motions of the sun and planets. The movements of the sun especially occupied his persevering attention, and in this way he made a very close approximation to the true length of the year; and the accuracy of his observations is very remarkable when we consider the imperfectness of the instruments he had to use. He also observed the irregularities of the rate of the sun's motion, and determined in what part of its course its speed was greatest, and thus ascertained that if the motion of the sun was uniform the earth was not situated in the centre of its orbit.

Another thing for which the name of Hipparchus is memorable, is a catalogue of fixed stars which he formed in order that future astronomers might be able to detect any alteration in their position or number. He appears to have been led to undertake this task by the appearance of a new star, and though the work of carefully ascertaining and noting each star was a work requiring great labor and patience, he persevered and completed a list which contained 1081 stars. In the progress of this work he made one very important discovery. On comparing the place assigned by him to a star in the constellation Virgo with that determined by some distinguished astronomers nearly two hundred years previously, he found a difference of two degrees in its longitude. He then made similar comparisons, where it was possible, with respect to other stars, and found the same change in their position. It was then evident that all the stars must have moved forward, or else that the points from which the measurements were taken must have moved backwards. This phenomenon is known as the precession of the equinoxes; the reason of it was discovered by Sir Isaac Newton.

Another idea for which we are indebted to Hipparchus was that of representing the stars on an artificial globe; and of marking the positions of places on the terrestrial globe by means of lines of latitude and longitude.

Nicias, one of the followers of Hipparchus, is said to have advanced further than his preceptor, and started an hypothesis that the apparent changes in the sky were caused by a daily revolution of the earth. The idea was, however, not supported by any arguments, and was lost sight of for ages.

The only other ancient astronomer we shall refer to in this sketch, is Ptolemy, who was born in Pelusium, in Egypt, in the year 69, B.C. He was a very learned scholar for his time, not only in astronomy, but in mathematics and geography. Having carefully examined the observations of Hipparchus, and others, he at length promulgated a system known as the Ptolemaic, which, though since proved to be quite erroneous, accounted so well for all known celestial phenomena, that its errors could not, with the instruments then in use, be detected; and accordingly it was universally received till the age of Copernicus, and even then it was long before it was entirely discarded. According to this system the earth is immovable in the centre of the universe, and the planets move round it, in the following order; first, the Moon, then Mercury, and Venus, the Sun, Mars, Jupiter, Saturn, and beyond all these the firmament of the fixed stars; all of which were represented as moving round the earth every twenty-four hours. To account for the apparent irregularities in their motions he introduced what he termed epicycles, which will be understood by reference to the figure where E represents the earth, and A B C the orbit in which the planet should move; but instead of this he supposed that there was a *point* C moving in this orbit, and that the planet P moved round this point in a small circular orbit or epicycle. The combination of these two motions explained the irregularities. This system was afterwards rendered much more complicated by the alterations introduced by the successors of Ptolemy; and notwithstanding its absurdity, and its contrariety to the appearances of the universe, it continued in vogue, even among the learned, for the space of more than fourteen centuries; or until the beginning of the sixteenth century. During this period a few individuals appeared who cultivated astronomy, as Almansor, Almanon and others among the Arabians; Ulugh Beigh, a prince of Tartary; Alhazen, an Arab, in Spain; Alphonso X., king of Castile; Roger Bacon and several others; these all adopted the Ptolemaic system.

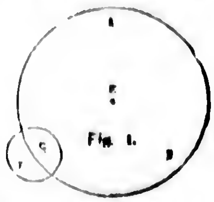


Fig. 1.

About the year 1472, was born Nicholas Copernicus, who, leaving all the speculations of former observers, studied for himself the motions of the celestial bodies. He first examined all the ancient observations, and then commenced for himself to closely and systematically examine the heavens. He compared the actual places occupied by the sun and planets with those which, according to former theories, they ought to occupy, and thus obtained a better knowledge of the irregularities and variations than any astronomers before his time. He continued this course for many years, and at length arrived at the conclusion that Mercury and Venus revolved around the sun instead of round the earth. He gradually extended his reasonings further, and at length started his celebrated theory which regarded the sun as the centre of the system, with the earth and all the other planets all revolving in regular order around it. By this grand idea all the complicated and bewildering schemes which had occupied and puzzled so many observers were at one stroke swept away. Instead of the cumbrous machinery of crystal spheres revolving one within the other the utmost simplicity is seen to characterize his system; order and regularity take the place of almost inextricable confusion; and as the observer transfers his station of observation from the earth to the sun, the planets which had previously appeared to wander on in ever-varying directions among the stars, now retracing their steps, and then, after an interval of rest, starting again, are seen to be steadily moving on in elliptic orbits around the central luminary of the system. The movements of the inferior planets Mercury and Venus; the reason why they were never seen very far removed from the sun; the retrograde motions of the planets, and their irregular movements, were all clearly explained by this grand yet simple theory.

We can with difficulty recognize the prejudice with which such a scheme was received; the earth was by it degraded from its central place, and reduced to the rank of a planet; and that which men had been accustomed to regard as fixed and immovable was now declared to be in rapid motion around the sun, and at the same time to be ever whirling round its own axis. He seems to have himself foreseen the effects of this prejudice, and hence he waited long before e fully accepted the theory, and still longer before he ventured to make it public. This system Copernicus understood to have been that of Pythagoras, broached 500 years before the Christian era, and hence he wrote a treatise in confirmation of it, entitled "Astronomy restored, or the Revolution of the Heavenly Bodies." This system was at first violently opposed both by the vulgar, the dignitaries of the Romish Church, and pretended philosophers, as contrary both to sense, reason, and Scripture, and many of its abettors were subjected to violent persecutions. Copernicus himself seems to have had a great degree of deference to the Church and consideration for the prejudices by which he was encompassed; and the dedication of his work almost takes the form of an apology for venturing to suggest such views, and his ideas were put forward rather in the shape of an hypothesis than of a definite system. It must not be supposed that Copernicus formed a complete system to account for all the motions of the planets; his life was too short for the task. His work was to indicate the true theory of the universe, leaving it for others to trace out more accurately the exact curves in which the planets moved, and to ascertain their various distances, magnitudes, and rates of motion. It was afterwards ably supported by the writings of Kepler, Galileo, Gassendi, Hevelius, Huygens, Cassini, and other distinguished astronomers by whom its principles were demonstrated, and established on a firm and stable basis.

This system was especially demonstrated by Kepler, whom we have had occasion to mention before, and who has sometimes been called the "legislator of the heavens," as it was he who first discovered the laws by which the movement of the heavenly bodies are governed.

Almost contemporary with Kepler there lived another great philosopher and astronomer named Galileo, chiefly memorable now as being the first to construct the astronomical telescope, though his powers were such as would have ensured his renown even had this great discovery not been made by him. He was born in 1564, and became a teacher of philosophy at Pisa. Here he soon rendered himself remarkable by his strenuous opposition to some of the teachings of Aristotle, which he proved by experiment to be incorrect. This brought upon him much odium, and even persecution; but though he thus opposed the received views on mechanical subjects, he continued for some time a stickler for the Ptolemaic system, and even refused to hear any explanations of the views and theories of Copernicus. After a while, however, he saw the folly of this, and communicated a careful enquiry, the result of which was that he became an ardent supporter of the new system.

In the early part of the 17th century, Galileo heard of a discovery which had been made by an instrument maker in Holland, by which distant objects could be made distinctly visible. He, therefore, made every enquiry, and at last succeeded in making a telescope which possessed a magnifying power of 30. This he first directed toward the moon, and here he at once detected many points of resemblance to the earth: he perceived rugged mountainous parts, and lofty elevations; level plains likewise, which were at first called seas. He made a greater discovery, however, when, on the 7th of January, 1610, he directed his magic tube toward the planet Jupiter. Not only did it present to him a brilliant disc, streaked across with dark bands, but close to it he perceived three small stars almost in a straight line. These he at first supposed to be merely fixed stars; on the following evening, however, when he again directed the telescope to the planet, he observed that they had moved along with it, and had also changed their positions with relation to each other. Here, then, was evidently some new discovery; and Galileo waited most anxiously the recurrence of a clear evening to enable him to decide the matter. The next view satisfied him that they were in reality moons accompanying the planet; and further, he found that there were four of them.

Intense excitement was created among astronomers by this discovery, some urging the absurdity of increasing the number of the heavenly bodies beyond the sacred number seven, and others angry at the man who attempted to depose the earth from its position of dignity by asserting that Jupiter had four satellites, while the earth had only one. It is said that some even refused to look through the instrument, which made such unheard of revelations. But the followers of Copernicus welcomed the discovery as presenting a miniature model of the solar system, and thus upholding their theory. The telescope soon made other discoveries. By its aid Galileo found that Venus presented the same phases, appearing at times as a narrow crescent, and then gradually becoming more and more illuminated, till at last it shone with an almost circular disc. It could not, however, be seen with a complete disc, as at such a time the earth must be in the part of its orbit exactly opposite to Venus, which would, therefore, appear in conjunction with the sun, and be lost in his brightness. This was a very important discovery, as it afforded a strong confirmation of the truth of the Copernicus system. In fact an objection had been raised against this system on the ground that these phases were not seen as they should be if the theory were true. The telescope, however, soon settled this difficulty, and silenced these objections. He made another discovery when he examined the planet Saturn. Instead of appearing with a circular disc, like the other heavenly bodies, he found it to be elongated, as if handles were affixed to each side of it. Owing to the imperfections of his telescope, Galileo failed to discover that this appearance was caused by a large ring which completely encircled it, and he imagined that the planet was in reality composed of three smaller ones. Both these discoveries were, according to the practice of scientific men in those days, made known in anagrams, only intelligible to those who possessed the key. It is thus seen what an important instrument the telescope proved to be, for not only these, but almost all celestial discoveries since, have been made by its use, and now nearly all our astronomical instruments consist either wholly or in part of a telescope. It is thus seen also to what important results the accident of a child playing with two spectacle-glasses has led; for such an accident, it is said, first originated the idea of the telescope.

The career of Galileo, though for the most part a splendid one, was somewhat marred near its close. The prominent position he had taken as an upholder and promulgator of the new doctrines had attracted the attention of the papal authorities, who regarded his views as heretical, and demanded of him a public recantation of his belief in the motion of the earth. This he reluctantly gave, though he is related to have said immediately afterwards: "It moves for all that." This was in several ways a sad scene! Not long after this, in 1642, he died. In the same year was born the illustrious Sir Isaac Newton, a man more celebrated than either Galileo or Kepler, and whom we have taken occasion to speak of before. From this time onward we come across the names of so many prominent astronomers that we can but refer to a few of the more celebrated. About the year 1658 Huygens, a celebrated mathematician and astromer in Holland, using telescopes of a much larger size than those of Galileo, discovered that the phenomena connected with Saturn was in reality an immense ring surrounding that planet, and, as he thought, thirty thousand miles distant from every part of it. He at the same time discovered the fourth satellite of Saturn ; and in these and other observations he used telescopes of his own construction of 12, 23, and even 100 feet in length. Napier had some forty years before this invented logarithms ; and thus reduced the work of the weeks to days or even to hours ; and a little later reflecting telescopes were introduced by Gregory. Some time afterward Cassini, a French astronomer, discovered the first, second, third, and fifth satellites of Saturn, and the periods of the rotation of Mars and Venus.

Flamstead was another celebrated astronomer, almost contemporary with Newton, and was the first that was called Astronomer Royal. The origin of the observatory of Greenwich, and of this post, was in the year 1675. Great inconvenience had been experienced in long voyages from the want of some method of determining the longitude in which a vessel was at any time, but at length a plan was proposed which was substantially the same as one that is in use at the present time. This consisted in noticing very accurately the position of the moon with respect to neighboring fixed stars. As the earth moves on in its path this position seems to vary. If then we have an accurate list of these "lunar distances," as they are termed, calculated for any given meridian of longitude, we shall be able to tell by observation what the time is at that meridian. We can then compare this with the local time of the place where we are, and in this way ascertain the longitude ; for since 15° of longitude make a difference of one hour in the time, we have only to allow 15° for every hour of difference in the times, and we shall at once tell the longitude. The method of solving this problem usually employed now is merely to compare a good chronometer, set to the time of the observatory, with the local time ; but it was not till a comparatively recent period that chronometers were made accurate enough for this purpose, and even now it is a great advantage to be able to check them occasionally by means of lunar observations.

When this plan of ascertaining longitudes was proposed an objection was made to it on the ground that the tables of the positions of the moon and fixed stars which then existed were not sufficiently accurate to be of any practical use for this purpose. It was therefore decided that an observatory should be built and sustained with this especial end in view, and Flamstead was appointed astronomer to the observatory. This observatory was erected, and the post established in 1675, and from that time to the present some of the ablest astronomers have resided in it, and an *almost uninterrupted series of observations has been maintained.* These have constantly proved in many different ways to be of the greatest practical utility. One main duty connected with this Observatory is the preparation of the "Nautical Almanac." This is an almanac published three or four years in advance, and containing a large number of important astronomical tables. The position of the moon with respect to any of the fixed stars is shown for every third hour throughout the year. The position of the various planets is also exhibited, as well as the eclipses and occultations of Jupiter's satellites, and many similar tables which are useful to the navigator in ascertaining his position, as well as to the astronomer. The reason of its early publication is in order that captains about to set sail on long voyages may have it to take with them.

Though this observatory was thus founded by the British Government it was some time before it was provided with instruments worthy of the place; Flamstead having to use his own for a considerable period. This astronomer was a very painstaking observer; and it appears to have been to his accurate observations that Newton was greatly indebted in many of his investigations.

Halley succeeded Flamstead in his position at the Observatory. He was for some time an intimate friend of Newton, and made several long journeys in the interests of science. An expedition was fitted out under his charge to observe and catalogue those stars in the southern hemisphere which are invisible with us; and a list of nearly 400 was compiled. This, however, was by no means a complete one, as the station chosen for observation, St. Helena, was in many respects unfavorable. After Newton had made the discovery that bodies under the joint influence of a centrifugal force and the attraction of a central body might revolve in a hyperbola or parabola, as well as in an ellipse, the appearance of a comet was anxiously awaited in order that, if possible, it might be ascertained whether these bodies moved in fixed orbits of either of these forms, or whether they were merely stray wanderers dashing swiftly past our system, and then forever lost in the deep abyss of space. In the year 1680, this desire was gratified by the appearance of a very remarkable comet, which attracted great attention, both by its brilliancy and the rapidity with which it travelled. Halley gave his earnest attention to the observation of this body; he accurately noticed and recorded its motion, and he discovered that a parabolic orbit could be constructed which would account for all its movements. Its eccentricity was, however, so great that a period of 600 years must elapse before it could again return to the sun.

After this comet had passed away Halley still devoted his attention to the subject, carefully enquiring into the recorded appearance of different comets, with a view to ascertain whether the intervals between the appearances of any of the most noticeable ones appeared in any way uniform. Shortly after this, in the year 1682, another large comet appeared, and Halley now with the information he already acquired was in a better position to enquire into its motion. He accordingly did this, and after a time announced that he had calculated its orbit, and found that it moved in an ellipse, its aphelion distance being nearly 3,500,000,000 miles; also that its period was about seventy-five years. He then looked back through his list of comets, and found that he could distinctly trace it back for a considerable period. This so far confirmed his calculations that he distinctly foretold its reappearance about the close of the year 1758; and so convinced was he of the truth of this prediction that he requested, since he could not live to witness its return, that when it was fulfilled people might remember it was an Englishman who had first traced the path and prophesied the return of a comet.

Long before the date assigned for the return of this comet, which began now to be known as Halley's, he himself had passed away. Astronomers were, however, on the watch, and some French astronomers, in particular, investigated most carefully and industriously the retarding effect which would be produced on the comet by the attraction of the planets, and as a result of their enquiries announced that it would be slightly delayed by the action of Saturn and Jupiter, so that its perihelion passage might be expected on the 13th of April, 1759. Just at the close of the previous year, a wanderer was detected by an amateur, and as it approached nearer, it proved to be the very one, whose return had been for so long a time foretold, and though its period of revolution was upwards of three quarters of a century, yet the observations and calculations were so accurate, that it actually passed the sun within less than three weeks of the predicted day. On the occasion of the next return of this comet, which took place in 1835, not only was the date, but the place of its appearance pointed out, and on a large telescope being turned to that spot, the comet was seen as a faint cloudy object. We see thus that Halley's comet was now to be reckoned as one of the members of our system, whose motions are fully understood. Its next return may be expected in the year 1912.

Bradley succeeded Halley as professor of astronomy at Greenwich. The great discovery which has rendered his name memorable, is that of the *aberration* of the fixed stars. The aberration of the stars is a small change of place in the heavens, which, in consequence of the earth's revolution in its orbit round the sun, they appear to describe in the course of a year, an ellipse or circle, the greatest diameter of which is about 40." These apparent changes of place, occasioned by the annual motion of the earth, are to a certain extent common to all the celestial orbs, and are only the more perceptible and striking in the case of the fixed stars. In consequence of this annual revolution of the earth round the sun, the stars appear, according as they are situated in the plane of the ecliptic or in its poles, or somewhere between them, in the first case, to deviate in a straight line to the right or left of their true place; in the second, to describe a circle or something nearly approaching to it around their true place; and in the third, an ellipse about that point which observation determines to be their real situation. The angle contained between the axis of the telescope and a line drawn to the true place of the star, which angle, in consequence of the earth's motion, must be continually changing, is what is called its angle of aberration. The aberration of the stars affords a sensible and direct proof of the motion of the earth in its orbit round the sun. If the earth were not in motion, no such effect could take place. If the earth were at rest, the star would be seen in the place in which it really is, never seeming to alter its position ; but the earth being in motion with its present velocity, the telescope is necessarily inclined a little in order to see the star, and it is the real annual orbitual motion of the earth that causes the apparent motion of the star, in describing such a figure in the course of our year.

Dr. Bradley, also, took an active part in the reform of the calendar, which had by this time varied a little from the true seasons ; and, in order to rectify the error, joined in recommending that eleven days should be struck out of the month of September, 1752, so that the day that would be the fourth of that month, was called the fourteenth. This measure was very unpopular at the time, and Bradley came in for a large share of popular dislike on this account ; and his death, which occurred a few days afterwards, was, by many of the ignorant, regarded as a mark of Divine displeasure at his presumption in thus daring to interfere with the regular order of the calendar. This alteration has since been effected in nearly all countries, except Russia, where dates are still reckoned according to the old style, and are now thirteen days behind those used in the rest of Europe.

We may now just glance at the services which have been rendered to astronomy by another of those men whose names will ever stand foremost in its annals, Sir William Herschell. He was a man of somewhat humble origin, and unable to procure a telescope sufficiently powerful by which to understand some of the mysteries of the heavens. He had, however, an intense desire to do so, and having acquired a knowledge of the principles of the telescope set himself to construct one. In this, he succeeded well ; and he is said to have ground altogether upwards of 500 specula for reflecting telescopes. In March, 1781, when he was examining the sky by the aid of one of these instruments, he came upon a small star, which as he examined it with higher powers seemed to exhibit a disc. He accordingly took an accurate note of its position so as to watch it again on another evening. When he again examined it, it was at once clear that it had changed its position. The idea, however, of a new planet does not appear at all to have entered into his mind, so accustomed had every one been to regard Saturn as the extreme planet of our system ; accordingly, he set it down as a new and strange comet which he had discovered,and announced it as such. Its motions, however, soon showed that, unlike the comets, it moved in an orbit of but small eccentricity, and it was then found to be a planet revolving in an orbit outside of Saturn. This planet he named *Georgium Sidus* in honor of King George III., who had been his patron, but the name was afterwards altered to Herschell, and finally to Uranus, by which name it is now known.

Soon afterwards he constructed a much larger telescope,the speculum of which was four feet in diameter, and the tube forty feet long. The space-penetrating power of this instrument was reckoned at 194, that is, it could enable the observer to see into space 194 times as great a distance as could the unaided eye, With this he discovered two more satellites of the planet Saturn; six out of the number that revolve around Uranus were also detected by him; so that he made a very large addition to the number of the heavenly bodies then known. But his most important discoveries were made about the stars and nebulæ. A large number of double and triple stars were first observed by him and carefully noted, with a view of determining, if possible, whether any of them exhibited any sensible parallax. The Milky Way was also resolved by the power of his magnificent telescope, and thus some idea was formed of the size and character of the cluster of which our whole system forms but an insignificant fraction.

Sir John Herschell, the son of this distinguished man, who died recently, displayed a similar love for astronomy. In conjunction with Sir J. South he produced a catalogue of 380 double stars, whose distances and angles of position they had determined. Sir J. Herschell afterward produced a list of upward of 3300 double and triple stars from his own solitary observations, accompanied with all the micrometrical measurements; and he also undertook a journey to the Cape of Good Hope for the purpose of making observations in the southern hemisphere of the heavens, and made many interesting discoveries both of stars and nebulæ. Other astronomers we have named in the other places in connection with certain discoveries, and there are still other distinguished ones which we would wish our space permitted us to mention. There is, however, an astronomical instrument which we may refer to before closing this historical sketch of the science, as having been found of great use in determining many difficult points. This is a reflecting telescope constructed by the late Earl Rosse, the speculum of which is six feet in diameter, and its focal length fifty-four feet. Its higher powers, however, owing to the amount of moisture in the atmosphere can only be used at rare intervals. This instrument, though not so clear in its definitions as telescopes of lesser magnitude, such as the large one of Herschell, may still fairly be considered as one of the wonders of the age.

CONCLUSION OF PART FIRST.

From all the facts which the science we have now reviewed has revealed to us, both in relation to the world in which we dwell, and to all the other luminous and non-luminous worlds which surround us, in the heavens, on all sides, infinitely, it is evident that astronomy intimately and necessarily pertains to the demonstration of the subject which it is our endeavor to elucidate, the subject of Existence and Deity. Confined as man is to this terraqueous globe, and to only a limited portion of it, he could have no worthy idea of the great universe, or of the glorious worlds which surround him, did not the earth itself afford him the means, in the telescope, of enlarging his views with respect to them. This noble instrument, as well as the microscope, by which we become acquainted with the invisible world in the other direction, is made of what are regarded as the humblest of earthly materials; still, but for their use we might be to-day in the position in which the people of 1500 or 2000 years ago were, having no definite knowledge, and constantly changing our views and groundless theories, as to the system of the universe and Infinite existence.

There is nothing more evident than that man is of the same nature in every respect as the world in which he dwells, the media in which he lives and moves. He is in fact, as any other creature that exists in it, a part of it. It is quite as evident, from what astronomy and other sciences teach us, that the earth is of the same nature as are all those glorious worlds by which it is surrounded. It is, in fact, if we may so express it, a part of the universal whole. We see all these orbs, co-existent in space, in mutual dependence on each other, as are the members of the human body; yea, and more so, for the human body may lose one or more of its members; but one of those heavenly bodies, a member of the great universe, cannot be lost, not a particle of it. They all universally obey the same laws proceeding from that simple principle of gravitation, a principle which not only *preserves their existence in the forms in which they are, but also governs their motions, and confines them exactly to their own places.* We see that the principles of light and heat and gravitation act exactly alike, and equally, with respect to them all. This effect is abundantly sufficient to teach us that they are all of the same general substance; but of this fact we have sensible evidence by being made, as it were, intimately acquainted with the surfaces of those that are nearest us by means of the telescope, and with the nature and constitution of those that are far distant from us by means of the colors of their light, and *spectrum analysis.* They are all the same general substance, the same spirit pervades the whole; they are all *individual members of the infinite whole.* When we walk abroad and see a laborer digging a ditch or a pit in the earth the thought sometimes strikes us, that the substance on which that laborer is operating is just the kind of substance of which we ourselves are composed, and to which we shall one day, perhaps, ere long return, as it has happened to an infinity of our predecessors of mankind: that substance appears humble, but wherein is our superiority to it. And yet how few there are of mankind to whom such a thought ever occurs in its proper sense. Men are accustomed to look upon such things as altogether beneath their notice; and not to allow such thoughts for a moment to occupy their mind. They look upon the earth as a dead thing, devoid of life; and yet it is full of the principle of life; there is not the minutest particle of lifeless matter in the whole earth, nor in the universe; yea the earth itself, as well as all worlds, is all existing in life. We who are present are accustomed to think of the earth as a dark, cheerless abode, and to wish that our lot had been to live in some of those bright worlds we see surrounding us ; but were we situated on the moon, or even on the planet Venus or Mars, we should behold what a glorious orb our earth appears from thence ; it partakes of that glory which we have seen to characterise the other heavenly orbs ; being of the same nature it is no less intrinsically good and glorious than they. Why then should we be discontented with our abode ? Why should we wish to transfer our residence from it to other worlds which are not superior to it in kind ? Why should we be afraid when we die to return to it, in hopes that we may again arise superior in scale of being to what we now are ? We should always cherish the strongest faith and hope that we shall live intelligently and happily after death. We should indeed live to be good and to do good. We should use the gifts and privileges which the world affords us, as not abusing them ; we should obtain them and use them in the best possible manner ; we should in fact live in such a way that we should never be afraid to die ; and thus we should in reality find that our world would present to us a heavenly aspect, a delightful abode with which we should be contented, and which we should not be desirous of changing for another. We should endeavor to attain, while living here, the first resurrection, that is, the resurrection, or new birth, from the death of sin to the life of righteousness. We should crucify the natural man, with its affections and lusts ; denying ourselves the inordinate pleasures of the world and all ungodliness we should live soberly, righteously, and honestly in this sphere of our existence. We invite all to take this course, and we promise them thus doing, thus living, they will experience a heavenly peace and happiness in themselves such as the followers of natural and worldly lusts shall not experience ; and they shall not be afraid to die when their time comes to die. They will come to know God, and God will always support and comfort them ; and be a near and true friend to them, in whatever condition they may be in life ; they will also be taught of God, and great shall be their peace !

Blessed and holy are they that have part in the first resurrection ; on such the second death shall have no power ; even the approach of their natural death they shall not fear ; it will present no terrors to them ; resting in the faithfulness and goodness of the Lord, their minds are stayed in perfect peace ; they shall be priests unto God, and shall reign as Christ forever !

In conclusion of this first part we would remark that in treating of the system of the earth in the beginning of this book we have merely brought forward facts which tended to demonstrate and illustrate its eternal existence, or that of the order of nature and man in the main as now existing, without intending to impose upon others the belief of this eternal existence, unless the demonstrations which we have made, and will make in the second part, together with their reason, should lead them to believe it. It is proper that each one should exercise their reason and judgment concerning this matter, and believe otherwise concerning it, if, after all that we have said, and shall say in the second part of our work, they feel fully assured that they have sufficient ground and reason for so doing. We brought forward the arguments which we did in demonstration and illustration of the subject of the eternal existence of the earth, &c., because they tended pretty conclusively to prove it to any rational mind, more especially as we could discover no valid evidence to the contrary.

But some, notwithstanding, may consider that they have sufficient reason to believe that the earth and all the heavenly bodies were brought into existence at some time in the past, or during past times, by some agent external to them; or that they came into existence during past ages from existing before in an aëriform or nebular state, and were given, or assumed, their present forms and motions; and that all things or beings in and on them were given or assumed their present shapes, characters, conditions, or motions, &c.

Some may, perhaps, conceive of a personal creator in the form of man, or in some other form, bringing all these things into existence, although we confess that we know not of any power existing external to or aside from universal or infinite existence, as we have illustrated it; and that it is contrary to our experience and belief that man can create even the most trifling natural object, even to a hair on his head. Our Creator is indeed infinite, which excludes form on His part, and omnipresent, which surely argues the eternal existence of the universe in the main as it now appears; He is also infinite in wisdom, intelligence, and power, as He is in being.

When, however, our readers have perused the second part of our work, in which we propose to do away with that mystery connected with religious subjects which has induced so much superstition and error among mankind, they will be better enabled to see things in their true light with respect to the subject of Existence and Deity. Our work for mankind is a labor of love; our mission is to make men intelligent, holy, and happy, rather than to induce them to believe necessarily and precisely as we do concerning this subject. We can do only our part for the enlightenment and happiness of mankind; and when through our instrumentality others have become enlightened and converted, it will be well that they enlighten and strengthen their brethren. It is, however, our desire that all men may come to the knowledge of the truth concerning the important subject of which we treat, and that they may live and abide in, and inculcate that truth.

We now ask our readers to accompany us in the second division of our subject, which we hope will not prove wearisome to them; and that they will give it that degree of attention, and of careful consideration, which its importance demands.

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