SACRED COSMOGONY;

—OR—

Primitive Revelation Demonstrated

BY THE

HARMONY OF THE FACTS OF THE MOSAIC HISTORY OF THE CREATION, WITH THE PRINCIPLES OF GENERAL SCIENCE.

TRANSLATED FROM THE FRENCH OF

L'ABBÉ A. SORIGNET,

C. P. R. archbishop Kenrick of St. Louis.

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INTRODUCTION.

There comes a moment in life when the geologist, tired of gathering specimens, and the naturalist, of counting the number of rings that compose the paw of an insect, ask themselves this serious question: *Whence have I come; what am I; whither shall I go?*—and, if they cannot answer it, rightly judge that their science is vain, their labor fruitless. Of all the things to be known, what most nearly interests us, and what has a paramount claim on our attention, is ourselves; because the knowledge that stops at what are called "facts" may, indeed, supply useful applications for material existence, but cannot satisfy the intellectual, moral and religious wants of man. Science must look higher; it must ascend from cause to cause until it reaches the first of all causes, the principle of the laws which govern existences, facts and phenomena; and, receiving the dogma of creation, admitting the cosmogony of Moses, it must accept it with all its legitimate consequences. Then is consummated the union between science and theology; then science and religion harmoniously combine to teach man his origin, his nature, his destinies, and duties, and to establish society on its natural basis. Hence, in his introduction to the "*History of the Sciences of Organization*," Blainville defines science, in general, to be "the knowledge, *a posteriori*, of the existence of God and of His perfections by His works, with the view of establishing the laws of human society—the duties of man—on principles derived from his nature. We must remember," he observes, "that the nature of man is at once physical, intellectual, moral and religious; and that man must know himself, and his relations with the world and with God. Science, then, is only general, or complete, when it embraces all the particular sciences which have relation to the world, and those which have reference to man, considered as a physical, intellectual, moral and religious being."

Consequently Blainville restores the sciences to philosophy, which ought never to have been separated from them; and he defines philosophy, with Plato, to be "the knowledge of things human and divine." For him, religion and philosophy—when this latter is taken to be what it really is, and the former is Christianity—are one and the same science; philosophy embracing the same objects—the world, man, God, in themselves and in their relations; having the same end—the establishment of the principles of the social order: the one acquired by demonstration; the other, by faith in divine revelation. This alone addresses, and can alone address, its infallible teaching to all ages and all degrees of intellectual development; while philosophy demonstrates this same doctrine in its grounds, and wherever, by the aid of natural facts, human reason and the discursive faculty can reach; so that the child who has received the simple elements of faith has already reached the point at which the philosopher arrives after a long and laborious demonstration. On the one hand, there is question of Christianity which, under the direction of an infallible rule, has been preserved from individual eclecticism; and, on the other, of social philosophy, which should find, as in fact it does find, in the sincerity of its own principles, an orthodoxy no less rigorous than that of the physical, logical and moral progress of man.

But for many men, who have given less attention to study the relations between religion and science than to science itself, the first chapter of Genesis presents a point of contact between science and religion which is well calculated to attract attention. It is from it the history of religion begins; from the doctrines taught by Moses are derived all other doctrines, and, with them, all religious and moral truth. To it the sciences must recur to find their base and principles. Abstract from the doctrine of a God that created and disposed all things, and nothing is seen but beings which present no reason for their existence, means without end, plans without architect, laws — in the material, intellectual and moral world—without a lawgiver; and the order which is so conspicuous throughout the universe become an enigma without a principle of solution. When Moses received, through tradition, the cosmogony, and committed it to the guardianship of the chosen people, he laid the foundation of theology and of all human sciences.

Thus, for more than three thousand years, it has been the central point of the eternal contest between the *spirit* and the *flesh*—to use the profound language of the Sacred Scripture. All the inspired writers opposed it to polytheism and ancient pantheism; and it furnished arms to the fathers of the Church in their disputes with the paganism and heresy of their times. Theologians have used it in refuting new heresies. It triumphs, now, over the errors of the learned as it formerly triumphed over the errors of the ignorant. Without compromise with either, it does not say to the modern naturalist or philosopher, grant me this and I will grant you that; but it says, accept me in my entireness and literally, or reject me altogether; but, if you reject me, you neutralize your own efforts, you will not establish either physical or moral science. One or two of the fathers of the Church, departing in this from the universal teaching, called in question the literal meaning of the cosmogony. Origen, embarrassed by the creation of light and of plants before the sun, thought that the first three days were to be allegorically understood; but the science of light and of the vegetable world has progressed, and the allegory of this learned man has disappeared.

For the last hundred years the cosmogony has had to pass the ordeal of arbitrary interpretation, and geology has had the merit of rendering manifest, by its attacks, the admirable beauty and singular force of the inspired narrative. Geology, in its commencement, like all that is young and inexperienced, assumed a proud and dogmatic air. It taxed the Mosaic chronology with error, because, in its judgment, it allowed not sufficient time for the accomplishment of the phenomena. To meet this objection, Deluc first identified the *days* of the creation with the periods imagined by Buffon, in his magnificent romance of the "*Epochs of Nature*." The days of Genesis were no longer days of twenty-four hours, but periods which might be extended at pleasure; and chronology, instead of beginning with the first period, only began in the sixth, with the creation of man. This principle of interpretation interfered with the harmonious unity of the history of the world, made the text contradict itself, and substituted the action of secondary causes for the immediate action of God: but it allowed an indefinite time to the agency of these causes, and was thought thus to meet the requirements of geology. Moreover, Deluc supposed that each creation was followed by a total destruction of what had been created, occasioned by the falling in of the crust of the earth; and this rendered the narrative unintelligible. To compensate for this drawback, he explained the creation, the deluge and the phenomena, and he announced, also, a certain correspondence between the chronological order of the different creations and that of the appearance of the fossils in the deposits of our surface. Deluc was sincere; he hoped to convert Voltaire by this travesty of Genesis; for when he wrote the world was immersed in philosophy, and everything shared its circumambient influence.

Cuvier, a political and scientific celebrity, followed the direction marked out by Deluc, and endeavored to reconcile it with the irreligious tendency of his age. He had been a diplomatist, and consulted for all views, with the hope of finding partisans in all parties. "I think, then, with Deluc and Dolomieu," said he in two of his published works, "that, if there be anything certain in geology, it is that the surface of our globe was the theatre of a great and sudden revolution, the date of which cannot be placed further back than five or six thousand years." This declaration, favorable to our historical deluge, was repeated from the pulpit of St. Sulpice by M. Fraissinous, and the illustrious orator gave his sanction in these words to the geological theories of Cuvier: "If you find with certainty that the earth, with its plants and animals, is much more ancient than the human race, Genesis will present no contradiction to this discovery; for it is allowable to you to regard the six days as so many indefinite periods of time, and your discoveries will be the explanation of a passage the meaning of which is not altogether established."*

These hesitating expressions did not decide the question. They showed, however, that the literal interpretation might be abandoned, and a compromise effected between the representatives of geology and theology. In the "*Bulletin Universel*," Ferrussac announced the fact:† it was afterwards repeated by all echoes of the press. The system of *indefinite periods* became with us the doctrine of all, so-called, Catholic Reviews, from which it passed into our books and found its way even to our theological treatises.

Grounded on this statement, many set themselves to work to find in the text of Moses what he never meant to express, in order to confirm the wonderful agreement between the six genesiacal epochs and facts which were no less misinterpreted by geologists of the Cuvier school than the text of Genesis by these unwise apologists. After Deluc and Cuvier, two other protestant writers, Buckland and Chalmers, applied the newly recognized principle of interpretation to the texts that regarded light and the heavenly bodies. On the plea that the *epochs* did not harmonize with the fact that plants and animals are found together in the most ancient strata, they reproduced, in a modified form, a long forgotten system of their fellow-countryman and co-religionist, Whiston, according to whom the world of Genesis was only a new

* Moise considérè comme historien des temps primitifs.

† 2me sect. des sciences nat. et de zool., t. x., p. 193.

arrangement which God made of the ruins of a former world, to which the fossiliferous deposits belonged. The energetic words, "let there be light,"—"let there be luminaries,"—in this interpretation, do not indicate a creation in the strict sense of the term, but merely new relations established by God between pre-existent bodies, which He used in arranging the present world. This singular interpretation was accepted, although not by as many as followed that of Deluc—the biblical geologist, as he was called.

Men who were not the guardians of the cosmogony defended it. Letronne and Ami Boué—the one a judicious critic, the other an exact geologist—showed that the naturalistic exegesis was contrary to philology, grammar and reason—that it made nonsense of the Mosaic narrative, and destroyed its inspired character. No attention was given to these disinterested protests, or to those of some Hebrew scholars, and of a certain number of ecclesiastics who, applying themselves to scientific studies, were better able to appreciate the geological systems of the day. The word of God must needs be subjected to a searching and decisive examination. While journalists, reviewers, writers and lecturers redoubled their efforts to give currency to the rationalistic interpretations of Deluc, Whiston, Buckland, Chalmers, etc., and aid religion by what were called the reluctant avowals of science, this science, or rather these fashionable geological systems, had passed away. Their disappearance from the scientific arena was more silent than had been their announcement; and hence may be partly explained how it happened that their numerous unscientific partisans were unaware of the fact, and continued to accredit interpretations which were no longer available. The cosmogony, having thus passed through the ordeal, without having the literal force of its narrative affected by the trial, continued to withstand all *a priori* theories, which are the first efforts of man to attain truth by his own unaided powers. This was not, however, its only triumph.

If Cuvier was not a geologist, he was an anatomist. Paleontology, developed by him in the mammals, and after him, by several naturalists, in all the other great classes of the animal kingdom, and extended even to the plants, was later, in the hands of Blainville, to complete the demonstration of the natural classification of animals and confirm all the leading principles of zoology, this beautiful and comprehensive science, which from the time of Aristotle, its founder, has been perfected by two thousand years of direct observation. At the same time geology, re-entering the path of observation, where Buffon had at first placed it, became more circumspect as it became more positive. Chemistry combined to accumulate discoveries, and showed in the elementary world a connection between the life of animals and that of plants. Natural philosophy successfully investigated the nature and properties of light, and the relations of this fluid with the vegetable world. Astronomy, as far as concerns our system, acquired a high degree of perfection. For the first time during thirty-three centuries, the cosmogony found itself in the presence of science which had attained the knowledge of the laws which regulate beings, facts and phenomena. Here faith and science regard each other: they recognize the fact that they are both derived from the same light; they embrace, and cordially unite in directing the destinies of man.

In fact, there is agreement between the cosmogony and science on all points: on the commencement of beings—on their order in coming to existence, a successive creation being recognized—on the state in which the earth was created; on the creation of bodies in their substance and under their various forms—on the destination of the atmosphere—on the existence of light independently of the bodies called luminous—on the primitive division of our globe into seas, emerged lands, rivers, mountains, valleys, etc.—on the unity of the first basin of the sea—on the maintenance of the laws of the solar world since the creation—on the reality of species—

on their creation—on the simultaneous creation of their groups—on their primitive and general distribution on the surface of the earth—on the essential characters which distinguish the natural kingdoms, and afford ground for their classification—on the creation of animals and vegetables in the adult or perfect state—on the continuance of the same general media of existence for animals and vegetables—on the uninterrupted duration of animal and vegetable life from the beginning of the world—on the creation of animal domestic species—on the unity of the human race—on the creation of man in the social state and in the image of God—on the divine origin of articulate language—on our world, inasmuch as it has been created for man, and man for God—on the dogma of one only Being, Creator and Disposer of the Universe, etc. The agreement is perfeet between all the statements of Genesis which correspond to those parts of science which have passed from the condition of hypothesis to that of certainty. These harmonies are so numerous, they relate to questions which are so general and, consequently, so complex in their elements—questions so long controverted and so contradictorily resolved by the philosophic schools of all epochs and of all nations—that it would be folly to regard this agreement as the effect of chance. On the one hand, the statements of the cosmogony cannot be considered as the results of the science of the primitive times of the world, since we know that it has required a long series of ages to enable science to attain a degree of development which permits it to rise, by the way of deduction, to conclusions in harmony with the facts of Genesis. These facts cannot be supposed to have originated in the recital to their children, by our first parents, of what they had seen as witnesses of creation; for, in a simultaneous creation they could have seen nothing, and in a successive creation they could only have attested local facts, whereas the cosmogony contains only general facts. Still would it be necessary to suppose, contrary to what Genesis and science agree in telling us, that this successive creation should have begun with man instead of terminating in him. We are then necessarily led to this conclusion: *God has spoken to man, and has revealed to him His works*—a conclusion which is also conformable to Genesis, in which verbal communications by God to our first parents are recorded. Modern science then demonstrates the perfect exactness of the Mosaic narrative, and this exactness implies primitive revelation; and as christianity, as before said, not only accepts as revealed this sublime history of creation, but makes it the ground work of its dogmas and morality, it follows that its teaching is confirmed by the series of accords between both which it is the object of this work to demonstrate.

Before establishing this agreement, I begin with the exposition of the first chapter of Genesis, taking throughout the sacred text in its strict literal meaning. Following the method of the Church, I shall interpret it, not by geological or philosopic systems, but by the other sacred books written in the same language, and which frequently refer to it. Genesis and science, like two independent and incorruptible witnesses, will give testimony with sincerity and freedom. It would be impossible to enter on the demonstration of divine revelation by the accord of science and Genesis, without treating of those parts of science from which have been drawn so many objections against revelation. The rigorous refutation of the principal systems, which imply all others, was evidently an indispensible preliminary. This necessity being once comprehended, I have selected the method which appeared to me to re-unite a great many advantages. It consists in presenting the results of individual efforts, made without connection, and often in opposite directions, in their chronological order, and contrasting them with positive chronology, by means of an accompanying analysis of the labors of experimental geologists who have adhered to the legitimate method of observation. This method will enable us at once to distinguish science and the systems which assume its name. By it we shall assist, so to speak, at the successive discovery of the facts which constitute positive geology; we shall have an abridgment, as it were, of this science, deduced from its history; and we shall be prepared to understand the numerous theses in which it must intervene in the sequel of the work.

The review of the systems will afford us the occasion of observing the unfortunate application and abuse made of Genesis in most of these theories which pretend to explain, as facts of a purely physical character, the creation and the deluge. We shall see that not a single text would have remained, if the Sacred Volume had lent itself to the support of so many incomplete and erroneous views, and had been made to accommodate itself to so many contradictory theories.

On the other hand, we shall find science judging, from a scientific point of view, these systems which never failed to assume its name and claim its authority, rejecting their principles as incompatible with known laws, and disavowing their conclusions, as deduced from merely local and misunderstood facts. It will hence be seen that Genesis has no need of conciliating the theories of the learned; that it is always imprudent, and frequently dangerous, to support articles of faith by physical facts, as long as these facts and their accord with revealed facts are uncertain; because such arguments being liable to be confuted by new discoveries, religion is exposed to suffer in public estimation. In fine, we shall conclude that the faithful should not be astonished at beholding so many systems opposed to the revealed truth. How is it possible to reconcile them with truth when they are contradictory of each other? These systems will be improved, or they will give way to other systems no less powerless and barren; but the word of God will outlive all such systems. If the nature of this book permitted me to reascend to the beginning of this long contest of the Sacred Word and all sorts of systems—mystical, allegorical, philosophical, astronomical, archielogical, chronological, zoological, geological, chemical, etc.—an obstinate and continual struggle, out of which it has always come victorious, it would appear that the traditional documents transmitted by Moses have always been in advance of all the sciences, while these latter have continued to be hypothesis; and that the learned of our day should doubt of the solidity of their theories whenever they depart, no matter how little, from the teaching of Genesis. This task did not belong to me: I had only to speak of the geological systems; but what I have said of them will suffice, I believe, to diminish the blind confidence which is ordinarily placed in such theories.

Besides, the demonstration of revelation by the accord between the cosmogony and the deductions of science should astonish no one. Science will necessarily be led to confirm successively all the basis of religion; only this demonstration could not have been made with so much success before the point at which zoology and, especially, geology have arrived, had been reached; although these sciences, especially the latter, are far from having attained their ultimate perfection. The present work will, then, have but little in common with those which have hitherto appeared on the relations between science and religion, the writers of these works having almost always adopted ephemeral systems, instead of relying on ascertained facts and established principles. I must, however, except the great work of Maupied.* The author having acknowledged, in the introduction to his third volume, that I furnished him with many facts, prevents me from speaking of his performance in the terms I would willingly employ. All my thesis are, indeed in the three volumes of Maupied: but he has given them another direction. Instead of confining himself, as I have done, to the first chapter of Genesis, which alone presents points of contact with the natural sciences,

* Dieu, l'homme et le monde, connus par les trois premiers chapitres de la Genése.

he has embraced in his appreciation the two following chapters, where, especially in the third, there are only moral facts recorded. Hence his theses do not converge towards the same general conclusion as mine, and the plan of both works is necessarily different. Maupied has given himself a wider field; he seeks to resume the work of Albert the Great, and bring it in relation, with the progress of science. May his great and beautiful work call forth imitators in the ranks of the young clergy, and develop in them the taste for these severe studies, which made the age of Albert the most brilliant epoch of intellectual civilization. However, notwithstanding the great difference in the form, management and end of the two works, I would not have employed the materials which I had given him, had he not frequently urged me to do so. He thought that this book, coming after his, would not want its appropriateness and special utility. Maupied was the friend of Blainville. In 1847 he prepared, after the notes and oral instructions of his illustrious master, and under his direction, "*The History of the Sciences of Organization and of their Progress as the Ground of Philosophy*"—a work of great utility, which should be in the hands of all professors. Having myself followed this course from 1839 to 1841, and having carefully noted it, I can testify to the fidelity with which Maupied has reproduced the ideas and, frequently, the language of the eloquent professor. At the same time, I attended the course of C. Prevost, a geologist no less modest than judicious, who, by his lectures and writings, has so powerfully contributed to bring back the science he still teaches to the way of observation. I have attentively read all the works which have been published on geology; I have made selections from almost all that have appeared on paleontology; in fine, I have long meditated on all parts of my subject. Have I escaped all error? Have I, throughout, been sufficiently methodical, clear and precise? I cannot say that I have; but at least I have endeavored to be so.

SACRED COSMOGONY.

PART THE FIRST.

GEOLOGY AND THE BIBLE.

GEOLOGY AND THE BIBLE.

CHAPTER I.

Fossils—Systems of Burnet, Leibnitz, Woodward, and Whiston.

To Fossils must be ascribed the origin of Geological systems ; but for their discovery no one, perhaps, would ever have imagined, that there were successive epochs, and a series of various operations in the formation of our soil. Geologists give the name of fossil, not as the literal meaning of the word would imply, to every thing that is exhumed, but to every trace of organized life, whether capable of being dug up or not, which is found in the formations or regular layers which underlie our soil. By regular layers or beds, they understand such as have not been deranged. The word "fossil" does not, consequently, imply, that the object has ceased to exist on the surface of the earth, or that it is to be referred to a certain epoch, or that it has undergone any modification in its nature ; but simply, that it is found in a certain formation or bed. A shell deposited but yesterday in its bed, is precisely in the same condition as was, the day after its deposition, that which was deposited a thousand years ago. Both are fossils ; and to call the former, with some of the old geologists, a 'modern fossil', a 'sub-fossil' or a 'pseudo-fossil,' is to say, that it is, and, at the same time, is not, a a fossil. When, then, would it become one ? In fifty, or a hundred years ? What motive can be assigned for preferring either term to the other or indeed any term ? All the formations from the earliest to the most modern, being the product of the same general causes, we must regard, with all modern geologists, as real fossils, the remains found imbedded in any part whatever of these formations, if these be regular layers.

All fossils are not found in the same state : sometimes they are unchanged, but, more frequently, the animal or vegetable matter has been replaced by mineral substances. Sometimes, the substitution has been made at once and in mass: at other times it has been effected by percolation; the mineral matter, having been introduced, particle by particle, into the pores of the organized substance, represents the exact detail of its form and structure. This change is evidently not a transformation, nor even a real substitution. The mineral molecules have occupied the spaces between the organic molecules, and these have been decomposed, just as if a sponge were saturated with a liquid capable of becoming solid, and that then the sponge itself were destroyed. Frequently we find nothing more than the impression of the bodies; which happens whenever the spaces resulting from their decomposition have preserved their exterior form; or when mineral substances, being introduced into the shells of molluscous animals, have reproduced and preserved their interior structure. Thus many shells have left in their *gangue*, or rocky bed, their interior or exterior mould; as have also the ferns, impressions of which are found in the coal beds. As examples of fossils preserved unchanged, we may take teeth and bones, the excrements of certain animals known in science as coprolites, vegetable juices, as the succinum or yellow amber with the insects it contains, and the products of human industry. The softer parts of animals rarely leave traces of their existence in the strata of the earth: yet the mould of the brains of a mammiferous animal, an *anoplotherium*, with its spiral folds, is said to have been found in one of the tertiary strata. The fishes of the pisciferous strata of the coal bed at Muse near Autun, are frequently found to have preserved their flesh. According to Mylius, the cristallin is still composed of a white substance, similar to that found in cooked fishes. In many of the fishes of the genus *macropoma* (Ag.) in the Sussex chalk, Mr. Agassiz has seen not only the gills, but even the entire stomach with its membranous structure solidified, and coprolites in the abdominal cavity. Among the species of the genera *trissops* and *leptolepis*, (Ag.) which belong to the Jura strata and to the lias, many intestine fossils have also been found in the abdominal cavity: but these are considered exceptional instances. Even the integuments, such as the skin, the hair, the plumage, are sometimes, though rarely, found preserved; and their preservation in their natural state, when it occurs, is owing to the suddenness with which they were envelopped in imputrescent mineral substances.

Of all classes of animals, the mollusks being the more abundantly represented in almost all the strata, their shells first attracted attention. Among the ancients, Herodotus, Strabo, Plato, Aristotle, Seneca, Ovid, Plutarch, and Tertullian, regarded them as indisputable evidence of the sea having formerly covered our continents. This observation, which is the germ of the science of geology, was a long time unaccepted by science. The fossils were long considered as figured stones, *lapides figurati;* as simple sports of nature, extraordinary results of a certain plastic force and certain occult laws; and this is, even at this day, the opinion of the peasant class. Towards the close of the sixteenth century, a potter, Bernard Palissy of Agen, was the first among the moderns, who protested against this general prejudice, and maintained that the fossil shells were real shells, left by the sea in the places where we now find them. The opposite error, however, maintained its ground for almost a century after, and found a zealous advocate in Beringer, a professor of Wurt-Bourg; but the work he composed in its defence had more effect in dissipating the illusion than the good sense of Palissy. To test the credulity of Beringer, some of his own disciples procured compositions which had the appearance of petrifications, and which represented stars, moons, suns, spiders' webs, and other objects, which they secretly buried in a place where they artfully contrived they should be found by the Professor himself. The toils were so well laid that Beringer was caught. He published a folio volume in Latin, in which are found exact representations of these pretended fossils; and their discovery was advanced as a confirmation of the assertion, that fossils are nothing more than freaks of nature. When apprized of the trick which had been played on him, the mortified Professor made every effort to withdraw his book from circulation. The animal and vegetable origin of the fossils being once recognized, it was necessary to explain them; and they were at first regarded as the results of the deluge. This idea appeared the more reasonable as but two events, two epochs of change on our globe, were then admitted,—the creation and the deluge; and all the efforts of the early geologists aimed at the explanation of the earth's actual state, by imagining a certain primitive state, which the deluge changed in a manner they endeavored to explain both in its causes and effects. Here begins the series of theories which I have to review, the earlier of which represent the infancy of geology.

THOMAS BURNET (1) was the first to attempt a complete theory. In the beginning, according to him, the earth, a fluid mass, was composed of various materials; the heavier elements fell to the centre and formed a solid nucleus, round which the waters were gathered, and above these the atmosphere. Between the waters and the atmosphere was formed an oily layer, which gradually received all the earthy particles wherewith the atmosphere was charged. On this layer of solidified slimy matter, which was of inconsiderable thickness, and the surface whereof was a perfect plane, without mountains, vallies, rivers or seas, the antediluvians lived. At the deluge, this earthy crust, under the influence of the Sun's heat, split, and fell into the great abyss of waters which it had covered. Thus was explained an expression of the Sacred Text, which merely designates either the waters that originally covered the earth, or that portion of them which was collected into seas. Hence the universal deluge, the derangement of the earth's axis, and the change of climates. The fragments of the earth's surface, in falling into the watery abyss, left vacant spaces, through which the waters gradually entered into the subterranean reservoir; and soon none remained except in the lower parts of the surface, that is, in the great vallies which contain the ocean. The ocean is consequently a part of the great abyss; the isles are small fragments, and the continents large masses, of the original earth. The mountains and other inequalities, which are now visible, are

(1) *Sacred Theory of the Earth.*—London, 1681.

the consequences of the breaking up, and falling in, of the former surface.

Happily the theory of Burnet is a dream, a philosophical nightmare, and we have no reason to fear, lest the slimy crust which sustains the rocks and mountains over the waters of the great abyss, should, at any time, involve us by a new break up in irreparable ruin. The whole system was invented to explain the deluge : but it is wonderful that the title of *Sacred Theory* could have been given to a system, founded on no observation, and directly opposed to the Sacred Text. Moses describes the waters, as envelopping the solid mass of the earth on the first day of creation, but Burnet spreads out the earth over the waters. Moses relates the deluge as a moral, and miraculous event; whereas Burnet regards it as a merely physical occurrence. Other contradictions may be hereafter noticed.

2. WOODWARD (1) believed that all the substances which compose the soil and rocky bed on which it lies, in England and elsewhere, are found in horizontal strata, as might have been the case with matter transported by water and deposited as sediment. He had seen a great number of shell and other strata containing remains evidently of marine origin. To this observation, which Bernard Palissy had already made, he added others not so exact. He maintained, contrary to the fact, that the mineral substances are superimposed in the order of their specific gravity. We often meet with pebbles and pudding stones overlying sand, and sandstone over clay and coal, etc.

The composition of the earth's surface does not follow the law of specific gravity, and consequently, its materials have not all been precipitated at the same time, but they have been successively transported and deposited by the waters. It was however, on this groundless basis that Woodward constructed his theory. He believed that all the materials of the globe had been dissolved in water and were simultaneously precipitated at the time of the deluge. To the objection, that there

(1) *Essay on the Natural History of the Earth.*—London, 1702.

was not enough of water on the earth to effect this universal dissolution, he replied, that the waters of the great abyss had ascended and were united with those of the ocean. In reply to the question, how could the granite and other massive rocks, have lost the adhesive attraction of their particles, while the lime-stone, shells and other organic remains, retained their forms?—he answered by referring to the will of God that such should be the case. There was evidently nothing more to do, than to get the waters back to the great abyss, and to adapt, as well as he could, his gratuitous suppositions to the history of the deluge. Such is Woodward's system, which, we need not say, is purely imaginary, having no foundation, and which is inconsistent in itself, and equally opposed to the laws of gravity and to the narrative of Moses.

3. Whiston (1) was disposed to look on the heavens with the eye of an astronomer, rather than with that of a philosopher, and he could not conceive that the Creator had spent more time in arranging our planet, than he had given to the rest of the Universe. He maintained, that the text of Genesis had not been rightly understood; that the idea generally entertained of the work of the six days was entirely false; and that Moses had not given us the history of the original creation, but merely the detail of the last form which the earth assumed, when God made it a planet, whereas before it was a comet. We shall find, further on, Chalmers and Buckland adopting, with some modification, the same principle. According to Whiston, the earth was formed of the atmosphere of a comet, the lighter parts whereof are the mountains. In the centre, there is a solid and burning nucleus, retaining yet the heat which it received from the sun, when it was the nucleus of a comet, which heat it diffuses in the direction of the circumference. This nucleus is itself encompassed by the great abyss, which is composed of two concentric spheres, the lower of which is a ponderous fluid, the lighter one is water, which latter is the foundation of the earth's surface. Whiston attributed the deluge to the tail of another comet passing near the

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(1) *New Theory of the Earth.*—London, 1708.

earth; and referred to the deluge all the changes which have happened, either on the surface of the earth, or in the interior of the globe. He, moreover, blindly received the hypotheses of Burnet and Woodward. "These extravagant assertions", says Buffon, "are put forward with a degree of address and a display of science, which give them a dazzling effect, even for men of scientific habits." The theory of Whiston met with prodigious success; five editions of the work appeared; and Newton, whose astronomical principles he had adopted, made him his Assistant in the chair of mathematics at Cambridge, and afterwards recommended him as his successor.

Let us now see how Whiston interpreted the text of Moses. In the beginning, God created the Universe; but the earth was as yet but an uninhabitable comet, in the atmosphere of which the elements were by turns dissolved, vitrified and congealed; they formed a chaos, an abyss envelopped in thick darkness, "and darkness was upon the face of the deep."(1) From the first day, when the atmosphere of the comet was freed from its solid and earthy elements, there remained only the air through which the rays of the Sun freely passed, and this at once produced light, "let there be light"; a singular interpretation which has been adopted by Chalmers and Buckland. The terrestial heat, arising from the central nucleus was greater in the earlier ages of the world; it impelled men to evil; every creature became guilty, excepting, however, the fishes, who, dwelling in a cold element, appear to have had less violent passions. The deluge was caused by the vapour and transparent nebula of a comet's tail, which met the earth, on passing from its perhelion. This event is indicated in the cataracts of heaven, "and the flood-gates of heaven were opened."(2) But Whiston was not satisfied with assigning the deluge exclusively to so far fetched an inundation; he took water wherever he could find any. The great abyss, as we have seen, contains an immense quantity of it. On the approach of the comet the earth experienced the force of its attraction, and the liquids of the great abyss, whose equili-

(1) Gen. I. 2. (2) Ib. VIII. 11.

brium was disturbed, ebbed and flowed so violently, that the exterior crust of the earth, whose foundation was thus disturbed, split, and in many places sank down and thus the waters of the interior spread over the surface of the earth; "and the fountains of the great deep were broken up."(1)—Such is the explanation of the historical narrative of the creation and deluge, and such the causes of the deluge and of the actual form of the earth, which, originally spherical, became elliptical, a change evidently produced by the concussion of a comet's tail.

Whiston believed in the reality of the deluge, and in the authenticity of its inspired description; but he paid exclusive attention to physical astronomy, and regarded the statements of Scripture as physical facts, and the results of astronomical observation. Hence he mixed up divine statements with human imagination, and produced the fanciful theory we have noticed.

These three theories agreed in one point, that at the time of the deluge, a change of form had been produced as well in the interior as on the exterior of the earth. According to Burnet, before the deluge, the earth had no mountains, no seas, no rivers; and its actual state is the result of the subsidence of the former surface. Woodward maintained that the earth was entirely dissolved at the time of the deluge; and the annihilation of all plants and animals, except those in the ark, and the entire change of the earth's surface would have been the necessary consequence of the dissolution of the planetary mass. Whiston adopted all the ideas of Woodward. These writers must, then, have believed, that the antediluvian earth, having been inhabited by man and the same forms of animal and vegetable life as at present, must have been even then such or nearly such as we now find it. Genesis tells us that before the deluge there were rivers, a sea and mountains; that these rivers and mountains were, at least in one part of the earth, the same as at present, the Tigris, the Euphrates and Mount Ararat; that animals of the same kind, as also like

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(1) Gen. VIII. 11.

vegetables, peopled the earth, as we read of the serpent, the dove, the olive and the vine. We cannot, then, on the one hand, make the supposition that there were not mountains, seas or rivers before the deluge, since Moses states the contrary; and on the other hand, it is certain that these mountains, rivers, plants and animals were not destroyed by that catastrophe, as we find mention of them subsequently to its occurrence. The incompatibility of these hypotheses with the Sacred narrative, is then, undeniable; and they are no less contradictory of physical science. Burnet, who first wrote on this subject, was far behind Bernard Palissy; he made no observation. Woodward adopted two general observations, that the surface is composed of horizontal layers whose materials were deposited in water, and that these layers contain sea productions. To explain this stratified condition of the beds, and the presence of fossils in them, at so many points of the globe, and at such various depths, he had recourse to the waters of an universal deluge which dissolved the whole earth. But if the earth had been dissolved, how were the numerous classes of the animal and vegetable kingdom preserved, Noah having taken only the birds and the great aud small mammiferous animals into the ark? It was by the waters of the ocean the world was dissolved, but this was the element of fishes, shell-fishes, corals, etc.: it is in it that they secrete those shells, those teguments, and those solid parts which are found in the strata of our continents. Can it be supposed that the same water which, at the epoch of the deluge, dissolved the terrestrial limestone and even granite, would not equally have dissolved the calcareous shells which were floating in its depths. If water were the dissolvant of all these mineral substances, why has it lost this quality? Why do not the seas now dissolve their granite bed, or their calcareous deposits, or the flints which harden in their depths? The name of Natural History of the Earth could not have been seriously given to a system whose principal agent has never, in the memory of man, possessed the chemical or physical properties attributed to it. The dissolving force of Woodward is, as he acknowledges, a miraculous quality, and he has recourse to the momentary

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suspension of the cohesive quality in minerals, a supposition which is open to the same difficulties as the preceding one, as far as regards the preservation of the plants, the animals and fossils, which are congeners of living species.

The theory of Whiston combines five or six hypotheses, all equally improbable; and although separately taken, says Buffon, "they may not be impossible, their combination is an absolute impossibility." The shock or approach of a comet; the existence of a central nucleus, at once solid and burning; that of an aqueous fluid round this nucleus, etc., are suppositions by which it is easy to destroy the world and create physical romances under the name of theories of the earth.

"An error," says Buffon, "which deserves to be remarked, is that of regarding the deluge as possible by the action of natural causes, whereas the Scripture exhibits it to us as resulting from the immediate will of God. Woodward, Whiston, Scheuchzer and others have involved themselves in the clouds of a physical theology, whose littleness and obscurity take from the clearness and dignity of Religion, and leave nothing for the mind but the absurd combination of human ideas and divine facts. Does the Scripture say, that the deluge formed the mountains? The contrary is implied. Is it said that the waters were in such agitation as to raise the shells from the bottom of the sea, and scatter them abroad over the surface of the earth? No: the ark moved tranquilly over the waters. Is it said that the earth was entirely dissolved? By no means. The recital of the Sacred historian is simple and true; that of these naturalists complex and imaginary." (1)

The great LEIBNITZ amused himself like Descartes, in making of the earth an incandescent Sun, a vitrified globe. (2) According to him, the greatest part of the earth had been the prey of a violent fire, at the time Moses says the light was separated from the darkness. The fusion of the globe produced a vitrified crust: when the crust cooled, the humid parts, which had ascended in the form of vapour, fell and formed

(1) Preuves de la théorie de la Terre. Art. V.
(2) Protogaea. 1683.

the sea; and the sea deposited the calcareous rocks. At first it envelopped the whole surface of the globe, and surmounted the highest points which now form our continents and our isles. Hence the shells and other marine exuviae, which are found every where, shew that the sea has covered the earth; and the great quantity of fixed salts, of sand and other matter, fused and calcined, contained in the earth, proves that the conflagration was general and that it preceded the existence of the seas.

Leibnitz wisely separated the question of the deluge from his geological ideas, which, however, otherwise he refers to the creation, when he says that the earth became incandescent when God separated the light from the darkness. This conflagration, however, does not harmonize with the Sacred Text, which represents the earth as covered with water on the first day when God separated the light from the darkness. On the second day, instead of ascending in the form of vapour, as the hypothesis of Leibnitz supposes, the waters were gathered together into the basin of the sea. The second hypothesis of Leibnitz is entirely opposed to the Sacred Text and to observation. It is a mistake to suppose that shells are everywhere found, and that the sea formerly covered the whole earth. This is to neglect the order of time in the creation, for in that case we should admit that the inhabitants of the sea were the first created, and existed long before the plants and terrestrial animals; but a theory which leads to this is self refuted, for animal life cannot exist without vegetable life. Besides, independently of the testimony of Genesis, which explicitly states the contrary, we have, in the terrestrial vegetables of the schist-slate, of anthracite and of coal, satisfactory evidence that the population of the earth is more ancient than that of the sea. For us it is certain that the sea and the uncovered land have always co-existed; and, consequently, that the ocean has never permanently occupied more than a part of the earth's surface. Sea fossils are not every where found: the deposits which contain them, although of immense extent, are still but local: they do not cover the whole earth in concentric strata, as the fruit is covered by the pellicules which envelop it.

All that science has gained from these theories, which were once so popular, are two or three exact observations ; whereas hypothetical geology is found in them almost perfect. Leibnitz may be regarded as the founder of the Plutonian theory, by his supposition of the original incandescence of the unstratified rocks. Whiston suggested the temperature of the Earth, the central heat and the reorganization of the Earth, turned into a planet for the purpose of fulfilling its new destinies. Burnet must have the credit of having first taught the change in the axis of the Earth, and the higher temperature of our climates ; while Woodward was the father of Neptunian geologists, by dissolving the Earth in water. Of all these hypotheses, hazarded without proof, one or two, after exact observation, have been admitted as scientific data. The temperature of the earth is established, but its cause is problematic : the external temperature also appears to have varied ; and there is reason to suppose that the heat in the first ages of the world, was, if not greater, at least more equable and more uniform in distant places. Hitherto geology, having no facts, embraced in the same study the mass of our planet and its envelope, or surface, and hence sprung so many absurd or unfounded systems. The great Buffon dissipated this chaotic cloud, and laid the foundation of positive geology.

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CHAPTER II.

Buffon and Pallas.

When we recall the time when Buffon produced the works, the titles of which we give below,(1) they must be regarded as an effort of genius. He did not attempt to explain the creation, which is inexplicable ; nor to account for the deluge, which was a supernatural event. He was even wise enough not to encumber his theory with conjectures on the formation of the planets. He was the first to perceive that geology

(1) Theorie de la Terre, 1744.—Preuves de la Theorie de la Terre.

ought to be divided into two parts; the history of the surface or of the strata on which the soil lies, and the history of the underlying mass or planetary nucleus. The surface of our earth is generally composed of materials which have been deposited, and which geologists figuratively call, the crust or peel of the earth, or, in simple language, the surface. These materials, however, suppose the pre-existence of a base which sustained the water and the fiery element, and on which the effects of these two general causes of our surface were developped. This base, this primitive surface, and all the underlying matter, is called the planetary mass. The study of these two parts, is, doubtless, intimately connected: but we must distinguish the facts which refer to one from those which have relation to the other. Geologists can only have a conjectural knowledge of the planetary mass: the surface is more within the sphere of their observation, and Buffon made it, in the works referred to, the exclusive subject of his investigation. He was content to take the earth at the moment when, on its primitive surface, began to be formed those strata or superficial deposits which cover it, and in which our mines and quarries are found. Having thus limited himself to the sphere of practical observation, he assumed as a principle, that the occupation of our continents by the sea being proved by unquestionable facts, in order to explain the deposition of the strata,—the surface of which, since their emersion from the waters, has become the habitation of terrestrial beings, we must examine what is actually taking place at the bottom and on the shores of our seas. Profiting by his own numerous observations, and of others made before him, he entered on the investigation, the result of which is the principle which, at the present day, is admitted by geologists, namely, *that the causes which produced the earth's crust are the same as those now in operation under our eyes.* The plan adopted by the great Naturalist was rational. Unlike his predecessors, he proceeds from the known to the unknown. He observed that as the strata were not found superimposed in the order of their specific gravity, it was impossible to suppose that they had all been deposited at the same time; that such is the thickness, the number and the extent of the strata, and the quantity of marine exuviae which they contain, that it could not be supposed, that all these animals had been contemporary, and that all these strata had been formed at the same time and under the influence of a transient cause, such as was the deluge. He established moreover that the horizontal position, the parallelism, the stratification of all these rocks, evidently suppose the action of some other cause than the deluge would have been, violent, irregular, and disturbing, and can only be accounted for by admitting a slow, uniform, continuous and permanent cause, like that of our sea currents combined with that of the winds which govern and change their directions. By establishing in the most satisfactory manner the transport by water of the materials of the sedimentary rocks, Buffon refuted by anticipation the system of Deluc and Cuvier.

He then proceeds by elimination. "These beds he observes, are not the effect of the deluge; these mountains of shells have not been raised from the bed of the sea by earthquakes." But when he wishes to establish his thesis more directly, and to shew in what is actually going on, the continuation of what has been done from the first day that the waters began to flow on the earth's surface, we regret to observe that facts were not at hand to sustain his thesis. He shews us, indeed, that the waters which produced the ancient sea-deposits, are still in their basin, with their ebb and flow, and their other currents: but he goes no farther; he does not enter on the comparison of the ancient with the modern deposits. His investigation becomes complicated by the admission of certain inadmissible hypotheses, which are also foreign to his general thesis; he suffers himself to be misled; and at length arrives at a conclusion, which is erroneous on more than one principle, and different from what we had reason to expect. "The sea," says he, "has thus covered, and may, hereafter, cover successively every part of our continents; and hence we should not be astonished at finding *every where* sea-products, and formations evidently of marine origin."

The question, however, was not, had the waters of the sea formerly changed their bed; and was it possible for them to change it again: the fact to be ascertained was this, does the sea, taken in its entire extent, at the present time, produce results which in importance may be compared, and in disposition and composition may be assimilated, to all the ancient deposits; and does it find the materials for such deposits in the same sources as formerly. This question could be answered by modern geologists only. They have completed and perfected the beautiful thesis sketched imperfectly indeed, by Buffon, who, however, must always be considered as the real founder of positive geology.

All the ancient rocks of aqueous origin are reduced to four or five sorts; calcareous rocks (limestone, marble, chalk, etc.) silicious rocks (silex, sandstone, millstone, grit, etc.), argillaceous rocks (potter's earth, fuller's earth, plastic clay, etc.), carboniferous rocks, (anthracite, coal, lignite, etc.), and marl rocks, which are formed by the combination of the other species. Buffon saw this; but he was not able to shew that the waters actually produce all these rocks at the present day. The fossils of the ancient rocks oblige geologists to refer the calcareous rocks in general to the sea; and to recognize in the siliceous, argilaceous and carboniferous rocks, with some few exceptions, materials derived from *our* continents and transported by rivers into former sea or lake basins. Now all these sorts of rocks are at the present being produced, and produced by the same causes as formerly. The laws of formations, and the exceptions thereto, are the same now as heretofore. Buffon, however, at the time he published his theory, saw only in the ancient bed of the sea, sea-fossils and sea-formations. He saw fresh water fossils only in the alluvions of our rivers, and he considered the carboniferous matter as belonging to the clay.(1) Hence he occupied himself exclusively with the products of sea currents. He observed the cliffs that border the sea, which the tide continually disintegrates, and forms out of them new strata; and did not suspect, that what the sea takes from its shores and from its solid bed, is

(1) Preuves de la *Theorie de la Terre.*—Art. VIII.

nothing compared with what the waters of our continents carry to it.

Not only does the sedimentary part of the soil continue to increase in the basin of our seas, and this, as formerly, by the action of fresh and salt waters, but these waters derive the elements of their deposits from the same sources as in the most ancient geological epochs. In this respect also, there is nothing changed, nothing destroyed in Nature. The calcareous matter wherewith the waters are charged is an element not solely derived from the disintegration of the ancient aqueous rocks; there is another and very abundant source of the carbonate of lime in the shell-fish, ray-fish, the infusoria, etc., which people the basins of the seas, the lakes and the rivers. The chalk and Jura limestone are the result of the trituration of the shells and the corals; the coarse limestone is composed, for the most part, of the spoils of molluscous fishes. At the present moment, the corals are occupied in building archipelagos in the depths of the sea. It is true, that the animals which secrete calcareous matter are developped in the waters which are saturated with this substance; but we must bear in mind, that animal life existed in the waters before the deposition of the sedimentary rocks, and that whatever carbonate of lime it borrowed from them, is infinitely small, compared with what it supplied them with. Animal life leads us to the primitive source of carbonate of lime, which is as active and as effective in our days as at any other epoch.

Thus the rocks derive their silicious matter from various classes of animals, as also from the continual decomposition of the primitive mountains. Whether silex, be, or be not, soluble in waters of the sea, certain it is, that crystals of quartz, sandstone and silicious millstones are still daily formed in its depths. The mechanical action of water deposits silex as a fine sand. If the sand is not cemented by a silicious cement, we must admit that it is rendered solid by carbonate of lime, or by very attenuated grains of silex, with which the waters are charged, and which seize on the vacant spaces, or act in some other way as yet unknown to us. Of these two primitive sources of silex, organized beings and granite, Buffon made account only of the second, and even this was not for him a primitive source, as he attributed the granite mountains to the action of sea-currents.(1)

The clay-rocks have for base, alumen, silex and water; but the alumen predominates. This results from the disintegration of granitic rocks. The feldspath of these rocks decomposes; the waters carry away the alumen and silex, and produce clay-sediments, in which the form of grains of feldspath are frequently observed. The sand, or grains of quartz, and the clays are borne to the sea by the rivers which continually wash away the soil. From the mixture of clays, sands, silex and carbonate of lime, result the marl rocks, which are called sandy, calcareous, silicious or clayey, from the predominant element.

Buffon, in his "History of Minerals," has satisfactorily established the vegetable origin of coal rocks, but in another work (2) he appears to identify them with the clay (3) No one now doubts for a moment, that the coal rocks are composed of vegetables, more or less triturated, which have been transported and deposited by continental currents in sea or lake basins. The conifera and ferns appear to predominate in the coal and anthracite. In the unreclaimed forests, the soil produced by the leaves and branches which fall and decompose on the spot rapidly increases. At the time of inundations, these substances, transported by the rivers, descend to the great lower basins. This primitive source of our ancient coal deposits, which the canalization of the waters and disappearance of the timber, have gradually diminished in all the countries originally inhabited by man, is still very abundant on the American continent. It is evident that the vegetable deposits which in woody countries are now in process of formation cannot be otherwise than local in extent and limited in number; and this is known to be true of the ancient coal beds. These observations may be thus resumed. The number of

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(1) *Preuves de la Theorie de la Terre.*—Art. VIII.
(2) Ib. (3) Ib.

rocks whose sedimentary part is derived from the soil, is reduced to four for all epochs anterior to our own ; namely calcareous, sand, clay and coal rocks ; and the waters produce even now all these kinds of works, the materials whereof are derived from the same sources as formerly. And thus is established at least for the rocks of aqueous origin the principle recognized and maintained by Buffon,—that the causes which produced the ancient deposits are identical with those now in operation under our eyes ; and that what is now being done is the continuation of what has been done from the beginning.

As for the igneous cause which has concurred with the waters to form the earth's surface, Buffon only considers it in its relation to the displacement of the bed of the sea. What he says on this occasion of the volcanoes, is replete with the results of sound observation, and contains a refutation of the central heat-theory.

When he prepares to investigate the cause of the waters of the sea quitting our continents, he acknowledges that this new problem is difficult to solve ; but the displacement of the waters being certain, the manner in which it occurred may remain unknown, without prejudice to the judgment we are to form of it. Then laying aside all the agents which are not in the ordinary course of things, such as the shock or approach of a comet, the absence of the moon, etc., which other writers employed, he points out the causes actually in operation to which this result may be referred : the falling in of the surface over subterranean cavities, the subterranean fires, and earthquakes, the destruction of the barriers which formerly separated basins of the sea, placed at different levels, etc. This was what Buffon found most likely to explain satisfactorily the laying bare of the ancient bed of the sea. In this respect we are not at the present day more advanced than he was. In the second part of his History of Minerals, Buffon solidly proved the transformation of water and other substances by the vegetable and animal remains found in rocks which continue to increase the mass of the earth and change the appearance of its surface. In his "*Epochs of Nature*," he partially attributes to this cause, so general and so powerful, the diminution of the waters, and the successive lowering of their level; this observation of Buffon, and the consequence he draws from it, appear to me singularly happy.

The *Theory of the Earth* placed geology for the first time on a positive basis. This book, however, was not applauded as that of Whiston had been; it was even made the subject of severe criticism. Voltaire laughed at it, because he had not sufficient genius to comprehend it, or was too envious to recognize its merit. In a letter written by him, in Italian, on the changes which have taken place on the globe, he said that the petrified fishes were nothing more than rare fishes rejected from tables of the Romans because they were not fresh, and that the pretended beds of shells were nothing more than the shells gathered on the shores of the Levant, which had fallen from the hats of the pilgrims of St. James of Compostella; and this was the reason why they were found petrified in France, Italy and all countries of Christendom. This absurdity drew from Buffon some severe raillery. Their friends reconciled them. Voltaire wriggled out of the controversy with his ordinary art. "I shall not quarrel, said he, with Mr. de Buffon on account of shells."

PALLAS.(1)—The pursuit of positive Geology was continued by Pallas. His essay on the formation of mountains or stratified rocks modified the original ideas of Buffon, and condemned to oblivion many of the then current theories, which this latter, however, reproduced at a latter period in his Epochs of Nature.

Pallas perceived that the high mountains of the world are composed of granite; that this ancient rock formed the base as well of the elevated plains, as of the lowlands; that granite is never found in layers, as Buffon supposed, but in blocks, and mountains, or at least in masses superimposed on each other; that it never contains any vestige of fossils; that the

(1) Observation sur la formation des montagnes et les changements arrivés à notre Globe. 1777.—Description physique de la contrée de la Tauride. 1779.

highest eminences formed by this rock, either in plains, or mountain-saddles, or abrupt peaks, have never been covered with clay or calcareous deposits, of marine origin, but appear at all times to have been elevated above the level of the sea. "This observation," he remarks, "refutes the hypothesis of those who believe that all the mountainous elevations of the globe are the effect of a central heat, and of its explosions in the first ages of the Earth, when the crust which envelopped this wonderful furnace, had not sufficient strength every where to resist so powerful an interior force. This could not have been effected without elevating, at the same time, various layers of different character, which we would now find on the abrupt heights of our granite mountains." According to Pallas, the assertion of Buffon, as to the corresponding angles of mountains, is subject to many exceptions, as well with regard to the granite chains as to the mountains of secondary formation.

The granite mountains are always accompanied, on the sides of great chains, by schistous, heterogenous belts, which are stratified and are either perpendicular or very abruptly inclined. They are the result of the decomposition of the granite, and appear to have suffered from the action of intense heat.

"We may speak," says Pallas, "more decisively of the secondary and tertiary formations. These present the most ancient chronicle of the globe, and one which is more easily read than the character of the primitive rocks; they are the archives of nature, which it has been reserved for our age to dig up, to interpret and to publish, but which many succeeding ages will not exhaust." "The secondary formations, which are of a very different nature and origin from the preceding, are situated on the sides of the schist-belts, which they cover. They are, at first, more or less deranged, and become as they rise more and more horizontal and stratified." In leaving the mountain-chains, we find the calcareous layers rapidly assuming a horizontal position and abounding in all sorts of shells, madrepores and other marine exuviae. In this secondary formation he enumerates a layer of potter's earth, the ancient blocks, above the Jura limestone, terminated by the chalk, which sometimes contains silex. He sees here nothing but sea-deposits. Hence he did not make the distinction of the organized bodies of sea and fresh water fossils, in the same formation, (aestuary deposits) and the same series; a distinction which was subsequently made in France and Italy.

On the chalk is superimposed the tertiary beds, composed, for the most part, of sandstone, of marl and of mixed deposits. They generally extend, in long belts, parallel to the principal declivities which the water courses follow. According to Pallas, they contain very few marine products, (an observation, however, formally refuted by the tertiary beds near Paris); and they abound, on the other hand, in entire trunks of trees, (much less, however, with us than the sandstone which accompanies the coal-beds of the secondary formation,) in fragments of petrified wood, often mineralized by copper and iron. Impressions of palm-tree trunks and of some foreign fruits are also found in them, as also bones of terrestrial animals, so rare in the lower series.

Such are the principal facts which Pallas gave to positive geology. He attempted to assign their cause. He accepted the granite, without seeking to investigate its origin, which he regarded as impossible to assign. This rock, decomposed by atmospheric influence, and the presence of a saline principle, has produced the gravel, the sand, the disintegrated rocks which form the schist, as also the vegetable earth. While the secondary formation was undergoing decomposition, the centre of Asia formed an isle surrounded by mountains. "Africa," says he, "must have also, in the central part, regions equally elevated, surrounded and crossed by mountains, which have served, like the plateaus of Asia, as a nursery of the organic creation." He attributes, as is done at the present day, the caverns of the secondary system, either to dislocation of strata, or to water courses.

He is less accurate in regard to the tertiary formation, which he refers entirely to the deluge. He attributes the exposure of the ancient submarine continents to many causes, frequent overflowing of the Ocean, the successive elevation of the schist and secondary rocks by volcanoes. We must bear in mind that in his time the volcanic islands were regarded as having been produced by upheaval.

Pallas was the first to distinguish the rocks, since called tertiary, according as they do or do not contain organized remains, and further as these latter are of sea or land origin. "By this means," says M. de Blainville, "he made speculative geology the foundation of paleontology. He made, however, the important observation, that we must not conclude that all the fossil animals are extinct from our not knowing them to be actually existing. He was the first to observe, that the fossil remains which are found in such quantity in the tertiary series, approached more the products of Asiatic climates than to those of the countries where they are found. He proved, by successive examples, the only ones which have been given, the degeneracy of all our domestic animals. From this point, it was possible for him, with anatomical zoology, to institute an exact comparison between the fossil bones and those of living animals; and he compared the embossed teeth of the mastodon with the Ohio specimen of that animal. It was by laying down these principles, which we shall see so well applied and developped at a later period, that Pallas created paleontology, and gave it a tendency towards the great questions connected with the origin of our globe. He himself applied them to the investigation of a great number of fossil teeth of the mastodon, the elephant, the rhinoceros, the buffalo, the gazelle, the right horned gazelle, etc., and he always remarked, that these animals are found with sea shells, bones of sea fishes, ammonites and belemnites. He is the only one, who, relying on his own observations, applied himself to the study of the disappearance of the species and of the natural history of man."(1)

II.—Buffon.(2)—In his *Theory of the Earth*, Buffon had determined the true point of departure for the science of geo-

(1) Hist. des Sciences, t. II. p. 536.
(2) *Epoques de la Nature.*—1788

logy,—of that geology which acquires, observes, and compares facts, without going farther or more rapidly than they permit, and seeks to explain the phenomena of the past by causes actually in operation. In his *Epochs of Nature*, however, he adopted another system, and thus became in France the leader of that hypothetic geology which gives scope to all the freaks of the imagination. If we except some accidental suppositions, which are either gratuitous or erroneous, and which the author himself subsequently abandoned, the former work accords as closely with Genesis, as the latter is fundamentally opposed to it. Let us investigate this monstrous system. My friend, M. Desdouits, has discussed its physical part. I will quote his words "Buffon finds at the beginning of all things, stars, a sun and a great comet. He does not say whence they come. This comet, which advances, we know not how, strikes the sun, and furrowing it, as a cannon-ball furrows the Earth, causes to flow from it an igneous substance, which resolves itself into various masses. The Earth is one of these! By force of the laws of attraction, globes of various sizes and densities are the result; and these, having attained their equilibrium, begin to revolve round the sun, in the direction of the comet's motion, this being modified by the mutual reaction of the parts of these liquid masses. Hence the planets! But inasmuch as these spheres had been projected by a shock, which did not pass through their centres of gravity, "this," says Buffon, "explains why the planets revolve round the sun and revolve in the same direction, from west to east, and why they turn on their axes in parallel directions." Moreover, as they all proceed from the same point of the solar mass, we can understand why their orbits intersect each other under such small angles; in other words, why they are so little removed from each other. Later the planets cooled, and their surface became solid. We now inhabit a crust of the formerly incandescent earth. The swellings caused by the cooling of the fluid-matter gave rise to the primitive mountains: but after thirty or thirty-five thousand years, the fire having abandoned the terrestrial crust it was possible for it to receive the waters of the ocean and the germs of vegetation. These are the two first epochs of Nature."

"This original liquidity accounts for the flattening of the poles of the Earth, and, still more satisfactorily, for that of the planets. Jupiter, for example, is much more flattened than the Earth; and accordingly he has a more rapid motion, which is produced by an excessive centrifugal force; whereas the moon, whose motion is so slow, has no sensible flattening. Moreover, he adds, if such be the case, the disposition of the planets in the solar system must follow the inverse order of their densities, as is actually the case, as any one may see by the calculations on the planetary densities which astronomers have made. But is not the declaration of Laplace a presumption favorable to this system,—"that considering the forty-two planetary motions in the same direction there are four thousand millions to one that these motions are the result of a common physical cause"?—I find the expression of Laplace very ridiculous or very unmeaning; further on I shall say why; but for the present I am of the opinion of this same illustrious geometrician, when he makes the conjecture, that the physical cause assigned by Buffon is not the real one. His reasons are:—

"First, the planets having had the starting point of their motions in the surface of the sun, they should describe curves which would graze that surface, so that, at each revolution, they would pass by the sun. Buffon, it is true, observes, that the molecular reactions of these liquid spheres may have modified the direction of the initial forces, and given results of a different character. Laplace replies, that in making to Buffon all possible concessions on this subject, his planetary curves would still be exceedingly excentric, and the perihelion-distances very small, whereas, on the contrary, the excentricities are very little, and Uranus is 660 millions of leagues (1980 millions of miles) distant from the sun. His next reason is, that the line of the rotation of a sphere round its axis, arising from a received impulsion, depends on the position of the point struck in regard to the centre of gravity. Buffon does not, however, explain how the original shock on the sun's surface could have been distributed among the various masses which have resulted from the collision in such a way that the centre of gravity is universally found in the same point of relation to the force which produced the rotation.

"There are, moreover, many other objections to the system of the Epochs. I will not ask, how comes it that the rotation of the moon and that of Jupiter, the result of the same shock, have different velocities, so different that Jupiter revolves on its axis eighty times faster than does the moon on hers: but, referring to this theory, true or false, which Buffon vaunts, —that the distances of the planets from the sun ought to follow the inverse order of their densities, I will remark that the facts are in contradiction with his system. The planet Uranus, much farther distant from the sun than Jupiter and Saturn, should have a much lesser density, whereas its density is greater than that of Jupiter, and more than double that of Saturn. Uranus, it is true, was not known at the time of Buffon; but this only shews the value of a system on which a profound genius devotes years of experience and reflection, and which a glimpse through a telescope suffices to refute. Moreover I must not omit to observe, that, if the matter of the planets comes from the sun, their densities ought not to be greater than that of the sun's surface, which is necessarily the lightest, and far under the mean density of that body. Now we know that if the mean density of the sun be taken for unity that of the Earth would be 4, that of Mercury 6. We must, then, say that cooling has condensed the matter of the planets; but we would have to shew, in the known laws of nature, a fact of condensation, in which a solid body was reduced, I will not say to the tenth part of its volume, as the hypothesis requires, but even to the half, or to the third part. No one pretends that such can be shewn. Besides, there is another difficulty in this hypothesis. Mercury, much nearer than we are to the sun, with a temperature that would make quicksilver boil, ought to be much less condensed than the Earth, whereas its density is far greater.

"I pass over in silence many other considerations, and I shall briefly refer to a conclusive one which might dispense one with alleging any other. The substance of the sun is not liquid; it is a solid, and, probably, a cold, nucleus, surrounded by a gaseous and incandescent atmosphere. This fact, which the phenomena of spots on the sun had long caused to be suspected, has been placed beyond question by the experiments on polarization of light, by means of which M. Arago has proved, that this immense furnace can be nothing more than incandescent gas. To this there is no reply.

"As to the formula of Laplace, I have said and I maintain, that it is ridiculous or unmeaning. It is unmeaning, if making a purely physical hypothesis, he only wished to say, that supposing natural causes to be the principle of all the planetary motions, the probability in favor of a single cause would be as four thousand millions to one. It is ridiculous, if he wished it to be understood absolutely, and without making any account of the moral causes which cannot be expressed by cyphers. To the wager of four thousand millions to one, proposed by Laplace, I would add: "unless it has pleased the Creator to dispose things precisely as they are by a single act of His will." What could any calculator reply to this? Whatever may have been the intention of Laplace, in uttering this formula, more than one person has made it the subject of a gross and materialistic commentary. There are, indeed, men, who, taking abstract mathematical theorems, in an absolute signification, use them for the purpose of combatting a system of an entirely different order. Thus there are persons who, grounded on this celebrated formula, have concluded that all the planets are certainly the result of a shock, and that, in supposing any thing else, Genesis has erred. This, they will tell you, has been proved mathematically, and they will refer you to Laplace. This has been said; I have heard it; I have read it."(1)

This intelligent writer leaves us at the end of the second epoch. At that period, the Earth, which had cooled down, was able to receive the waters which had been previously volatized in the atmosphere. At first they were of a high tem-

(1) *Les Soirées de Montlhéry,* par M. Desdouits, p. 49, etc.

perature, and, excepting, perhaps, the summits of the highest mountains, covered the whole Earth. During this third period, which lasted twenty thousand years, they furrowed the surface of the Earth, transformed into schist and clay all the debris of vitreous matter, and spread them out in beds on the vallies of the primitive nucleus. The heat of these waters was too great for the organized beings then existing; and "consequently," says Buffon, "it is to the earlier portion of this epoch, to the period between thirty and forty thousand years of the Earth's age, that we must refer the existence of those lost species, of which we do not now find living congeners. While she gave fecundity to the sea, Nature scattered the principles of life on all the points which the water could not cover or which it quickly abandoned; and these points, as well as the seas, could only have been peopled by animals and vegetables, capable of bearing a greater heat than could now be supported. "The vegetable *debris* which the organic molecules had formed, at the bottom of the sea, and on the mountains, gave rise to the coal beds, which are contemporaneous with the schist and clay-rocks"

In the fourth epoch, the action of water, of the earth's inherent heat, of electricity, of organic vitrescible substances, produced volcanoes, which, in their turn, modified the surface of the Earth and produced new combinations, of matter. Marine animals and vegetables alone existed; we find them in the slate, the coal and the limestone. Terrestrial animals appeared later, as is shewn by their remains which are comparatively so near the surface of our soil.

It was in the fifth epoch, and after a cooling down, which required several thousand years, that, in the northern countries, the organic molecules which are diffused throughout matter, combined under the influence of a temperature sufficient for the formation of the largest animals and vegetables. Subsequently, on account of the diminished temperature, these appear to have emigrated southwards, while, at the north, smaller animals and vegetables continued to be formed under the influence of a cooler atmosphere and an exhausted organic matter. The remains of these various animals and flora are deposited in the places where they successively dwelt, and they are now found in the crust of the earth.

The sixth epoch corresponds to the separation of continents. In fine, the seventh and last epoch is marked by the appearance of man.

I shall not discuss the whole of this theory, nor shall I ask of the author a minute explanation of the contradiction and impossibilities it involves; impossibility of the separation of masses of matter from the solar mass by the impact of a comet's tail;—impossibility, in this case, of a motion, regular, mathematical, uniform and in harmony with that of other planets and their satellites;—and impossibility of the spontaneous birth of animals and vegetables. The vegetable is the product of a grain, the animal of an ovule: both imply the pre-existence of species by which these have been produced. There is contradiction in supposing that the smaller and less perfect animals were produced when matter was richest in organic molecules and had its highest temperature; then the larger animals and vegetables, when the organic matter was exhausted; afterwards, animals and vegetables of stunted growth, when the heat was cooled down and the organic matter almost exhausted by the production of the larger animals, and, finally, there is contradiction in the production of man, the most perfect of visible beings, when there was scarcely any organic matter left.

The famous question of epochs of indeterminate length, so often renewed by the partisans of hypothetic geology, was here for the first time proposed, but without any more satisfactory proof than has since been adduced. The first epoch of Buffon is founded on a supposition mathematically false. In the second, the original fluidity of the globe is open to the same unanswerable objections which Buffon himself opposed to the theory of central fire, in his Theory of the Earth. His third epoch is grounded on the lost species, which have not their congeners at the present day, and on the deposits of schist consequent on the disintegration of the primitive rocks. It was not then known, that schist and gneiss are found parallel with limestone; that the most ancient strata contain species which have their living congeners; that the extinct species appertain to every age, and that in position they are associated with living species.—His fourth epoch is marked by the birth of volcanoes, earthquakes and the appearance of animals exclusively marine. Now, neither marine formations, nor rocks of igneous production belong exclusively to any one period. It was not then known that fresh water fossiles, either mollusks, fish, or reptiles, are found in the beds of almost all formations: as also that lacustrine and sea deposits are found superimposed on each other. The phenomenon of metamorphism, or the modification of igneous deposits by the influence of fire, was not then known to present itself at all stages of our soil; nor was the simultaneous action of water and fire suspected.

The system, from beginning to end, is in opposition with the laws of nature and physiology, as also with experience, and consequently with Genesis. The epochs do not correspond with the days of Moses. According to Buffon, the stars existed from the first epoch: Genesis records their creation on the fourth day. The animals appear in the third of Buffon's Epochs: Genesis assigns their creation to the fifth day. The terrestrial animals begin to shew themselves in the fifth Epoch of Buffon; in Genesis, they are created on the sixth day, as was also man, whom Buffon brings into existence in his seventh epoch.

This great Naturalist thus abandoned himself to the same freaks of imagination which he had so severely rebuked in the early geologists. He had said of the Theory of Leibnitz: "The great defect of this theory is that it does not apply to the present state of the earth; the past it explains, and this past is so long past, and has left so few vestiges, that we may say of it what we please, and in proportion as a man has talent he will be able to say things which will wear the appearance of probability. To assert, as Whiston did, that the earth was a comet, or to pretend, with Leibnitz, that it had been a sun, is to say what may or may not be possible, but to which it could be useless to apply the rules of probability." (1) And yet this

(1) *Preuves de la Theorie de la Terre.*

same Buffon, who thus judged Whiston and Leibnitz, gives us himself a new theory, which is nothing more than theirs remodelled and magnified; hence he pronounces by anticipation his own condemnation. Leibnitz thought, that the planets and the earth had been suns: Whiston, that the earth had been a comet; Buffon appears to unite both hypotheses, by making the earth and planets fragments of the sun, struck by a comet. This is substantially the same thing, and whatever may be said about it, nothing can be proved.

Buffon reproached the English geologists with having contradicted Moses; yet he himself does so repeatedly. To give but one example. The earth was created on the first day, according to Genesis; Buffon makes it proceed from the sun, which was created the fourth day.

In speaking of the theories of Burnet and Whiston, he said, "I thing that hypotheses, however probable they may be, should not be discussed with a shew of science that savors somewhat of charlatanism," and yet he combined all the powers of his mind to give his romance of the Epochs of Nature all the prestige of genius and learning, and all the charm of truth. It is perhaps impossible to conceive a theory so vast, so well connected, so replete not only with general facts, but with the results of observation, all concurring to the general plan, and which are proofs of immense research and profound meditation. Appearing in an age which seemed to have resolved to sap all the foundations of social order, Buffon could not entirely escape its fatal influence. He was impelled by the universal blindness that prevailed and (1), without, perhaps knowing it, and certainly without intending it, he lent the power of his genius to this destruction of great principles; he abandoned the theological object of science to embrace, with exclusive devotion in his writings, that of material utility and to secure the approbation of his readers. His *Epochs* had an immense success; but notwithstanding the bad instincts they flattered, they afterwards fell, as all that is not truth must fall. They had cost their author forty years of labour!

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(1) *Preuves de la Theorie de la Terre.*

Calmer after he had published them, he acknowledged, that his hypotheses were not sustained by proof, and he seemed to excuse, rather than applaud, himself for having imagined them. Thus at least he corrected the exaggeration of his plagiarists, who proclaimed them to be demonstrations.

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CHAPTER III.

Deluc. — Delametherie. — Delamarck.

Deluc. (1) — Notwithstanding the great impulse which Pallas had given to positive geology; and the reserve and wisdom of his hypotheses, a great many authors, who had much less experience in geological facts than he had, occupied themselves with producing imaginary theories.

I shall not speak of Patron, who took the earth to be a living animal; nor of Dolomieu, whose hypotheses are partly found in the system of Deluc, which itself is nothing more than "Buffon's Epochs" somewhat modified. According to Deluc, the chronology of Moses begins only at the creation of man. The days that proceeded it are not days of twenty-four hours, but periods, which may be made as long as we please. As the Creator employs secondary causes in the conservation of the world, so He employed similar causes in its creation.

All the rocks of our continents, including granite, were once part of a watery liquid, an inform and confused mass of various elements,—(an arbitrary translation of *terra erat inanis et vacua*,) which covered the entire globe. By communicating to this chaos a certain amount of caloric, God produced in it those chemical deposits which successively separated its elements, and spread them out in horizontal beds. The substances which served as basis to the first beds, (apparently those of granite) in passing from the pulverized to the massive state, formed vast cavities, which by causing the superincumbent mass to fall in, formed the inequalities of the

(1) *Lettres sur l'Histoire de la Terre. Elements de la geologie.* 1770—1810.

earth's surface. These depressions, which extended over the greater part of the surface, were immediately filled with water and became the original basin of the seas. Then appeared the first continents, much more extensive than ours. The sun was not yet created, when God covered them with vegetables much larger than our actual species, and of so different a kind that it is evident they were developed under the sole influence of light. Their accumulated remains formed immense turf-pits, which, during the following periods, were buried under mineral beds, and which we now dig up under the name of anthracite and coal. These events filled up the three first days, or indeterminate periods of time so called in Genesis.

In the fourth period, natural causes, modified by solar influences, produced in the waters new precipitations, among others, the calcareous strata in which are found the first vestiges of marine animals. This period was also characterized by the origin of a great number of volcanoes; by the deposit of sand strata, coal, chalk and rock salt. The water and air underwent new changes, from which resulted different strata, containing the remains of sea animals of various kinds, the production of which was favored by these altered circumstances. At this time, all the stratified masses fell in for the second time, and occasioned, by their breaking, our great chains of mountains and all the irregularities we find in them. These phenomena correspond to the fourth and fifth days of Genesis.

In the sixth period the precipitations scarcely contained elements to form solid deposits: these are the soft and movable beds of the surface of our continents. These also present traces of great catastrophes. They contain remains of terrestrial animals, which are found in climates where these animals could not live at present, on account of the diminished temperature. When they existed, the sea covered our continents, as the strata in which their bones are found, contain also the remains of sea animals. We cannot, then, suppose with Buffon, that these animals emigrated from another climate to that in which they are found in the fossil state. What is true of the vegetables of the coal beds, may be said of the terrestrial animals; those which dwelt on islands, whose surface had not as yet found a solid foundation, were submerged by the caving in of their abode: some, in the effort to save themselves by swimming, perished in the waves, and their remains were transported by currents to the places where we now find them. Such was the origin of terrestrial fossils.

Man, who was created last, lived in scattered families, and perished with his abode, when, by a great and final catastrophe, the former continents fell into the subterranean cavities. The sea, overflowing these depressed surfaces, destroyed all their inhabitants. This was the deluge of Moses. Then appeared our actual continents formed under the sea, and laid bare by the displacement of its waters. In the movable beds of this new soil, lie in a confused mass, earthly mammals, which occupied the islands the sea had engulphed before the deluge, and the cætacea which peopled the ancient sea. The preservation of some of these animals on the coast of the Icy Sea, and the comparative thinness of the beds which cover our continents, concur to prove that their emersion does not date from a distant period.

The deluge produced changes in the soil and atmosphere which have abridged the term of animal life and caused the extinction of many species. But, since this great and latest catastrophe, all has remained quiet; no new strata have been formed, the temperature has not sensibly varied, and the species of the two kingdoms of animal and vegetable life, have ceased to be exposed to the revolutions which desolated the world in the first periods of its history.

Such, in substance, is the somewhat confused theory of the celebrated Geneva geologist. Instead of leaving geology in the path where Buffon had placed, and Pallas had kept it, he followed the example of the English geologists and brought it back to the realm of hypothesis. He did not endeavor, like Buffon, to explain what happened formerly, by what now happens; for, according to him, nothing new is now produced; but he assigned extraordinary causes which no longer exist, and the supposition of whose former existence is gratuitous.

Although Buffon shewed that the fossil shells are not, as they had been called, the medals of the deluge, many Naturalists after his time maintained that position. One of the least difficulties it presented, was to explain, how the sea had furnished, at one and the same time, as many shells as are found in all the strata. One writer thought that he explained it by supposing that the germs of animals and plants, scattered over the earth and diffused through the air, had been transported, and spread by the deluge-currents on all points of the surface of the Globe, and were buried down as low as two or three thousand feet in the soil where they subsequently germinated, where they lived, died and left their remains. Religion was thought to be interested in the discussion. It was not possible to conceive how animals and land plants, which were thought not to have existed before the deluge, could be found buried in our continents; and even in the supposition, that they had lived and had been buried before that event, it was feared, that this opinion might involve a too high antiquity of the world and thus disturb the faith of Christians, by contradicting the Chronology of Moses. The theory of Deluc seemed calculated to meet every difficulty. Aided by a new interpretation of the word "day" in Genesis, it assigned innumerable ages for the action of secondary causes, wherein might be produced all the geological phenomena; it explained the formation of the central nucleus, and that of the superficial soil; the creation, the deluge, the burying and extinction of the lost species, the displacement of the sea, and the emersion of our continents,—all were explained. It indicated a certain correspondence between the chronological order of creation and that of the fossils in our strata.

These circumstances gave it success. It remains to be seen whether, as a scientific and religious hypothesis, it merits the favor of Theologians.

Deluc ascribed the origin of our planetary mass and of its crust to an aqueous solution. To this there are at least two insuperable objections; first, the greater part of the mineral elements of the granite and porphyry rocks are insoluble in water; and in the next place, it would have been necessary, that a measure of water should have dissolved fifty thousand similar measures of rocky matter. As for the lowest strata, gneiss, mica-schist, &c., they indicate the action of fire as well as of water; they are beds deposited by running waters, and afterwards modified by volcanic agency. They are found at all levels. These simple observations destroy the fundamental principle of Deluc's Theory. We must not, however, pass too severe a judgment on his aqueous principle, and the chemical precipitations which are involved in that hypothesis. He had found them in Dolomieu and in De Saussure, and, after him, they reappear in Werner and all those of his school. These are therefore called *Neptunians*, in contradistinction to the *Plutonians*, who, on grounds equally uncertain, give us fire for water, and ascribe to it the production of all kinds of rocks.

The Neptunian theory was grounded on two facts, the crystallization of the granite rocks, and the spheroidal figure of the earth. The crystallization of the primitive rocks, was not, however, a proof that they had been dissolved in water, as many substances, fused by heat and gradually cooled, assume a crystalline form; and on the other hand, a large class of substances, reduced to the gazeous state, become crystallized by condensation, in the same way as by aqueous or igneous agency. Moreover, matter having been created in some state, and in masses, as we shall see, the crystalline state of the nucleus of our planet may have been a primitive, and not a secondary fact. The spheroidal figure of the Earth, if not a primitive fact, may have been determined by a gazeous state, as Laplace supposed; or by the fluidity, or the soft state of the surface of the Globe, as the calculations of Clairault imply. The Neptunian theory is not, then, necessary to account for it. Moreover it is not proved that the Earth is a perfect spheroid of revolution, such as it should be were it originally created in the liquid state. "By the laws of hydrostatics and gravity, of the centripetal and centrifugal forces, it may indeed, be shewn that a liquid mass, revolving on its axis, should assume an elliptical form, swollen at the equator and flattened at the poles. Mathematical calculations have shewn that such is the form of the Earth. Hence, it has been concluded, the Earth was originally in a fluid or liquid state.

This reasoning supposes what is to be proved. The laws of hydrostatics, of gravity, &c., are derived from the form of the Earth; are its properties in its actual state,—properties which would not exist but for its actual state, and therefore, could not have determined it. All the calculations in the world, how exact soever they may be supposed, would only prove this, that such is the actual state of the Earth, such the actual laws of motion: but this state and these laws necessarily presuppose the existence of the Earth."

Besides, is it so certain that the calculations as to the Earth's spheroidal form are exact, and that experience has confirmed them? By no means; many results of direct observation appear irreconcilable with them.

The most generally received calculations assign to the pole a flattening of $^1/_{305}$; but Geodesic and meridian-measurements shew different results. Thus the degree measured by the Swedish astronomers towards the pole, indicates a flattening of $^1/_{312}$. The different parts of the arc measured in France in late years, on being compared with each other, shew a flattening of $^1/_{180}$; while a comparison of their totality with the degree of the equator indicates $^1/_{309}$, and with the Lapland's degree $^1/_{317}$. Mudge measured two continuous degrees, which gave a difference of 216 metres (1296 feet) less while they should have give 33 metres (198 feet) more. The operations of Lacaille resulted in a flattening of $^1/_{169}$. It is, then, by no means certain, that all the meridians of the Earth are perfect ellipses, and, consequently, that the Earth is a perfect revolving solid mass.

"The differences of the level of the seas,—for example of the Red Sea and Mediterranean,—are irreconcilable with these calculations. Were the Earth a perfect spheroid, the level of the sea should be everywhere the same; but the observations made in the Red Sea and the Mediterranean, shew that such is not the case. In a word, to have data sufficiently general, and, consequently, reliable calculations, it would be necessary to measure a large number of meridians in all parts of the Earth. These various results should agree, or differ so little, that the difference might be attributed to an error of calculation. We are not, however, so far advanced; and at present it is not demonstrated that the Earth is a perfect revolving spheroid."(1)—Even were this established, the hypothesis of an aqueous original state would not derive any advantage from the fact, since the form of the Earth might be as reasonably ascribed to a gazeous or fused state, or to the originally soft state of the Earth's surface. These considerations shew that the principles of the Neptunians, and, consequently, the system of Deluc which is built on them, are not unquestionable.

I shall not say anything of the thin crust of the Globe, suspended over the fragile roofs of those immense caverns, in which the antediluvian world was so often buried,—an idea borrowed from Woodward and adopted by Deluc, to explain the deluge and the mixture of fossils of different epochs and origin. The hypothesis of depressions, assigned as the cause of the displacement of the ocean, has lost none of its credit since the time of Deluc; but it would be impossible now to rest it on the grounds imagined by this author.

There remains, however, something more serious. Deluc does not stop his aqueous precipitations, when he has formed the mass of the planet; he assigns the same cause to all the fossiliferous strata, and extends the series of his chemical operations to the deluge, which, he says, may have been separated from the original creation by many thousands of ages, according to the extent that may be attributed to his imaginary periods. In this present epoch, however, all is quiet; the sea no more changes its bed; there is no more any formation of strata, no more any deposits of fossils. Unfortunately for Deluc, this notion of the actual surface contradicts all the principles of science, and all the results of observations; in such a degree that, if we will be correct, we must reverse all his ideas, and adopt the contradictory of all his assertions.

Terrestrial or fresh water, vegetable and animal fossils are indeed found in the bed of the sea, but not, as Deluc maintains, in consequence of the caving in of the countries which

(1) *Dieu, l'Homme, et le Monde,* t. I. p. 286.

they inhabited; the materials in which they are imbedded, are not the ruins of former submerged continents. Nothing in them indicates a soil or surface which had been exposed to atmospheric influences. They are horizontal stratified beds, made up of matter derived from the dry earth but carried to the sea, in the sedimentary state, by land-currents. Sometimes land fossils are found in marine, and sea fossils in fresh water, strata. These combinations only prove that sea and river waters have mingled their products; they indicate æstuary deposits.

Deluc maintains that the changes of the liquid in which these precipitations were effected, have produced rocks peculiar to each epoch; but the fact is that each epoch includes all the same kind of rocks. In all the epochs, not excepting our own, we find sand, sandstone, flint, limestone, clay, coal, &c.

The series of phenomena, from the formation of granite to the present time, presents no break of continuity. In our lakes, at the mouths of our rivers, along the whole coast of our seas, and in their depths, there are now forming deposits analogous to those of former times; and this will be the case as long as there are waters on the Earth. Their organic materials differ in no respect, as fossils, from those of the most ancient beds; and were they to decompose and disappear from their *gangues*, they would leave moulds, as the fossil beings of former periods. Nay more, it is proved, that the general level of the sea has fallen considerably since the last emersion of our tertiary rocks and bone-caverns. This is the teaching of observation; but, then, what becomes of the system of Deluc? Neither chemical precipitates, nor the temporary changes which have occurred in the atmosphere and in the waters, have formed the Earth's surface, since, according to Deluc himself, all this has ceased; and yet effects perfectly analogous to those of past times continue to be produced.

There is no identity between the order of the creation of beings and that of their appearance in the layers of the Earth's surface. In this respect, also the statements of Deluc were unfounded. The vegetable fossils do not always present themselves first, as he supposed; they appear, for the most part after the mollusks, the corals, fish and other sea animals. The mammals, on the contrary, which should not appear before the sixth period of Deluc, that is, according to him, in our movable and uppermost strata, existed before these were formed; since they occur, probably in the Jura-limestone, and certainly are found in the lower beds of the tertiary rocks.

Thus the transformation of the days of Genesis into long periods of unknown duration is not more accordant with observation than with the Sacred Text. If the third day, that of the creation of vegetables, had been one of these immense intervals of time which, according to Deluc, were required for the revolutions of the Globe, we should be obliged to admit with him that these vegetables, which existed long before the Sun, and under the sole influence of heat, differed essentially from ours. The vegetables of the coal and anthracite beds had, however, the same organization as ours, in relation to the solar light; they were developed under the influence of this luminary. The fossil animals which accompany, or precede them, in the earliest beds, had eyes. The eyes of the *trilobites*, a species of crustacea almost exclusively found in the transition rocks, are in their structure exactly like those of our living crustacea. It is a general fact, that all the fossil heads of fishes, reptiles, articulated animals, &c., whatever be the relative age of the strata in which they are found, have orbital cavities in which eyes may have been lodged, with holes for the passage of the optic nerves, although it is rare to find in these cavities any remains of the eye itself. All these, consequently, lived under the influence of the Sun; and hence the third day of Genesis was not a period of many thousand years. This new interpretation of the word "day" in Genesis, first imagined by Buffon in his "Epochs of Nature," and subsequently adopted by Deluc, with the view of reconciling the Sacred Text with observation, results in opposing them to each other. Observation itself brings us back to the literal meaning of the text, which never should have been lost sight of, because it is the only one that can be reasonably admitted, the only one that is conformable to the general tenor of Genesis, and, particularly to that of the history of the creation, as it is easy to shew.

Let us admit, for a moment, Deluc's interpretation ; let us transform the first five days into periods, as he begins the Chronology of Moses with the creation of Man on the sixth day. We may give these periods whatever length we please; but let us be a little more moderate than speculative geology ordinarily is, and let us assign to each period only three thousand years. Now, let us open the book of Genesis. The plants are created in the third period; the fishes and birds in the fifth ; but there was no rain before the creation of Man; before that period there had been merely simple dews (1); whence it follows, that the plants existed without water nine thousand years, and the birds six thousand years, for without rain there could be no rivers. It would moreover, be necessary to admit that the waters which were gathered together in the basin of the seas, at the beginning of the third period, had no tide at the creation of the Moon, in the fourth period, that is to say for three thousand years. The Terrestrial Paradise, planted with trees "from the beginning" which doubtless, means from the period of the creation of plants—during nine thousand years, that is to say, till the creation of Man—would have remained unharmed by all the revolutions which theoretic geology attributes to the action of secondary causes, during the course of these periods.

Moses exhibits to us God giving to man, whom he had just created, dominion over the plants and the animals. Every one not influenced by preconceived notions, had hitherto understood that the animals and plants, over which man was made master, were the same that God had created on the third and fifth day since Moses speaks only of these. But in the system of indeterminate periods, God could not have given to man dominion over the species originally created, as all these had already ceased to exist, at the period of the creation of Man. Ask Deluc and his partizans ; they will tell you that man and the species in question were not contemporaneous ; that the species now existing did not exist in the remote period of which we speak, because we do not find their remains in

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(1) Chap. II. 5. 6.

the ancient strata of our Globe; and that those which have left their remains in the ancient strata were not contemporary with man, because they are not found with him on the Earth's surface, nor on the superficial strata where the remains of man himself are found. It follows from this that Moses has spoken to us of species with which we never had any relation, and has said nothing of those which God has subjected to our rule!

This is not all. Grant Deluc, Férussac, Ampère, &c., that the creation of the different species of plants, as also that of the different species of animals, as well marine as terrestrial, had been successive, and you will abandon the sense of the Sacred Text, according to which each great division received existence in a moment: "let the Earth bring forth,—and the Earth brought forth."(1) If you maintain the unity of time in the creation of each division, your genesiacal periods have nothing in common with those of the geologists to whom you make useless concessions. According to them, the succession of the different species in the layers of the Earth's crust, accords with the order of their creation, and represents it; therefore, they ask not only for indefinite periods of time, but also suppose successive creations, corresponding to all points of duration during these periods. Nor would this be enough for them, if the successive creation of the species of each division was not distributed in the different epochs of their respective periods. In order to identify their interpretation of facts with the periods Deluc ascribes to Moses, it would be necessary, that the succession of the different species of plants, in the deposits of the Globe, should terminate at the point where would commence the succession of the different species of aquatic animals, and that this succession should, in turn, disappear when the first earthly animals were produced. Only thus would there be a correspondence in the system of Genesiac periods, between the order of successive appearance and the order of creation. Are fossils generally found in this order of succession? By no means: every one knows, that the

(1) Gen. I. 11. 12.

series of different vegetable species appears without interruption, from the first to the last of our strata, and that such also is the case with the series of animal fossils. The creation of the vegetable kingdom could not, consequently, have occupied the whole time of the third period; neither could that of animals have been limited to the fifth Genesiac period. It would be necessary to suppose that the Creator had given existence to new species of plants, in the period of aquatic animals, and to new species of aquatic animals in the period of earthly animals. This, in fact, is the supposition made by speculative geologists, although it is still more correct to say, of the more moderate of them, that, without any more regard to the periods of Genesis than to those of Deluc, they maintain that God has created new species, at every moment of time, to replace the original species as they became extinct.

It is not my present purpose to examine the hypothesis of successive creations, but enough has been said in relation to it, to justify the opinion which M. Letronne has formed of the Genesiac periods of Deluc. "Deluc and his imitators", says this writer, "did not perceive that this mode of procuring time sufficient for the formation of the various strata, which form the crust of the Earth, was paying too much for the advantage of making Moses a geologist: for this celebrated interpretation is in contradiction with the whole tenor of the text, and makes him completly unintelligible."(1) M. Ami Boué treats no less severely this celebrated interpretation. "It is only," says he, "by changing the natural meaning of words, and by confounding all ideas, that the Fathers of the Church, (a single one), like the Biblical geologists from Burnet and Whiston to Kirwan, Deluc and Fairholm have been able to reconcile Genesis with their systems. Thus, they have all found in the word "day" of the narrative of the creation, the convenient indication of a period, which each one might lengthen or shorten at his pleasure. This interpretation, if adopted, renders the remaining part of the recital unintelligible if regarded from a scientific point of view."(2)

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(1) Revue des Deux Mondes, Mars 1834.
(2) Bul. de la Soc. de Géol. Vol. V. 1834.

Leaving, then, the periods of Deluc to the ridicule with which Hebrew Scholars treat them, let us return to the litteral interpretation of the Sacred Text. Whenever the word "day" in Hebrew, is connected with the words "morning" and "evening", it always indicates a period of twenty-four hours. To translate the Hebrew phrase, "there was evening and morning one day" as if it meant an indefinite period, is to render it by an expression which has no warrant in any other part of the Scripture, and to imply that Moses used unintelligible language. With such a meaning, how shall we render, "day", "evening" and "morning", the first of which expresses an indefinite period, which the other two limit with such precision? What limit can these expressions be supposed to indicate in unlimited periods?

Although the phenomenon of day and night might not have been completely produced before the creation of the Sun and of animals, the intention of Moses to express a full day a period of twenty-four hours, would sufficiently authorize the use of the words "evening" and "morning", because it is by joining these two words to the word "day" that the Hebrew language expresses that duration with the greatest precision: whereas, had he wished to convey the idea of an indeterminate period, the words "evening" and "morning" would form a veritable absurdity.

Were the meaning of the text obscure, it is not geology that could furnish the key of interpretation, but Moses himself. The historian of the creation teaches us, that God blessed and sanctified the seventh day, as being that on which he rested, after the completion of all His works. This day, consequently, belongs to the series of Genesiac days, being the seventh of them. (1) The circumstance of this benediction is recalled in Exodus, where it is accompanied by the precept which regulates the time of man's labour and of his rest. "Six days shalt thou labour and do thy work and on the se- "venth, the day of the Lord, thy God, thou shalt do no work, "—for in six days the Lord made the Heavens and the Earth

(1) Exodus XX. 9. 10. 11.

"and the Sea, and all that they contain, and he rested on the "seventh day; He blessed it and sanctified it."(1) Thus the seven days of the creation formed those of our week. Moses has not used other terms in designating both. The days on which the Lord created and organized the World, are the days on which man shall labour. The day on which God ceased to create, shall be the day on which man shall suspend his labours. The days of creation were, consequently, like ours, days of twenty-four hours; and Deluc would have seen this had he been free from the mania of System-making. (2)

Sacred Criticism must make him another reproach. He maintains that the ancient continents no longer exist, that they have been swallowed up by the deluge; but Moses tells us the contrary, at least as far as regards the part of the Asiatic continent inhabited by man immediatly after the deluge.

III. De Lametherie.(3) While Deluc was causing geology, to retrograde by many of his pet ideas, De Lamétherie, looking for the explanation of the phenomena of the past in the phenomena of the present, made it advance, and carried on the work of Buffon and of Pallas. With the exception of his exageration in regard to chemical precipitates, he was on all points of the science, on the right road. The coal, the volcanoes, the earthquakes, the formation of new soils, in a word, all the geological facts are explained by natural causes which are intelligible, known and capable of being analysed.

He remarked the general fact of the local character of strata and sedimentary deposits, which refutes the artificial generalization of superpositions from which so many erroneous consequences have been drawn. He saw that the rivers of our continents are producing, at this very time, in the sea formations which alternate with marine deposits; but the effects of this alternate action of fresh water and of marine water in the early rocks appear to have escaped his observations. He

(1) Exodus XX. 9. 10. 11.
(2) See Note A.
(3) Théorie de la Terre. Paris, 1797.

clearly saw and shewed, that there was no possible generalization of phenomena, because facts, like their causes, vary in nature and intensity, according to their localities. This led him to recognize the synchronism of aqueous formations, among themselves, and of these latter with igneous products. The action of these two causes was, then, simultaneous and local. These are important observations.

He admitted only one primordial and simultaneous origin of vegetables and animals. He rejected the general revolutions. The fossil species, according to him, have been embedded by natural causes. The extinct species perished by local circumstances ; that is, as he explained it, because they were no longer placed in suitable media, or by reason of changes of temperature. He assigns as cause of the change of climate, the former greater proximity of all the peaks and table-lands to the surface of the sea. His book contains the analysis of more than sixty systems, and he had not exhausted the number. This deluge of systems made Cuvier say : "that a science of facts and observations had been changed into a tissue of hypotheses, so foolish and so self-contradictory, that it was scarcely possible to speak of them without a smile." (1) While writing these words, the author of the *Discourse on the Revolutions of the Globe* was, no doubt, far from thinking that his own geological hypotheses were one day to be added to the systems more or less absurd, which talent has produced, but which common sense rejects.

IV. De Lamarck, 1802–1817. — Contemporary with De Lamétherie, his friend De Lamarck touched with a master's hand the science of geological paleontology. In his description of the fossil shells of the neighbourhood of Paris, (2) he afforded a beautiful example of the way in which we should proceed in the science of conchology applied to zoological questions. He considered the study of shells most useful in

(1) Rapport de M. Cuvier, sur la Théorie de la surface de la Terre, par M. André. Paris, 1806.
(2) Description des Coquilles fossiles des environs de Paris. 1802-1806.

the formation of a true theory of our Globe, and for the assistance it afforded in calculating the modifications which living species undergo in the various places they inhabit.

He was not satisfied with establishing the fact, that the fossil shells belonged to the actual series and that many of them had their living congeners. He sought in the study of living shells, the clear and precise characters which distinguish fresh water shells from those of the sea.(1) The result of this study applied to geology, necessarily led to the distinction of fresh water and marine formations, and, consequently, to the recognition of the alternance of these two sorts of formation, an immense step which opened the way to many important results.

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CHAPTER IV.

Cuvier.—*The Diluvium of Geologists.*

V. Cuvier.(2) The work whose title will be found at the bottom of the page was composed conjointly with Alexander Brongniart, who, according to Cuvier himself, contributed the greater part of it.(3) Cuvier's whole system is contained in the Preliminary Discourse on the revolutions of the surface of the Globe and on the changes they have produced in the Animal Kingdom. (4). When this work appeared, the state of geological studies was not, as he asserted, like to that of the time when some philosophers thought the Heavens were made of cut-stone, and believed the Moon to be as large as Peloponesus. (5) There had already appeared Buffon, Pallas, De Saussure, Werner, De Lamétherie, &c., names not entirely without the fame of scientific celebrity.

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(1) Diction. Hist. Nat. de Deterville, art *Conchiliologie,* 1817, et Hist. des Animaux sans vertèbres, 1815.

(2) Essais sur la géologie minéralogique des environs de Paris, 1811.

(3) Recherches sur les ossements fossiles des quadrupèdes, etc., 1821-1825.

(4) Discours préliminaire sur les Révolutions de la surface du Globe, et sur les changements qu'elles ont produits dans le règne animal.

(5) Discours préliminaire, p. 4.

Instead of following the course which these modest and laborious men had marked out, and encouraging by his example the study of known causes, Cuvier, who was rather an anatomist than a geologist, asserted that nothing would be more fruitless than enquiries made in this direction. He thought that "the thread of Nature's operations had been broken; that its march was changed; and that none of the agents which it now employs would suffice to produce the former works."(1) His system, so artfully proposed in his magnificent discourse on the revolutions of the surface of the Globe, of which it is the weakest part,—has done as much injury to the progress of geology, as his Researches on the fossil-bones, have served it, under another respect. This last named work prepared the way for the Osteography of M. Blainville which corrects it, and for the labours of Adolphe Brongniart, Deshayes, Agassis, Milne Edwards, Lartet, Michelin and so many others, on the remains of the different classes of the two organic kingdoms which are buried in the layers of our soil.

The geological ideas of Cuvier resemble those of Deluc. Their starting point is the same. The causes which have produced the geological strata are either extinct or at rest, since the emersion of the continents on which we dwell. Agreeing in these principles, the two authors differ, but slightly in the explanation of the phenomena. According to Deluc, the seat of terrestrial beings and of land-currents has often fallen in, and the sea has covered these buried places. Hence the association in the ancient bed of the sea, of the remains of animals and of land river plants, with sea animals. And yet the remains of land and river animals are not always combined in the same deposits with those of the sea animals. Both frequently occupy distinct beds, which are composed of different mineral substances; and those which contain the land and river fossils are as perfectly stratified as the marine strata. These circumstances of position, which Cuvier was enabled to observe in the former basin of Paris, destroyed the explana-

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(1) Discours.

tion of Deluc. It was no longer possible to admit that the deposits which contained land, lake and river remains, had been formed by the sea. On this account, Cuvier modifying the account of Deluc, supposed indeed with him that the sea had covered the present abode of terrestrial animals, but not until after the deposition of these latter in the beds already formed by the lakes and rivers. As if, however, he feared to depart too much from the Genevan Geologist, he admits that the irruptions of the sea in the continents were sudden, and that they destroyed and buried many animals which existed at these epochs; whereas the sea-animals perished by the effect of changes introduced into the element in which they lived.

This is his system. Considering with Cuvier and Alexander Brongniart the strata in the neighbourhood of Paris, we must first imagine a "sea which deposits on its bottom an immense mass of chalk. This sea retires: its bed becomes the habitation of plants and of fresh water-currents, which fill up the inequalities of its surface with clay, lignites and river shells. Another sea which maintains a prodigious number of shell-fish, different from those of the chalk, covers with its deposits those of the clay and lignites. The sea again retires, and the soil is covered with lakes which deposit gypsum and marl. Again the sea comes back: it now brings bivalve and spiral shells, and afterward oysters.—Once more the sea retires for the third time. Lakes and fresh water-marshes replace it and cover with the debris of their inhabitants almost all the summits of the sides."—But the tertiary strata, superior to those of the environs of Paris, "had also in like manner undergone, two or three irruptions of the sea, before the last revolution, which has laid bare the continents we now inhabit."(1) Cuvier thus admitted four or five irruptions of the sea, for the formation of the marine strata of our tertiary rocks.

In his preliminary Discours, he applies his interpretation of tertiary facts to the rocks of all ages. He endeavours to establish that these invasions of the sea on the once inhabited Earth were numerous and sudden; the first of them, almost

(1) Discours préliminaire.

universal, and some of them anterior to the existence of living beings. He examines the effects of natural causes, diminishes their force and finds them out of proportion with the ancient phenomena. He reviews some systems; he speaks of some obscure author who brought the fossiliferous rocks from the region of the moon; but he says nothing of Buffon's Theory of the Earth, nor of the labours of Pallas—works which their solid character yet maintains in scientific estimation. He lays down his principles of determination, the number of fossil species determined by him; and after having considered the relation of these species with the deposits of the soil, he gives physical, and, then, historic proofs of the newness of our actual continents, and concludes with the words: "I think then with Messrs. Deluc and Dolomieu, that if there be anything certain in geology, it is, that the surface of our Globe was the theatre of a great and sudden revolution, the date of which can not be much beyond five or six thousand years; that this revolution buried, and caused to disappear, the countries which man, and the animals now most known, formerly inhabited; that on the other hand, it laid bare the bed of the last sea, which now forms our present habitation; that since that period the small number of individuals whom it spared, have spread abroad and have been propagated on the lands lately laid bare; and, consequently, that it is only from this epoch that human Society has resumed its progressive march, that establishments have been formed, monuments erected, natural phenomena recorded and scientific facts compared."

"It was this conclusion," observes M. De Blainville, "which, repeated from the Christian Pulpit by a great orator, (1) and reproduced in a multitude of compilations, procured for Cuvier the approbation of Theologians. They stopped at the surface of his statements without entering into the depths of his system. They believed they found in it an easy conciliation with the teachings of Moses. Others, placed at another and opposite point of view, accused Cuvier of concealing his materialism for the purpose of reconciling science

(1) Mgr. De Freysinnous.

with Religion. Neither party appears to have understood the matter; for if, on the one hand, Cuvier in some phrases appears to favour the Mosaic narrative of the universal deluge, on the other hand, it is impossible to reconcile the rest of his system with the inspired history, without doing the greatest violence to the text and confounding all the laws of language, philology and logic. Moreover, this fact of a deluge, which history and tradition place beyond the reach of doubt, is neither proved nor disproved in geology; and this is much better than to identify a certain statement, such as that of Moses, with systems which are received one day to be rejected on the following." (1)

Cuvier's System was received with enthusiasm: it formed a school. The reason of its success was the reputation of the author and the literary merits of the book. M. De Blainville could not avoid analyzing Cuvier's labours. The following passages from this analysis will be read with interest: in them the theory of the revolutions of the Globe is subjected to the test of a severe examination.

"*Proofs that there have been numerous Revolutions.*"

"Cuvier derives them from the difference, in extent and nature, of the superimposed deposits, as also from the differences observable in the animal remains they contain; 'we find in them, says he, successive variations, of which the first only appear to have been almost general—and the rest appear to have been much less so. The more ancient the strata, the more each of them appears uniform to a great extent: the newer they are, the more limited they appear, and the more subject to variation at short distances.' These facts only prove, that the cause which produced them acted originally on a larger scale, and that, subsequently, the extent of its action was lessened. Thus, for example, a river with large bed and a large mouth, after having filled both, may have been divided into various branches, separated by immense deltas, and in these new beds and new mouths, may have formed deposits different from the first one, because the organic

(1) Hist. des Sciences de l'Organisation, T. III. p. 404.

and inorganic material found on the banks of the new rivers, branches of the original stream, were no longer the same, having varied by natural causes, either of successive habitation or otherwise. This does not prove the irruption of the sea on the continents which had been inhabited, nor variations in the nature of the liquid, which may have effected a change in the beings which it formerly contained."

"*Proofs that these Revolutions have been sudden.*" "He adduces the following proofs of the last catastrophe which inundated, and afterward laid bare, the continents we inhabit. It has left in the northern regions carcasses of the great quadrupeds, which the ice has enveloped, and which, with their skin, their hair and their flesh, have been preserved to this day. Had they not been congealed as soon as killed, they would have been decomposed by putrefaction. And, on the other hand, this eternal frost did not before prevail in the places where these animals perished, as they could not have lived in such temperature. The same moment, then, witnessed the destruction of these animals and the change of climate in the countries which they inhabited. The conclusion accords not with the premises. The instances of animals preserved in ice are very rare; besides, their organization proves that they could have lived in cold climates; they are covered with hair as are all animals of northern countries. They may have lived in that temperature and have died there naturally, or have been accidentally imbedded in the ice and were thus preserved. Their small number shows that the fact is the result of accident. The same moment, then, did not see these animals perish, and the climate of these countries change. There is, consequently, no proofs of a sudden catastrophe. As Cuvier has no other proof of the instantaneousness of the other revolutions than the analogy of the last one, there is no warrant whatever for the conclusion at which he arrives."

"*Proofs that there were Revolutions anterior to existence of living beings.*"—"Cuvier derives them from the crystallization and stratification of the steep summits of the great chains of mountains, which contain no vestiges of living beings; and from the appearance of derangements which their obliquity and declivity indicate. Crystallization is no proof of a revolution: it is a law of the mineral kingdom, and it may also, and with more probability, be attributed, in a multitude of instances, to liquefaction produced by fire rather than by water.

"Stratification is the only proof of the presence of water on these beds. The absence of fossils simply proves that these beds were not formed under the influences which would have left fossils in their depths, but does not prove that there were no organized beings living on the other points of the Earth. The obliquity of the strata and the steepness of the mountains, are natural effects of the form and destination of the Globe. The Earth,—having been created to receive organized beings, which require various climates, various latitudes, currents, &c., in order to maintain themselves, to live and be propagated,—has been created with mountains and valleys, to furnish these different climates, these various latitudes and offer declivities to the flowing off of water. It has moreover been created to execute in space a motion which is one of the conditions of life on its surface. Hence it has received a spherical shape, of which the mountains partake; and these, in consequence of the general movement of the Earth, of the various currents on its surface, of the action of volcanoes, &c.,—have necessarily undergone a derangement of their strata. Hence their obliquity and steep declivities. There is then nothing in this that proves *revolutions anterior* to the existence of living beings!"

" 'The fossil quadrupeds, he elsewhere says, characterize in a more distinct manner the revolutions which affected them. Shells tell us that the sea formerly occupied the places where they are found.'—But many circumstances may explain the variations of their succession. On the contrary, all is precise for the quadrupeds; their disappearance attests the fact, that this bed was inundated and that this dry land had ceased to exist. It is then from them we learn with certainty, the important fact of the repeated inundations of the sea.' (1)—

(1) Page 31.

Everything concurs to prove that the fossil quadrupeds of which Cuvier speaks, lived on the banks of rivers, and that after their death, they were carried away by the same rivers. Their disappearance was not occasioned by an irruption of the sea, and does not attest the fact, that this bed had been inundated, or that the dry land had ceased to exist: it only proves that these animals no longer exist. It is not, then, from them we learn, with certainty, the important fact of the repeated irruptions of the sea; neither do we learn it from the debris of marine animals; and hence the occurrence of these irruptions is not proved.

"Cuvier himself acknowledged that he did not study these remains in place;—a thing, however, absolutely necessary for the foundation of his theory. 'It is by no means,' says he, 'the fact that I have myself observed all the places where these bones have been found. Often I have been obliged to depend on vague and ambiguous reports, made by persons who did not always know what they should observe. Still more frequently have I been obliged to dispense with any information whatever.'(1) How, then, could he have the courage to put forward a system which he was not afraid to propose as certain? After having positively affirmed his revolutions, and his successive irruptions, he adds, as if to anticipate the charge of temerity: 'For the rest, when I maintain that the rock-layers contain the bones of many genera, and the movable beds, those of many species, which are now extinct, I do not assert that a new creation was needed to produce the species now existing; I merely say, that they did not exist in the places where we now find them and that they must have come from elsewhere?'"

Rigorously speaking, I might content myself with these observations of M. De Blainville on a theory so destitute of proofs, that, to maintain for sometime its reputation, its partizans had recourse to arguments of which Cuvier himself, never thought. He had, however, full time to reflect on all its proofs; for between the third edition of his "*Preliminary*

(1) Page 57.

Discourse," corrected and improved, in which he, endeavoured to establish his system, and the publication of his '*Essays on Geology*,' in which for the first time he proposed it, more than fifteen years intervened.

M. Constant Prévost, in his work on the history of tertiary rocks,(1) published in 1827, and especially in his public lessons, contributed more than any other person to lay open the errors of this system. Taking this judicious professor for my guide, I shall now examine the hypothesis of successive irruptions, in reference to the strata and their fossils, after I shall have established the fact, that the phenomenon of alternation, which appears to have embarrassed Cuvier, continues to be accomplished before our own eyes, and that, in this respect, there is nothing changed in the course of nature.

Phenomenon of alternation. The mineral substances which are transported by rivers into lake or sea-basins are not always the same; their variation arises from many causes. Of these causes the most common appear to be the intermittent action of certain water-courses; the changes of which take place in the mountains where the currents rise, the mineralogical difference of the soil washed by affluents, the falling and rising of the level of the waters, and the irregularity of their rises.

One affluent brings sand: another, clay: but if the rise in both does not take place at the same time, it will happen, that the affluent which has not risen, will scarcely bring any thing to the basin in which it debouches, and that we shall have, for example, in this first epoch, clay and no sand. If the rise takes place in the following year in an inverse order, we shall have sand and no clay. If the two streams have high water at the same time, there will result from it clay, sand, marl, as distinct from the two preceding layers, as these are from each other, since the three deposits are composed of different materials. If the intermittences in the intensity of action of the two streams are frequently repeated in this manner, they will produce a number more or less considerable of alternate

(1) Documents pour l'histoire des terrains tertiaires.—1827.

deposits of marl, sand and clay. Some affluents are continual; some periodical. As often as the products of both are identical, we shall have superimposed mineralogical beds of different character. An ancient stream may have transported vegetable matter: should it cease to flow, its lignite deposits may be covered by sand or sand-stone, brought down by the currents which flow from higher points on the same line. We find at the foot of mountains large blocks of granite decomposed by atmospheric influences: the torrents and rains will carry off the clayey particles, and these will bring them to the lower lakes, where, perhaps, they will form the first term of a series of argilaceous deposits. These will alternate with heterogeneous deposits, produced at the time of high waters by the concourse of all the tributaries; or with the calcareous deposits from subterranean sources, which may have their issue in the same basin. It is almost unecessary to observe, that the organic materials of these several beds will differ as much as their organic elements. The lime-stone beds will, for example, contain grains and stems of chava, paludina, lymnei, planorbes; the clay, sand and marl beds will present moreover terrestrial animals and plants, taken up after their death and transported by rivers. Thus the same causes which produce the variation of the materials in water-products, will also produce the alternation, that is to say, the repetition, the return of the same kind of deposits at different levels.

The phenomenon of alternation is at present produced by all our rivers; thus the Mississippi sometimes brings down red clay; sometimes blue; sometimes sand, and other times immense quantities of wood. So also the Seine is yellow when it laves the clayey soil of Bourgogne, and whitish, when its sediments are furnished by the Marne, which washes the chalk of Champagne.

Should these currents discharge their waters in a basin of the sea, the alternations will exhibit to us their combinations. There will be two great alternate movements in opposite directions; that of the rivers which bring down materials from the elevated points whence they descend; and that of the sea which brings up materials from its depths and accumulates them on the shore. There is a continual struggle between these two forces. At the time of great inundations, the rivers throw back the waters of the sea and deposit their sedimentary contents on marine deposits; they gain still more on the sea at the time of low tides; but during the spring tides, the sea, in its turn, throws back the current of the river, ascends its channel, and covers with the *debris* its waters have brought up the fresh water deposits which the river had left. The winds sometimes favouring the sea—and sometimes the land-current contribute to produce these results. These are not the only causes. At all times our great land streams advance more or less into the sea; and there are some of them which, by the colour of the water, we can distinguish for six hundred miles in the Ocean. When, by the accumulation of their deposits, these rivers are forced to change their mouths and directions, the sea, regaining the space which they had usurped, coats it with a deposit which alternates with theirs. Every one knows the rapid rate at which the mouths of certain rivers advance into the sea. We may calculate the increase of the alluvial soil on the shores of the sea of Azof, and, on those of the Black Sea, which the Danube daily fills up. The materials brought down by the Mississippi to its mouth, have advanced more than forty-five miles in less than a hundred years, according to Volney, Hall and Darby, who have given details on this immense Delta. The bed and deposits of these rivers thus occupy at the present time, the space which the sea formerly covered with its deposits.

Thus in a series of superimposed deposits, may be explained the mixture of fresh water and salt water organic remains, and the recurrence, more or less frequent, of marine and fresh water strata, or of fresh water strata alternating with those of the same origin but of different character. These phenomena are now produced in the basins of our seas and of our lakes; they must have been produced, and it is certain that they were produced, in the ancient sea, and in all the ancient basins which we inhabit. The rocks of all ages furnish us with numerous examples of this fact. The alternations, then, do not as Cuvier believed, necessarily imply, that the sea after having invaded a continent, retired from it, and that fresh water basins replaced it, that after a great number of ages, the fresh water basins, in their turn, gave place to a new sea; and thus, consequently, many times alternately! Nothing here obliges us to recur to these displacements and successions of seas and of rivers. The same seas and the same rivers deposit different beds and both these causes act simultaneously and continuously. Notwithstanding the variety of effects in the middle of the line, there is constancy at its extremities; that is to say, river-deposits on one side, sea-deposits on the other, and intermediately, alternations of the one and the other. The alternations shew, indeed, that, at the points which they occupy, there was by turns suspension and resumption of sea—and river—action; but only at these points: since, at the extremities, observation attests the presence of a series of beds of the same origin, either wholly marine or wholly fresh water. Thus in the tertiary rocks it is observed, that the series of marine-deposits is towards the sea, the series of fresh water-deposits towards the river-courses, and in the middle, the alternations.

Refutation of Cuvier's System.—Cuvier composed his theory from observations made on the tertiary rocks of the environs of Paris. It is by means of a long series of facts, furnished by these same rocks, more attentively studied, that it has been combated by Mr. C. Prévost. He has satisfactorily shewn that this theory cannot be reconciled, either with the connexion of beds of different origin, or with the analogy of the mineral composition of beds of the same origin, or with the number of alternating beds, or with the numerical proportion which exists between the fossils they contain and the living species.

1°. In the first place, the intimate connexion of the alternating beds is incompatible with the system of reiterated irruptions; for we must not imagine that in these alternations there is a rigorous precision, such as should be found if the river action had been entirely foreign to the production of the marine strata, and reciprocally. When we attentively consider the point of contact between the marine and fresh water beds, we do not generally find the line of separation clear and precise: we perceive transitions, shades, repeated oscillations of one to the other, which, however, do not exceed certain limits: in such a way that the mineralogical characters of a bed are only perfectly definite in its central points. From these points to those which correspond to them in the succeeding bed, there is mixture and fusion of both formations. Both these deposits were, consequently, formed in the same sea, and the contributions of one cause had not yet ceased when those of the other, on the same line, commenced. But if it were true, as Cuvier supposed, that the superior formation had occurred after the emersion and solidification of the inferior bed, these formations would be merely contiguous, and at no point would their rocks and fossils be confounded, one with the other. The system is, then, in contradiction with the general fact of the connexion of formations, or of beds of different origin. The analogy and the number of beds of the same origin is not more favorable to it.

2o. If the alternations represented the number of abodes of the sea on our continents, we should admit, for the Paris tertiary strata alone, not only three, with Cuvier, but double that number, as may be seen from the following list, which indicates the distribution of the strata, their number and that of their alternations.

TERTIARY STRATA OF PARIS.

NUMBER OF ALTERNATIONS.		
1.	Mill-stone grit. Fresh water.	Oyster-marl. Sand and sand-stone. Marine.
2.	Gypsum and calcareous rock. Fresh water.	Coarse calcareous rock. Marine.
3.	Lignite marl. Fresh water.	Coarse calcareous rock. Marine.
4.	Lignite-marl, or marl with lignites. Fresh water.	Coarse calcareous rock. Marine.
5.	Clay. Fresh water.	Coarse calcareous rock. Marine.
6.	Clay. Fresh water.	Pea-stone calcareous roch. Marine.

The Paris rocks represent only the middle and inferior beds of the tertiary system; and they exhibit the phenomenon of alternation no less than six times; consequently, we should admit for the production of these marine beds as many successive invasions of the ancient sea on our continents. But in the upper strata the marine and fresh water formations are also separated, many times in alternate beds. Nor is this all: the strata under the tertiary, which doubtless are the product of the same causes, have also their alternations; and the superimposition of formations, by turns marine and fresh water, is of so frequent occurrence that geologists reckon as many as sixty examples of this phenomenon in the carboniferous rocks alone. To this prodigious number of invasions of our continent by the Ocean, must be added, to explain the existence of the fresh water-strata, an equal number of different rivers, which succeded each other in the intervals of the retreat and reappearence of the marine element.

3°. This marvellous history of the revolutions of our Globe is not more in harmony with the analogy of the constituent strata of one and the same formation,—an analogy which forbids us to regard them as the product of different rivers and seas. In the supposition that the seas had invaded the Paris basin six times; and that, each time, they remained many thousand ages, and that, between their retreats and returns, six rivers successively came to overlay the oceanic strata with their own deposits,—is it credible, that, during the course of these long and terrible revolutions, all other circumstances, as well in regard of the sea as of the rivers, should have remained unchanged? And yet we must be prepared for this admission, if we accept the theory of marine irruptions.

The Paris strata contain at least, two beds of lignites, two of clay, two of coarse calcareous rock: but these calcareous rocks are so similar, that but for the fresh water beds that separate them, it would not be possible to distinguish them: and were we to place in continuous superposition the fresh water deposits, the lignites and the clay, we would find the same similarity, the same analogy. These similar deposits must have, then, been formed by the same sea or by the same rivers, unless we suppose that four different seas had, as it were, agreed to carry the same material, coarse calcareous deposits, to the same place; that rivers, separated from each other by a long series of ages, drained the same clayey soil, followed the same line and deposited their similar sediments in the same place which the seas had abandoned; and that two other currents having furrowed forests of the same trees,—re-planted, we may say, expressly in the same regions,—transported their debris to the same place, which the former seas and former rivers had selected to be the seat of similar combinations. Let this observation be applied to all the inferior strata, or let it be limited to the carboniferous strata, in which the alternations are eight or ten times more numerous, and what shall we say of the system which implies so marvellous a coincidence?

4°. The study of the fossils fully confirms these results of observation on the strata. If, placing ourselves at the point of view, assumed by Cuvier, we commence the study of the fossils under the influence of the idea, that the beings of which they are the remains, were suddenly overwhelmed by irruptions of the sea, and then overlaid with sediment transported by the same violent and disturbing cause, we should expect to find them, not in regularly stratified and homogeneous deposits, but in sea-beds, mixed up, contorted and exhibiting all the characters of diluvian deposits; we should represent them to ourselves, not as distributed throughout all the levels of the beds, but placed in the same zone, in contact at once with the soil in which they had lived and with the sediment deposited by the great sea-waves; and we should look for the effects of this powerful and disturbing cause, the action of which must have embraced a vast extent of country, in an accumulation of skeletons and of bones belonging to animals terrestrial, marine, and fresh water, mixed up confusedly with the shells and vegetables of every species, of every region and of every climate. But instead of these characteristic circumstances of diluvian-deposits, we only find, for the most part, with land fossils, fresh water shells; nowhere do we see accumulations of bones immediately under marine-deposits, intervening between these latter and a different soil which they may be supposed to have inhabited. In homogeneous and perfectly stratified sediments, marl, gypsum or clay, we find many terrestrial mammals. Instead of being found at the same level, they occur at every height; and the species are so peculiar to the beds in which they are found, that often by means of them we distinguish the beds themselves. Nothing is, then, more unlike the effects of a sudden and violent cause, than the position of terrestrial fossils in the strata of our soil.

There are doubtless positions which indicate violent inundations; there are true diluvian formations, but this phenomenon, purely exceptional and local, has nothing in common with irruptions of the sea. The observations on fossils shew that these cataclysms have been produced by fresh waters, which have, in overflowing, drawn nearer to the sea, as if lakes, by the wearing away of their dykes, had emptied themselves into the basin of the sea.

"I have often seen," says Mr. De Prévost, "beds of marine shells resting on beds whose fresh water fossils do not appear to have been in the least changed or disturbed, although they were of a very delicate texture, and did not in any way adhere to the movable beds which contained them." How can we reconcile this fact with the hypothesis of Cuvier? If sudden irruptions of the sea had produced the marine strata, which cover the fresh water movable deposits, would they not have first carried away or have broken the free and fragile shells which lay on the surface of the fresh water beds? Nay more; would they not have constantly swept and cleared this movable surface? Or, in the contrary supposition, would there not be points, either in the tertiary formation or more ancient layers, where we could determine with certainty the existence of a formerly habitable soil, which had been under atmospheric influences before it was covered with more recent deposits? "What!" says Mr. De Prévost, "the sea had come to search out the terrestrial animals in their abodes; it had killed and buried them in the places where they were found, and yet this cause, unequal to the destruction of small species, as the rodentia, the birds, of which almost perfect skeletons are found in gypsum, would have rooted up, destroyed, and annihilated all the forests, as well as the vegetable soil which sustained them; it would have carried away and removed all the turf-pits, effaced all vestiges of water-courses ; and neither deep gorge nor sheltered valley would have preserved any mark of its former exposure to atmospheric influences? Is it possible that the force, which could uproot the largest trees, and destroy even their smallest roots, should have left the animals remain on the spot where they perished?" (1)

The bone-caverns, the elephants of the Russian sands, the vegetables of the coal-beds, appeared for a time to favour the hypothesis of the *Revolutions on the surface of the Globe:* but these celebrated deposits, examined anew by unprejudiced observers, have fully confirmed the principle of the transport of terrestrial fossils by the currents of the continent. The beds and their fossils exhibit the same features as elsewhere, and no where has it been possible to discover in them the least traces of a soil which had been formerly the seat of plants and of terrestrial animals.

5°. Moreover, if these cataclysms which were imagined in order to explain the destruction of the lost species, had occurred, they would have embraced and buried all the living beings on the surface which had already emerged from the water. We ought, consequently, to find in the fossil plants and animals, the fauna and flora of all regions, of the mountains and of the plains, as of the valleys, the lakes and rivers. Why then have we not found more than a thousand species of fossil plants, while there are more than eighty thousand living species? Why do we find in general in the beds which contain continental species, only the vegetables and animals which are the analogues of those which now inhabit our lakes and rivers, and are found near their mouths, unless these only were transported after death by the rivers to marine and lacustrine basins, where we find them at the present day?

What has been for a long time established in regard to sea fossils in general, is also ascertained for terrestrial remains. All circumstances combine to prove the action of currents in transporting plants and animals. They were not buried where they lived; they did not live in the places where their remains

(1) Dissertation Géologique. 1827.

are now discovered; they were carried hither after their death. The mineral substances which enclose them are sand, sandstone, marl, clay;—materials supplied by the continents. These substances are distributed in stratified layers, as are the sea-beds, that is to say, composed of leaves or successive thin layers, superimposed one on the other, like the pages of a book. Hence they shew that they are the product of a slow, tranquil, uniform and regular cause, in every thing analogous with our continental currents. Instead of being accumulated in the lower part of these beds, they are found at all levels. They enter into the composition of the strata; hence they have been transported, one by one, by the same mechanical action of the currents which carried, grain by grain, the other materials of these beds. They are the product of lacustrine and pluvial-currents, and not the result of the Ocean's irruption on a soil which before was dry land and was inhabited. The sea-irruptions which Geology rejects are also rejected by Geometry and Astronomy, Laplace having established the stability of the equilibrium of the seas.(1)

Before quitting the consideration of Cuvier's hypothesis, viewed in its scientific relations, we should observe, that this idea of sea-retreats and irruptions had already been suggested as the cause of the destruction of the large quadrupeds, whose existence was assigned to four periods. The first and the most ancient, was that of the oviparous quadrupeds, these great reptiles that appeared first in the lower beds, before the chalk-deposit. The second that of the *palæotheria*, the lophiodons, the cheropotami, &c., comprized the middle stage of tertiary earths, that is, gypsum, the sand and the lake basins. In the third, the mastodons, the great elephants, the rhinoceri, the hippopotami, the ruminantia, the carnivorous animals, &c., occupied exclusively the higher tertiary stage, formed of the faluns of Touraine, of the bone-caverns, the Breccia and of great part of the diluvium, &c. The fourth was that of man, of the quadrumani and of all living animals, or of those whose remains are found in the erratic block-dilu-

(1) Exp. du Système du Monde, Ch. XII.

vium, and in all the beds then styled postdiluvian. It was then supposed that these four groups had appeared successively on the Earth; and that they lived thereon unknown to each other, because they had been separated by destructive irruptions of the sea. This explained their absence from the present world and from the beds which overlie those in which these remains were found. It is then, on the supposed fact, of the entire disappearance, at certain stages, of some genera, and on the supposition of their being replaced by new genera, that the theory of the alternate invasions and retreats of the Ocean has been formed. But later discoveries have shewn the inaccuracy of this supposed fact, as of many other imaginary facts of which Cuvier never should have made any account. Horses and quadrumani, animals of our period, are found as far down as in the middle tertiary, at Sansan, near Auch, where they are associated with rhinoceri, mastodons, carnivorous animals, &c., animals of the third period, and with the palæotheria of the second. The palæotheria, the lophiodontes, the cetacea are found as high up as the upper tertiaries in the marine-fluviatile sands of Touraine, in those of Montpellier and of Montebuzzard, where they are found united with either genera—with the rhinoceros, the mastodon, horses, ruminating animals, and even with reptiles, which Cuvier assigned to the first and the most ancient of his four ages. Many lost species of these genera,—among others the rhinoceros and the elephant,—are often associated with the bones of the house-dog and with those of man, in the regular layers of the bone-caverns. All these genera were, consequently, contemporary; they inhabited certain parts of Europe at the same period, and neither any nor all of them have been destroyed by general irruptions of the sea.

Cuvier might have anticipated some of these new facts which have disproved his theories. Of more than a hundred species of tertiary mammifers determined by him, eleven or twelve, as he acknowledges, are identical with living species; and of these eleven or twelve many were united in position with species which he considered extinct. Instead, however, of drawing from this association, the obvious consequence, he considered these as particular cases, unimportant exceptions to the general Rule, insignificant partial difficulties, unworthy of arresting the attention of those who, like him, were able to take in the whole body of the phenomena. As if these few species, not to say any thing of more than fifty more which have since been added to the catalogue, were not sufficient to correct general conclusions, especially at a time when investigation was so little advanced; and as he himself elsewhere says, unconsciously refuting his own theory, "*as if it were rational and wise to apply to the whole surface of the Globe an order of things which has in fact been discovered only in the northern hemisphere*, *and that*, *upon a few points which do not represent the ten thousandth part of the surface.*(1)"

In a word, Cuvier has not explained either the formations or their fossils. More than two hundred years were spent before the problem of sedimentary-beds was solved. The solution presented by Woodward and Whiston, of the dissolution of all the materials of the Globe by means of water, and of their simultaneous precipitation in this liquid was evidently erroneous. The explanation of the falling in of the surface inhabited by extinct animals and plants, which Burnet and Deluc imagined, in order to explain the presence of terrestrial bodies in the strata of our Globe, was incompatible with the stratification of these beds, and with the manner in which the fossils are associated with them. In fine, the theory of repeated invasions by the sea, is no less groundless as a supposition than insufficient as a solution of the phenomena; and is, moreover, in substance the theory of Deluc. We must then revert to the thesis of Buffon, perfected by observation. It will be found that our progress must be attained by elimination: experience has confirmed the conclusions arrived at by this method, and has proved once more, that scientific theories serve science only by their errors. Cuvier's System is no less contrary to revealed facts than to experience, and abounds with contradictions. He was unwilling to admit

(1) Discours.

successive creations. "I do not assert," he says, "that a new creation was necessary to produce the existing species. I merely say that they did not exist where we now find them and that they must necessarily have been carried there." (1) But in this same discourse, referring to his investigations on fossil bones, he says: "I was obliged to prepare myself for them by still more extensive investigations as to existing animals. An almost general review of the actual creation could alone give a character of demonstration to any conclusions on this former creation." He calls the palæotheria a first great production of mammifers; and elsewhere adds, that the genus lophiodons combines with those of the palæotheria and of the anoplotheria, to demonstrate the certainty—(contrary to what we have seen)—of a former state, of animal creation, which lived on the surface of our actual continents and which perished in an irruption of the sea."(2) Again he repeats, "that we are now at least at the middle of a fourth succession of terrestrial animals, and that, after the age of reptiles, after that of the palæotheria, after that of the mammoths, the mastodons and the megatheria, came the age when the human race, aided by some domestic animals, peaceably rules and cultivates the earth." (3)

It is a source of regret to hear him accuse the naturalists, "who regard," says he, "our animals as modifications of the fossil species, modifications produced by the variation of the media and carried to this extreme difference by a long series of ages," and afterward to find him encouraging them by the authority of his example; for he explains the succession of different species in the marine-deposits, by the numerous changes which took place in the nature of the waters. "We can understand," says he, "that amid such variations in the nature of the liquid, the animals it supports can not remain the same. Their species and even their genera, change with the strata. There has been, then, in animal nature a succes-

(1) Discours.
(2) Recherches *sur les os foss.*, T. II, Ire *part.*, *p.* 222.
(3) Discours.

sion of changes, which have been occasioned by those of the liquid in which the animals lived, or which at least corresponded with them, and *these variations have gradually conducted aquatic animals to their actual state.*" (1) If you do not understand how the relationship between living species and the assumed primitive species, so different from them can be demonstrated, let it be sufficient to know, that all these numerous classes of aquatic animals, which form more than three fourths of animated creation, have undergone changes, and that these changes are conformable to their nature; for, their specific changes might absolutely have arisen from slight changes in the nature of the liquid, or simply in the temperature; they might have been occasioned by still more accidental causes." (2) But in the supposition of these perpetual variations of species, by the variation of the media in which they lived, and which transform the turbot into a frog, what becomes of the science of Anatomy, founded on the supposed stability of the species? What becomes of those laws which Cuvier boasted he was the first to discover; those laws which preside over the co-existence of the forms of the different parts of organized beings? What, in fine, becomes of the whole animal kingdom, which, Cuvier assures us, is governed by invariable laws? (3)

True it is, that if, on the one hand, he varies so easily and so needlessly the genera and species of aquatic animals, on the other, by a new contradiction, he establishes the persistence of the species, as far as regards terrestrial animals. "There are among them," he says, "characters which resist all influences, whether natural or artificial; and nothing shews that time in their regard is more potent than climate and domesticity."—In fine, this anatomist, who will not recognize indestructible characters in the aquatic species, is so persuaded of the fact in the other parts of the animal kingdom, that he falls into the opposite extreme, and appears willing to deny the

(1) Discours.
(2) Id.
(3) Id.

unity of the human race, on account of the varieties he finds in it. He says: "that all the characters of the most degraded of the human race, the negroes, clearly shew, that this race escaped from the great catastrophe of the deluge, at some other point than that where were saved the Caucasian and Altaic races, from whom, perhaps, it had been, for a long time, separated." Thus while refusing to climate, to excessive heat, to domesticity, to food, to sickness to moral affections, to defects, to hereditary anomalies, &c., the power of producing in our race changes which are yet much less striking than those we behold in our domestic animals, he attributes to water the power to change the nature of the beings which live in this element, and to vary their genera and their species.

Cuvier did not spare those geologists who, to attract attention to their systems, take the days of creation for periods of indefinite length. He reproached the pantheistic naturalists with "the thousands of ages they accumulate with the stroke of open, to allow the species time for their numerous transformations."

Occasionally, however, he assumes, on his own account, all these thousands of ages, and the changes of species in the whole animal kingdom, as also their spontaneous production; and he maintains the most obvious contradictions of our sacred traditions. "It would be pleasant," he says, "he find the organic productions of nature in their chronological order: the science of organization would gain thereby; the developments of life; the succession of its forms; the precise determination of those which *first* appeared; the *simultaneous birth* of certain species; their gradual destruction,—would, perhaps, instruct us as satisfactorily on the essence of organization, as all the experiments we can make on living species; and man, who has had but an instant on the Earth, would have the glory of remaking the history of those thousands of ages which preceded his existence, and of the thousands of beings which were not contemporary with him." (1)

(1) Discours.—Ire Edition.

Genesis clearly teaches the creation of species. Now the existence and the reality of species, without which, indeed, there is no possible zoological science, is, according to Cuvier, no more than an hypothesis. "The idea of species," he says, "resting principally on the supposition, that all the beings which compose it might be reciprocally ancestors or descendants, it is only by conjecture that we can refer to it, as a variety, such or such being which differs from it more or less widely." (1) From this point, to the transformation of species, to their negation, to spontaneous production, there is but a step to make, and we have seen that Cuvier was not unwilling to make it. It is true, in another work, he calls in question the influence of circumstances on the transformation of species, and admits that they have been perpetuated, from the beginning of things, without overstepping the limits of their original forms.

"He denied," says M. De Blainville, "contrary to the evidence of numerous facts, that the fossils filled up gaps in the animal series, without suspecting that, by this negation, he departed from the principle he had adopted in recognizing lost species, and deprived himself of all means of being able to determine any of these animals; since it is only by their resemblances and relations to the existing genera and species that he was able, or would be able, to determine them." (2)

He wrote, and frequently repeated the assertion, that he could discover a genus, distinguish a species, reconstruct an animal,—from a single bone, or the mere fragment of a bone, taken, no matter from what part,—"an art," says he, "on the certainty of which depends that of all my labours" (on the fossils). (3) Unfortunately, this art is impossible: whoever casts his eye on a skeleton, will be convinced of it. A perfect and leading bone does not always suffice. Cuvier found the falseness of his own principle: the *tapyrium giganteum*, which he determined, on the strength of a single complete tooth, has been found, on the discovery of the whole

(1) Tableau élémentaire de l'Hist. nat., An. VI.
(2) Histoire des Sciences de l'organisation.—T. III. p. 388.
(3) Discours.

head, with teeth absolutely the same, to be a *dinotherium* an extinct animal, but not a tapir. To arrive at certain conclusions, it is necessary to have important parts, such as those of the head, and in the greater number of cases, it is necessary to have many and different parts of the skeleton. Thus he acknowledges that, in practice, he followed the same method as did Pallas, the founder of the science of paleontology—namely, multiplied comparisons between the fossil-bones and those of existing animals ;—but this did not preserve him no more than others from frequent errors, some of which are of a very remarkable character. The paleontological history of the *metaxytherium* is an instance. This extinct animal was assigned a place between the *dugongs* and the *lamantins*. "1° It has the cranium which Cuvier ascribes to the *lamantins ;* 2° the upper molars assigned by Cuvier to the doubtful hippopotamus ; 3° the under molars referred by Cuvier to the medium hippopotamus ; 4° the humerus belonging, according to Cuvier, to two species of *phocæ ;* 5° the fore-arm of the lamantins, on the same authority ; 6° and perhaps, in fine, a rib and a vertebra recognized by Cuvier, first as belonging to the lamantins, and, afterward, as pertaining to the morse."(1)

Cuvier had no principles of his own. He followed science as it progressed : he was a practical eclectic. In zoology, as in anatomy, he selected from the labours of his predecessors and contemporaties. He frequently acknowledged it. He knew how to cut and to clip admirably well. But to make all this a science, there was need of some one leading principle, a well connected system, which all who furnished their contributions to its illustration should recognize and adopt. The fact, however, was that each one had his own principle, which was only applicable to the special object of his studies ; so that Cuvier, in adopting the result of so many various principles, which were consequently no principles at all, assumed all their defective consequences. We must not, however, hesitate to recognize in him an immense aptitude for natural

(1) Rapport de M. De Blainville à l'Institut, sur un Mémoire de M. Jules Christol, relatif à des fossiles déterminées par Cuvier.—Journal de l'Institut, 1841.

science, the penetration of a sagacious observer,—as is seen in his anatomical labours on the reptiles, although yet regarded as of doubtful value; and in his observations on the *daman*, &c. He added much to our stock of facts. He gave an impulse and direction to geological studies, as also to those regarding organization; and gave them importance in the Academy of sciences, where, when a botanist was once reading a memoir, a geometrician was overheard to say: ‘Since there is question of salad, I prefer to go and eat mine own.’

VI. The Diluvium of hypothetic geology.—Following Deluc, Dolomieu, and many others, Cuvier believed he saw on the surface of our continents, traces of the last and great deluge, which he identified with that of Moses. This is the last theory in which we shall meet with this great event: and, consequently, this is a proper place to consider its relations to geology. In the first place, it must be admitted, that the deluge is rather an historical event than a natural fact; and to history and the tradition of the human race are we to look for its proofs. It was for the surface of the Globe a transient revolution, and it is not easy to understand, how we are to distinguish between the traces it has left, and those of so many other changes produced also by the agency of water. To look for vestiges of the deluge in Europe, we should be certain that it was universal, and that our continent had then emerged from the Ocean, when it occurred,—two things which we have no means of ascertaining. Most interpreters, it is true, recognize the absolute universality of the deluge: but Vossius and the German Hebraïzants maintain its relative universality. According to these writers, the deluge only drowned those countries which were then inhabited by man. The Church has never condemned this opinion. The learned Father Mabillon did not think it censurable; and it appears, that Father Mersenne would have adopted it, had he not been deceived in regard to the height of Mount Libanus. It is not improbable, if we prefer the Hebrew Text to the Vulgate, which is less precise. On this question, and on all questions connected with the deluge, see a very solid article of the

Abbé Maupied, in the *Encyclopedie Catholique;* it is also found at the end of the author's last work "*Dieu, l'Homme, et le Monde*."

I shall now state the opinions of modern investigators, regarding the hypothesis of the geological *diluvium*, on the value of which the historical deluge by no means depends. It has been shewn, against Woodward and Whiston, that the Earth never having been dissolved by a deluge, the existence of fossils in the lower strata could not be the effect of such a cause; and against Deluc and Cuvier it has been proved, that the tertiary strata which are covered, lack the characters of diluvian formations. But above all these strata in series, which form the habitable surface,—whatever be their relative age,—there are movable deposits, masses of vegetable-matter, rounded flints, sand-stone, gravel, pebbles, marl, furrows traced by erratic blocks, breccia and bone-caverns. All these terminal strata have been grouped by Buckland under the name of *Diluvium*, and were by him, at one time, referred to the historical deluge. While using this term, *diluvium*, geologists have given very different explanations of the phenomena. Some continue to see, with Buckland, results of the deluge: others consider the diluvium as the sum of the effects of the causes which had for the last time raised our continents. It would be, according to them, the beginning of our historical era. They assign as its characteristics,—that it is not overlaid by other rocks, and does not contain remains of our species, or products of human industry, or of animals like those which now exist, but of those belonging to extinct races. Others designate as *postdiluvium*, whatever formations have been produced since our Earth underwent its last change, and *antediluvium* whatever preceded it. They regard these postdiluvium-beds as corresponding with the commencement of our historic times: and assign to them the character of containing human remains, or the products of human industry, and of animals and plants like our own; and they call these fossils, *pseudo-fossils*, that is, fossils which are not fossils; as if the great event which had given our earth its present appearance, had changed all nature, and that existing beings were essentially different from those which preceded them; as if before, no less than after this event, the rocks might not contain the remains of man in the neighborhood of places then inhabited by the human race. Moreover, the historic times are not the same for all peoples, and geology does not tell us when they commenced. Be this as it may, this third explanation contradicts the preceding ones. Some have endeavoured to distinguish in the diluvium vestiges of two deluges, the last of which might be that related in history. Others, in fine, like M. De Prévost, regret not to be able to banish from geology the name of *diluvium*, because it expresses a cause which could not have produced the effects attributed to it. These see in the upper-beds, neither the product of a single cause, nor even that of a deluge; and attribute these effects to the successive lowering of the level of the Ocean, to the drying up of rivers, the rupture of dykes which separated ancient lakes, placed at different levels, &c. This last explanation is naturally suggested by general facts, and is, in many respects, confirmed by observation.

VII. Vegetable earth, sand, gravel, rounded flints.—Let us, in imagination, place ourselves on a primitive soil, already peopled with vegetables and covered with a vegetable earth. If we suppose that a lowering of the water-level, corresponding to our primary deposits, should increase the surface of the continent, a quantity more or less considerable of vegetable earth would soon be carried away by the torrents, the rivers, the rains, the winds, to the belt of earth recently laid bare, where other vegetables would, in their turn, produce new beds of soil. Let a new lowering lay bare a new belt of land: it will receive, in consequence of the furrowing of the higher terraces, a part of the soil of the preceding epoch, which will afterward be augmented by the *detritus* of the vegetables which had their place there. The emersion of a third belt of land, will be followed by similar results. During these three periods, the erosive and prolonged action of atmospheric agents will have completely laid bare some elevated points of the original continental surface which will remain deprived of all vegetation. We would, then, have on such a continent soils belonging to three different epochs, and there will not be found any mark by which we may assign these different soils to their respective epochs : in other words, we shall have nothing to enable us to determine their ages. This illustration is applicable to the vegetable earth and the other movable beds, the transportation of which is attributed to the *diluvium.* It has not been considered, that at all times, before as well as after that event, the same causes existed, and produced effects precisely similar to those ascribed to the *diluvium.* At all times there must have been vegetable earth, sand, pebbles, and rolled flints. As soon as a surface emerged, heaps of flints, of sand and gravel, resulting from the decomposition of the soil, were transported by currents from the more elevated to the lower-levels. Here they formed conglomerates, which changes in the level of the water afterward laid bare in successive belts. As soon as there were vegetables and animals on the surface of the continent, currents carried their remains away and made fossils of them ; and, at the same time, these currents displaced vegetable soil. Thus, we would see in the earth of the most ancient epoch, as in subsequent periods, beds of sand-deposit of rolled flints, and of cemented pebbles, vegetable formations, under the name of anthracite, coal, lignite, &c. : and we could not, without absurdity, admit, on the one hand, that at all epochs, the currents of the continent carried down to the sea—and lake—basins, where we now find them, beds of vegetable-matter, of sand, of gravel, of flint ; and suppose, on the other hand, that the same causes were not able to produce the same effects, on a surface laid bare by the retreat of the waters, by transporting material from one part of the surface to another.

There is, however, this great difference between the beds of sand, of vegetable earth, &c., which are in series in our soil, and the terminal beds of the diluvium ; that the former, because in series, make known to us their relative age, whilst the latter, never having been covered by other beds, afford us no means of calculating the period of their transportation : so that the character which has been assigned to these beds, that of not being overlaid,—which might have been the case at any epoch, is precisely that which prevents us from determining their ages. It is, then, easy to be deceived, by attributing to a general cause, operating at the same time on all points, effects, which, although perfectly similar, may be referred to different revolutions and very widely separated epochs. Soils, and gravel-beds of the same epoch as our coal-deposits, would no more be covered, from the time that such part of the surface should be laid bare. The character, then, of not being covered, may be found in beds which have emerged at different epochs; and hence the impossibility of determining the age of formations from the consideration of this circumstance.

Neither will the fossils enable us to determine the age of the *diluvium;* because, in the first place, they are rarely found in it; and, in the second place, they belong to all epochs. Certain beds, indeed, have yielded mastodons, elephants, horses, or deer; but these have been found in the lowest tertiary strata. The sands and pebbles of the diluvium contain also fossils of the second epoch. Thus, I have found in the sand of the Paris and the Vernon *diluvium*, the *fungia orbitolites* (Lamark), which is so common in the Jura-beds of Ranville. Fossils, then, cannot enable us to assign the ages of the movable earths of the diluvium.

Other causes besides the lowering of the level of the Ocean, may have laid bare our upper-strata. There were formerly, and there are yet,—Caspians and lakes placed at different levels, which, in discharging their waters into those lower than the rest, necessarily left in their beds, deposits of flints, of gravel, of sand, altogether like those of the diluvium; and which cannot, without violence, be referred to one sole epoch and one sole occurrence. Hence may be explained both the position of certain diluvian-deposits, on points of the surface relatively very high, and the characters,—sometimes lacustrine, sometimes fluviatile,—which are generally found in the *diluvium*-strata; for marine-fossils rarely occur in them. If an earthquake, a volcano, or some other similar occurrence, burst the dyke of the lake of Geneva, there would be laid bare movable-beds on the hills which the waters would have abandoned, and the strata would present the lacustrine and fluviatile characters of our diluvian-deposits.

If, in consequence of some dislocation of the surface, our rivers were to change their beds, we would find earthy, marl and sand formations, analogous to those of the *diluvium*, and placed at very considerable elevations. If the higher lakes of North America, by the bursting of their dykes, should empty themselves successively into the lower lakes, they would exhibit in their basin, and would form in the interval that separates them, deposits of flints, gravel, sand and marl; and would also yield lacustrine, fluviatile, and land-fossils, and these at very different levels. The junction of these immense bodies of water, would form a great current, which would gradually wear out its own bed, and discharge its waters into the sea ; as formerly ancient lacustrine-basins that we discover may have produced, in discharging their water, our actual water-courses, which in the lapse of time have eaten out the channels through which they flow. For, if the descent of water-courses towards the sea be a fact of all epochs, we must not believe that our present river-beds have always been such as we now find them.

They all exhibit to us small streams of water, descending from the mountains, forming rivulets and rivers to supply one great basin,—that of the Ocean. We have here another explanation of the origin of the movable beds of the diluvium.

VIII. Bone-caverns.—Bone-caverns are found in all the countries of Europe, in different parts of America, as in Brasil and the United-States, and even in New Holland. They appear to have been produced by dislocations of the surface, and to have been enlarged by subterranean water-courses. Not unfrequently they are still found to be penetrated by rivulets or small streams of water, and the smoothness of their floor attests the length of time during which the water formerly remained on it. The cavities though which certain rivers, such as the Rhône, near the lake of Fort-l'Ecluse, and La Charente, near Angoulême, lose a part of their waters, are nothing else than the reproduction, in modern times, of the phenomena of the ancient caverns. There are to be found in Carniola, in England, and almost on all points of the Globe, currents which disappear in profound cavities, resembling in their forms bone-caverns. They are very numerous in Greece. In the same valley, where the famous Kirkdale-cavern occurs in England, the small river of Hodge-Bridge is seen to disappear in a similar cavity. Bone-caverns are also represented in our days by the Katovothra (1) of Greece, filled by currents which disappear there.

Bone-caverns are of varied no less than singular construction. The mud in which are bones, the gravel, the rolled flints, which, either entirely or partially, fill them, are always stratified, and laid out in planes more or less horizontal. These are even sometimes found in the walls or ends which separate the different chambers of these caverns. The bones are often found rounded, almost always separated, broken and fractured, although they frequently contain as great an amount of gelatine-matter as do recent bones. They belong to all the genera: and the largest species are found in them associated with the smallest; the mammoth, the rhinoceros, the hippopotamus, the hyena, the bear, the stag, the horse, the ox, the wolf and the fox commingle with the porcupine, the hare, the mole, the rat, the cat,—with birds and insects. But the carnivorous animals are the most numerous; and among these the hyena and the European bear are the most frequently found: the first, in the English-caverns; the second, in those of other parts of Europe. In many caverns in the South of France and Belgium, with these are associated bones of the human species, or the products of human industry. With these species are also found land and river-shells; but never sea-shells, except in those caverns which are near the sea. This last fact, common to the caverns and the osseous breccia, shews, that both were not filled till after the retreat of the waters of the Ocean.

Such, in a general view, are the phenomena of the bone-

(1) "Swallow-holes," see Principles of Geology, by Lyell, p. 734.

caverns, Despite of these facts, an attempt was made to attribute them to the deluge, or to irruptions of the sea. It was said, that they were successively inhabited by the various animals whose remains they contain; or that they originally served as abodes for carnivorous animals; that these carnivorous animals, after having dragged thither and accumulated the remains of other animals, were suddenly overwhelmed in their abodes, by the waters of the great deluge; or that, having there died a natural death, the diluvian-currents subsequently occurred, and arranged all these remains in the stratified order in which we now find them. But none of these suppositions agrees with the state of the places and the circumstances of their stratification.

The animals did not dwell in these caverns before they were filled up. Before the introduction of the mud and gravel, they were not habitable, as is proved by the alabaster of carbonate of lime, deposited in *stalactites* on their ceiling, and in *stalagmites* on their actual floor, by the infiltration of water charged with calcareous matter. These concretions evidently suppose, that, at the time they were formed, the caverns were without water, at least so far as these concretions extend; for the waters which would have filled, or at least, washed the caverns, would have carried away the matter of the stalagmites, and prevented their formation. But the constant superficial position of the stalagmite-deposits, suppose also that the caverns formerly were, and have not ceased, down to our epoch, to be occupied by water; and, consequently, that they could not have served as retreats for animals before they were filled up. In that case, the bones and the mud would sometimes rest on an original bed of stalagmites: these concretions would be found on the primitive floor of the caverns, as well as upon their actual floor,—underneath, as well as above, the fossiliferous-deposit, which is never found to be the case. The stalagmites always form in the caverns superficial deposits; if sometimes they are found in the upper part of the mud, it is owing to fissures, caused by the retreat of the waters.

Had the caverns, however, been without water, they could never have been inhabited by the carnivorous or other great animals: because, for the most part, they were not habitable. They are composed of a series of chambers, placed at very different levels, between which there are extremely narrow passages; and these sometimes so much inclined, that, to pass from one to the other, it is necessary to cut out steps, or use ladders.

Moreover, all the animals found in these caverns, such as the rhinoceros, the elephant, the ox, the horse, the sheep, the stag, &c., are not accustomed to dwell in caverns. We cannot, then, agree with G. Cuvier, and regard as an incontestable fact (1), that tigers, and lions, large and small, lived together at the same time as our bears, and retired into the same caverns, where their bones are found, mixed pell-mell, with those of the hyena; because, although this assertion is not a geological joke, as Schmerling calls it, it is at least a zoological absurdity; the animals of these three species, so far from being naturally inclined to associate, are known to live in the most lonely manner, even for the individuals of their own species.

The other animals were not dragged thither by the carnivorous animals. Because, in the first place, they were filled with water and, consequently, uninhabitable, as well for carnivorous as for other animals. Moreover, supposing the possibility of the caverns having been inhabited, the carnivorous animals could not have dragged thither the large remains of the pachydermata which we so frequently find there: still less, the entire mammoth—skeletons, such as have been dug up, three in number, in a single cavern of the isle of Padresse. The smaller species are no less embarrassing in this hypothesis, than the larger ones. For, how can we suppose, that the larger carnivorous animals, such as the wolf, the hyena, the tiger, would have spared, and so often left untouched, the bones of the field-mouse, hedge-hog, spider-mouse, moles and birds. In the cavern of Argou (Eastern Pyrenees),

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(2) Ossemens fossiles, T. IV. p. 495.

no remains of carnivorous animals have been found; and yet the bones of the rhinoceros, of the ox, of the horse, of the sheep, are there furrowed, like the bones, supposed to be gnawed, of the caverns of Lunel-Vieil, and others, where are found carnivorous exuviæ. These furrows are not the work of the carnivorous animals. Besides, the bones might have been gnawed before they were transported to these caverns.

Moreover, the bones of carnivorous animals are found to be furrowed in these caverns no less than those of herbivorous animals. Must we, then, adopt the principle of those who maintain that these caverns were inhabited; and say, that the carnivorous animals, after they had devoured the herbivorous animals, devoured one another?

The animals have not been transported to the caverns either by diluvian-currents or by sea-tides. In either supposition the caverns should contain marine-exuviæ: and none such are found, except in those which are near the sea, and even there, not very frequently. A violent action, such as that of an irruption of the sea, or of any flood, would have confounded in one mass all the mineral substances; whereas the caverns exhibit them to us in small and distinct layers, with a marked stratification, and as horizontal as the forms of the various chambers would permit. They would have accumulated, confusedly, the animals in a small number of places, and especially between the primitive floor and the mineral layers: but, on the contrary, we find that they are uniformly distributed at all levels of the muddy soil, and even to the height of the walls or partitions, where the beds are as distinctly stratified as in the lower parts. A transitory cause, such as that supposed, would not have so completely polished all the walls of the caverns. The hyenas are so abundant in the English caverns, that as many as 240 of them have been found in one cavern. Moreover, there have been dug up in a single cavern about 800 of the same teeth of the bear, representing, consequently, as many individuals. It is difficult to conceive, how an action of short duration could have brought together in a small space, so large a number of bones, belonging to species which live solitary and apart, in small isolated groups, preying on each other, and which must needs scatter and spread abroad, in order to find sufficient prey; as the bear, the hyena, the lion, the tiger, the wolf, the fox, &c.

The animal, and the mineral substances in which they are embedded, have been transported to the caverns by land-currents. The stratification of the beds indicates an uniform, constant, and tranquil action, such as that of rivers. The fossils, which are exclusively land and river productions, lead to the same conclusion. Their immense quantity obliges us to suppose that the action which accumulated them, and brought them successively to the caverns, lasted a long time; that it was in communication with considerable extents of habitable country; and that it had a determinate and constant direction, which made it exactly meet the apertures of the excavations. These characters make us recognize in the deposits a fluviatile action. The habits of the animals which are imbedded in the mud shew also the phenomena of caverns connected, on another side, with the same cause. These are fresh water fishes and shells associated with such land shells as are generally found in the vallies. The other species found in the caverns are such as must have frequented the banks of rivers, either for the purpose of finding there an abundant and continual vegetation, as the elephant, the hippopotamus, the rhinoceros, the horse, the ox; or, for the purpose of slaking their thirst, as the stag, or with the view to find dead prey, as the hyena, or living prey, as the wolf, the fox, the tiger and the lion. These species were, then, more likely than others to be carried away after death by the currents, and transported to the caverns. The transport of animal substances by the currents, is a fact which we ourselves may witness in regard to animals which have died on the banks of rivers. Those whose carcasses had not time to be decomposed, being raised by the currents, in the time of high water, and swelled by the gases which facilitate their transportation, may have been carried, after some days, to points four or five hundred leagues distant from the place of their departure. The different positions of caverns, the comparison of their respective fossils, and of the totality of their remains with those of living animals, prove, that all these deposits are not ascribable to the same causes; and that they display the evidence of the different local circumstances in which they occurred. The river-cause furnishes also the explanation of this difficulty. But in this case, the caverns must have been uninterruptedly occupied, from the beginning to the end of the mud-deposits, and this fact is demonstrated by the uniform superficial character of the stalagmite-masses. In a word, the analogy of these excavations with the whirlpools of our rivers, the smoothness of their walls, the small streams of water which still traverse them,—oblige us to regard them all as having had the same origin. We must then ascribe to rivers the cavern-deposits, and the transport of their fossils. It is at least clearly proved that the phenomena presented by the caverns, taken in a general sense, cannot be referred to one epoch, or assigned to a violent cause. If in some of these caverns, a local inundation had confounded in one heap whatever was above the stratified deposits; and that carnivorous animals had, subsequently, dwelt there, this would only be an exceptional and accidental fact, when compared with the modes of such caverns being filled; and consequently would not have any importance.

IX. Osseous-Breccia.—The fissures, more or less vertical, which bear this name, are of much less importance than the caverns of which we have spoken. Those most generally referred to, are found in the Gibraltar-rock, and communicate with caverns, and those of Perpignan, of Nice, of Corsica, of Algiers, of Sicily, and of Greece. They are filled with mud and bones. They also contain land and river shells. The bones are those of the rabbit, the stag, &c.; in general, those of animals whose congeners still inhabit the neighboring places. The rodentia prevail in the Breccia, as do the carnivorous animals in the caverns. It is almost needless to say, that the filling up of the Breccia, may have been effected by rain and ordinary currents, and that it does not suppose a deluge.

We have already seen, that it would be impossible to consider the *diluvium* as the effect of a single cause, and the event of a single epoch. It is, moreover, clear that it does not prove a deluge. A deluge is the total or partial submersion, through a violent and disturbing cause, of a soil which had previously emerged. The phenomena, however, which are referred to the deluge, show, every where, a soil, which has been laid bare for the first time. A deluge would not have produced the diluvium: it would not have transported to the mountain-summits, flint and pebbles, which were originally on the lower parts. It would not have worn and rounded the flints, without wearing and rounding the delicate matters which are associated with them,—bones, timber and shells: it would not have transported to great distances from their original site, erratic blocks of ten, a hundred, a thousand, or fifteen hundred cubic yards. A deluge, a violent cause would not have arranged the mineral substances in stratified layers.

The destruction and burial of the large animals in the Russian sands, have been also referred to the deluge; but observation shews them to us in eight successive beds, superimposed over each other. The stratification of these layers implies a slow and uniform cause: the superpositions shew that this cause was the same at different epochs, and, consequently, that it was not the deluge. We must, however, acknowledge that all these have not been slowly formed; there have been violent causes, as is evinced by their confused results: but, if we reduce the diluvium to this small number of non-stratified deposits, it has no longer a character of universality, and may be attributed to local inundations.

The diluvium, such as it was described by Buckland and other English writers, and such as it is even now regarded by many geologists, is, evidently, the product of various causes and of different epochs. The manner of proceeding followed by these geologists is not logical. They have said: "There has been a deluge; this deluge must have left traces of its passage; we will call them *diluvium.*" And then, without knowing whether this deluge was universal, or whether all our continents had emerged at the time of its occurrence, they set about observing all the layers which are above our tertiaries, and which do not necessarily belong to them, as if it followed, that they should be referred to the deluge; and perceiving the impossibility of distinguishing these layers by their age, they have confounded them by attributing them to one cause and to one epoch. As if, to use an illustration of C. Prévost, an archeologist who had contemplated the ruins which strew the land wherever man has dwelt, should group them under the name of *ruinium*, and attribute to the invasion of the Barbarians all these destructions, whereof some are the results of war, others of time, others of fire and earthquake; and which, for the most part, belong to different epochs. These geologists have not considered, that if some portions of the diluvium were the result of the Mosaic deluge, it would be impossible to distinguish them from so many partial and local inundations, which might have preceded or followed that event;—that these effects are, naturally, of different times, and result from various causes; that they may be very satisfactorily explained without supposing a deluge; and cannot be explained in the supposition that they were produced by a deluge; that some were produced by the successive subsidences of the waters, others by Ocean waves; others by local inundations; others by the disappearance of rivers; others by the overflowing of lakes, placed at different levels; for, if the basins empty themselves, they will deposit flint and gravel; but, if the sea encroaches on them, it will not carry either blocks or flint-stones to the soil which it covers with its waves.

The name *diluvium* has, then, been unhappily chosen: the idea it expresses does not accord with the facts; it indicates a cause which is not adequate to the effects attributed to it. C. Prévost, however, remarks, "that, as it would be inconvenient to change a name so long used in science, we must preserve it, but should define its meaning. Hence, wherever we find confused masses, resulting from sudden irruptions or the flowing out of ice, we will call them *diluvium*. We shall recognize the diluvian formations, because this word 'formation' indicates the origin of the layers; but we will not admit the diluvian series, because the word 'series' implies age;

and it is impossible to determine the age of the diluvium. The best geologists are now agreed on this meaning of the word *diluvium:* and, I do not see how their arguments can be answered." With so rational an interpretation before us, it must be admitted that the hypothesis of Buckland has no probability; and that to persist in seeking in it a support for the Mosaic deluge, would be to injure the cause we maintain. This cause gains rather than loses by the progress of observation; for, in the first place, the deluge has no need of being confirmed by systems; and, in the next place, the Mosaic chronology, in the mind of many persons, is embarrassed rather than aided by this geological diluvium. The observation was made: "If there has been added so little to our series of rocks, since the deluge has passed over them, is it not evident, that it required more than sixteen centuries to produce what we find under the diluvium? We must, then, either abandon the chronology of Moses, or take the days of creation for indeterminate epochs; or suppose that our series are, for the most part, the product of a more ancient world than that of which Moses has described the creation."—The objection is not so formidable, as we shall, elsewhere, have occasion to shew: but it can be no longer urged; it falls with the hypothesis of the geological diluvium. It is impossible to say, to what epoch of our series the deluge of Moses corresponds.

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CHAPTER V.

Adolphe Brongniart and Ampere.

X. Adolphe Brongniart.(1)—Accepting, as a fact established by Cuvier, the distribution of the different species of great fossil-quadrupeds in the different stages of the soil, and their successive creation in a complicated order, M. Brongniart sought to ascertain if the vegetable fossils led to the

(1) Périodes de végétation. Prodrome d'une histoire des végétaux-fossiles.—1828.

same results. He accordingly studied all the fossil plants of all the series. Unfortunately he appeared too soon. With a few more facts at his command, the learned botanist, instead of being influenced by Cuvier, and of confirming his theory, would, doubtless, have arrived at opposite conclusions. One thing is, however, certain, that the study of fossil plants has established the simultaneous creation of the various groups of the vegetable kingdom.

Brongniart refers to four periods of vegetation the various flora of the geological series. By a period of vegetation, he understands a greater or lesser length of time, during which the numerical relations of families, or classes with each other did not sensibly change. "The first period extends from the earliest traces of vegetation, which appear in the primary series, to the end of the coal formation. It is characterized by numerical predominance and by the great development of vascular cryptogami.—The second, less known than the others, corresponds with the period of variegated sandstone, and appears to be separated from the preceding one by rocks which contain no vegetable remains, or have only impressions of sea-plants, such as the red sandstone and the Penean limestone.—The third commences at the epoch of the conchylian limestone, and extends to the chalk.—It is remarkable for the abundance of cycadaceæ united with the ferns and the coniferæ. In fine, the last period, of which the present is the continuation, corresponds to the time when the tertiary series were deposited. It is distinguished from the preceding ones by the numerical preponderance of dicotyledon plants and by the absence of forms different from those of the actual vegetation.

Brongniart has given the result of these observations in the following table, which shews the difference of vegetation during these four periods. I have inserted three particular columns, indicating the intermediate series in the periods of vegetation, and the number of species which have been found in them, since the publication of his work.

CLASSES.	First Period	Zech-stein.	2d. Period	Musch-elkalk.	3d. Period	Chalk.	4th. Period	Present Period.
Agamous	4	10	7		3	19	13	7000
Cellular Cryptogami ...	0		0		0	1	2	1500
Vascular Cryptogami ...	220		8	1	31	1	7	1700
Gymnosperm Phanerogami.	0		5	2	35	2	17	150
Phanerogami Monocotyledon	16		5		3	5	25	8000
Phanerogami Dicotyledons...	0		0		0	5	100	32000
	240		25		72		164	50350
	501							

Brongniart refers to the development which the vegetable kingdom has successively acquired down to our days. "In the first period," he observes, "there existed almost solely cryptogami vegetables of a simpler structure than those of the succeeding classes. In the second period, the number of the two classes becomes proportionably more considerable. During the third period, the gymnosperm phanerogami principally predominate, and the simultaneous creation of the cycadaceæ and the coniferæ,—families of which botany shews us the relations, notwithstanding the difference of their external forms,—is not one of the least singular phenomena. This class of vegetables may, moreover, be considered, by its structure, intermediate between the cryptogami and the real phanerogami; and its epoch of appearance follows in fact that of the cryptogami; and precedes that of the generality of phanerogami; which are only found to predominate in the fourth period."

"We may then admit," adds the author, "among the vegetables, as among the animals, that the more simple forms preceded the more complex, and that the Creator has successively given existence to beings of increasing perfection." This conclusion was unexpected, for it is in contradiction with his premises, and with the results of his observations, as given in the foregoing table; where we find that the vascular cryptogami and the monocotyledon phanerogami appear with the agami in the first period; the cellular cryptogami, which all should find after the agami and before every other class, only make their appearance in the last period; and the gymnosperm phanerogami, which we should meet with before the monocotyledons, come after them in the second period. In examining the deposits of our surface, it is the fact of the gradual and successive predominance, of the most complicated vegetable forms over the more simple forms, that our botanist has established; and from this fact, the value of which we shall have to discuss, he has, inadvertently drawn the same conclusion as if he had found a general order of the successive appearance of the more simple before the more complex classes,—an order which has nowhere been found to exist.

"It is remarkable," he continues, "that the great changes of the terrestrial fauna and flora have been almost simultaneous. Thus the reptiles do not appear in great number before the early part of the third period of vegetation, according to Keuper, an epoch which answers to the creation of the cycadaceæ. That of mammiferous animals co-incides with the commencement of the fourth, that is to say, animals of the most perfect organization began to exist, or *at least to become numerous*, at the same time as the dicotyledons, which, no less justly, we may regard as the most perfect vegetables. In these observations *I abstract* from the only exception hitherto known, supplied by the mammiferous fossils of Stonesfield; as also from the *very rare exceptions* supplied by some dicotyledon plants, anterior to the chalk formation."

The words italicized clearly shew that Brongniart's observations do not authorize him to conclude that the order of the distribution of the fossils is from the simple to the compound. He makes no account of the two Jurassic mammifers of Stonesfield; he does not enumerate, in his first period, certain plants of the coal-beds, the *asterophyllites*, which, however, he regards as very probably belonging to the class of dicotyledons.[1] These omissions are the less excusable in this case, because every thing is accidental in the fossils, from the moment we regard as a necessary condition for fossilization, the transfer of bodies by running waters, and this law of fossilization is demonstrated. All these precautions do not change any of the facts: the order of complication no more exists in the subdivisions than in the great groups. The class of cycadaceæ and of coniferæ, which he regards as intermediate between the cryptogamous, and the phanerogamous monocotyledons, ought to precede the appearance of the monocotyledons. And yet, according to his own observations, the naiades, the palms, the canes, and a great number of monocotyledons of uncertain family, appear long before; and the liliaceæ present themselves at the same time as that class in the second period of vegetation. The cycadaceæ and the coniferæ do not immediately follow each other in the strata of our surface; the cycadaceæ begin to appear only in the conchylian limestone, whereas the cycadaceæ are found in the variegated grey-stone (2d period). Hence their appearance is not only not almost simultaneous, but the more perfect family appears long time before that which is less perfect. My conclusions in this respect are derived fom the facts collected by Brongniart: but these facts are not exactly stated; for the cycadaceæ appear as early as the red-sandstone, and the coniferæ have been found under the mountain limestone. Both, then, belong to the first period of vegetation, and not to the third; they are, consequently, as ancient as the most simple vegetables—the agami. Since the publication of Brongniart's work, the presence of many dicotyledon-plants in the coal-beds has been ascertained. The myosotis has been found in the coal-beds of St. Hubert; anemones in the coal-schist of the same locality; the cactus in the coal-beds of England, and of the Cévennes; and ceratophylla in those of Thuringia and Silesia. There is not, then, any coincidence in the apparition of the mammifers and of the dicotyledon-plants; all classes of vegetables are then equally ancient.

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(1) Prodr., p. 158.

Besides, were the plants and animals of our formations found to follow an order of ascending gradation, this would not authorize us to infer that there had been successive creations. It would, moreover, be necessary, that the order of the apparition of fossils was essentially connected with that of their creation, and represented it. Neither Cuvier nor Brongniart has touched upon this subject; nor shall I, at the present moment. I am satisfied to abide by this review of the facts which have been mentioned. The most perfect forms of vegetable life are associated with the most simple, from the earliest formations; and hence Botanic paleontology does not prove that creation has followed a serial order in plants. We shall, however, see what facts led M. Brongniart to believe that his periods are not arbitrary.

First fact.—" These periods," says he, " are separated by formations which contain no land fossils, and which, therefore, appear to have been contemporary with catastrophes that annihilated all the pre-existing vegetables." Brongniart was too hasty in giving magnesian limestone, shell-limestone, and chalk the title of sea-formations, and in stating that they were without land plants. It is now established, both by himself and by other botanists, that the land vegetation is not foreign to any of these formations; and that it abounds especially in the chalk-sandstone of Schona in Saxony, of Tetschen in Bohemia, &c. The pelagic deposit of the chalk of the plains, has, it is true, yielded only a small quantity of floated wood; but that of the Alps abounds with land plants, and has even lignites. How could botanists reasonably look for numerous remains of plants in deposits formed in a deep sea, far removed from the continents and the islands,—in deposits, which possess so little of the material furnished by the dry land? On the other hand, terrestrial plants abound wherever there are sandy or earthy substances, and where we yet behold traces of great torrents and of continental deposits. Were it even true that the shell-limestone and the magnesian limestone contained nothing but marine vegetation, this would not prove either a contemporary immersion of all the earth's surface, or a general and destructive revolution of every earthly species, because these, as well as all other deposits, are only local and do not cover the whole Earth.

Second fact.—" What shews that the vegetation of each period is, indeed, the result of new and successive creations, is, that there are no imperceptible transitions between the vegetation of these different periods, whereas there are *almost* always such between the different formations in each period." The most imperceptible transitions between different flora, are formed by identical genera, and especially by identical species. Now we have numerous examples of genera and species passing identically from one period to another. In the family of the *equisetacea* the *equisetum mongeotti* is found in the variegated sandstone and in the keuper (upper red sandstone) of Marmoutier, Lower Rhine. The equisetum *arenaceum* of the variegated sandstone of Wassellonne and Marmoutier, reappear, according to Berger in the keuper of Cobourg, and according to Mérian, also in that of the canton of Bale. Among the ferns, the *clathropteris meniscioides* passes from the variegated sandstone of the Vosges, at Ruaux and St. Etienne near the English Channel, into the keuper and the sandstone of the lias of Stor in Scania. These three plants existed, then, at the time of the muschelkalk (shell-limestone), which is intermediate to the formations which contain them. The *sigillaria reniformis* is found in the coal-sandstone of Mons, of Essen and of England ; as also, according to Lindley and Hutton, in the keuper-sandstone of Gotha. In the family of the lycopodiaceæ the *lepidodendron phlegmarioïdes* passes from the coal-beds of Newcastle and of Silesia into the keuper of the environs of Cobourg. Thus, these two plants passed through the period that corresponded with the deposit of zechstein (magnesian limestone), and of muschelkalk (shell-limestone). All the classes afford examples of genera, which are common to many periods of vegetation. The genus *neuropteris*, of the family of the ferns, is seen in the grauwacke, the coal-formation, the variegated sandstone, the shell-limestone, the keuper, the oolite, and the carbonic marl formation of M. Brongniart.

The genus *aspidites* (goppert), occupies the transition series, the coal-beds and the tertiary. The *genus equisetum* is found under the mountain limestone, passes into the coal-beds, fails in the zechstein (magnesian limestone), reappears in the variegated sandstone, fails in the muschelkalk (shell-limestone), re-appears in the keuper, in the lias, in the lower oolite, fails in the other oolite stages, as also in the chalk; and afterward is found, at a later period, in the coarse limestone, in the gypsum and at the actual period. The genus *auracaria* of the family of the coniferæ begins to appear in the coal-beds, fails in the zechstein (magnesian limestone), reappears in the variegated sandstone, fails in the muschelkalk (shell-limestone), and in keuper; is found again in the lias; and is not discoverable in any of the more recent rocks, but is found in the flora of living nature. Were there no imperceptible transitions between the different periods distinguished by Brongniart, this would not be a sufficient reason to admit successive creations. These periods do not differ more among themselves, than the flora of central Africa, for example, differs from that of Europe, or this latter from that of America. Hence the divisions of Brongniart are arbitrary; because the facts on which they are founded are erroneous, and because, were they certain, they would not warrant his inference of successive revolutions or creations.

Result. "In dividing the fossil-flora into four periods, we find that the cryptogami predominated in the first and second; the phanerogami gymnosperm in the third, and the dicotyledons in the fourth." Conceding to Brongniart, that his divisions are less arbitrary than those of others, and that his determination of fossil-vegetables is always accurate, it would still be impossible to accept his comparison of vegetable-fossils among themselves, or with living vegetables in respect of number; because a thousand circumstances may have originally influenced their fossilization, and, subsequently, their preservation—more or less complete,—or the disappearance of a multitude of families in the interior of the earth. In the fourth period of Brongniart, we find mention of two mosses and of seventeen coniferæ,—data which by no means prove that the numerical relation of these families at that time was

2:17. Is it not natural to suppose that trunks of coniferæ were preserved rather than mosses? And, if he has not found more than two species of moss in this epoch, does this justify him in saying, that the species of moss may not have been at that time ten times more numerous than those of coniferæ? In his third period he enumerates 35 gymnosperm-phanerogami, and 31 vascular cryptogami: in the second period, 7 agami, 5 gymnosperm phanerogami, 5 monocotyledon phanerogami, and 8 cryptogami. It is upon these slight differences he establishes the preponderance of cryptogami over agami, that of gymnosperm phanerogami and of monocotyledon phanerogami in the second period, and that of gymnosperm phanerogami over the vascular cryptogami in the third period. The first period, which, according to the views of Brongniart, should contain in abundance the most simple organizations, only presents 4 agami! It will, then, be always impossible to establish, approximately, by geology, for any particular epoch, the numerical relations of the species of different classes. Brongniart counts 50350 living vegetables: at the date of his work (1), he was not acquainted with more than 501 fossil-vegetables. The number of these last has since been augmented. When I ended my researches, they were about 780. Our living vegetables are developed, some exclusively in the sea; others in fresh waters, or on their borders; and the remainder, that is the immense majority of them, thrive indifferently near to, or far from, the water. Such, at the present day, is the general distribution of plants; and all botanists admit, that the fossils must have lived in the same circumstances as their analogues of the present day. These three great divisions, which taken collectively, contain 50350 species, would, then, be represented in the known fossil-flora by no more than 780 species. Of this number only 139 are marine, 462 are developed either in fresh waters or in moist and warm places, such as river-islands and mouths of rivers; so that there are only 279 species of the number which might live without water-courses; and yet, among them we re-

(1) Prodrome.

mark many plants which prefer the neighborhood of water, such as the plantain, the birch, the poplar, &c. The sea species which live under the same water where all the great deposits are formed, ought to be, and in reality are, more rarely found in the fossil state than those of land-currents; because they grow only where the waters are tranquil, and where there is little or no sediment collected: they become fossil only when branches or other parts are detached from them, and are abandoned to the currents, which transport them to a distance. The numerous species which dwell at a distance from the seas and the rivers, on the plains or on the mountains, are in still more unfavorable conditions, and hence their fossils are not numerous. The contrary holds for those which love the neighborhood of currents: more exposed than the former to be carried away by the streams, they occur much more frequently in the strata of the earth. The lycopodiaceæ, the equisetaceæ, almost all the ferns, choose damp and warm-beds; and in such places are found ten of these vegetables to one of the others. Hence the united species of these three families make the half, and the ferns alone more than the third of the total number of the vegetable fossils which have been hitherto discovered. It is, then, obvious that the number of existing species exercises much less influence on that of the fossil vegetables, than their position, were there a hundred times more vegetables, either in species or individuals, on the plains, on the mountains, in the places distant from running waters, not one of them would become fossil; while, less numerous as living beings, those which grow on the borders of rivers, would be more numerous as fossils, because carried away by the streams. We must not, however, suppose that all the species which were so transported have been preserved: they were soon decomposed by their contact with clear water, unless they were speedily enveloped by imputrescent materials, which their depression withheld from immediate contact with air and water; and were exposed to many other causes of destruction in the strata of the earth. If these strata were not composed of elements sufficiently fine, or if, for want of cementing material, they remained for a long time in motion, the soluble bodies they contained became decomposed and disappeared, without leaving traces of their presence. In a word, geologists can in general observe but a very small portion of the strata which have been laid-bare from other than geological motives; and every thing in the fossils is accidental,—their transportation, their embedding, their continuance in the strata, and their discovery.

It is, then, evident that the fossils supply no basis whereon to establish the numerical proportion of the species of the different classes, at the different epochs of the strata; each epoch not having been able to transmit to us more than a small proportion of the beings which then dwelt on the Earth The absence from the earlier rocks of certain classes, or certain families, which are at the present day very numerous, however, astonishing it may be for paleontologists, is nothing more than a purely negative fact: it does not prove that the species of these classes, or of these families, were not then existing; it would almost indicate their rarety in the countries which have been sufficiently studied, and it would not always shew even this with certainty. For, if these vegetables, by their position occur only in the river banks, and if these banks had been destroyed by the subsequent action of water, how numerous they might have been, there would remain no trace of them in the strata. But in a series, which is composed of but one or two formations, as the zechstein (magnesian limestone), and the muschelkalk (shell-limestone), this absence of vegetable fossils would have still less significance: for it might have depended on a thousand circumstances, on the localisation of the strata, on their origin, on the site of these vegetables, on the destruction, by the currents, of portions of the beds which contained them, &c. Brongniart himself admits, that the coarse limestone, being of marine origin, can only make us imperfectly acquainted with the contemporary land-flora. (1) Can his carbonic-marl, a fresh water formation, make us better acquainted with the contemporary sea-vegetation? Or let us take, for example, the lacustrine paleotherian, or the

(1) Prodrome, p. 210.

tertiary gypsum formation. Brongniart acknowledges that the vegetables are extremely rare in the Paris gypsum, while, on the contrary, they are numerous in those of Aix, of Armissan near Narbonne, and of Stradella near Pavia: he admits the influence of local circumstances on the deposits of these fossils. (1) Had the gypsum of Aix, of Armissan and of Stradella, been entirely destroyed, as that of Paris has partially been destroyed by the cause which scooped out the ancient Paris basin, that fresh water formation would not contain any land vegetables. Could we, then, have concluded that the land was without vegetation at the period of the gypsum formation? The millstone-rock is a fresh water formation; and yet the fossils which are found in it, belong exclusively to five or six aquatic-plants, and,—what Brongniart regards as very remarkable,—not a vestige of land-plant, either fruit or foliage, has been found in them.

XI. M. Ampere.(2) Had irruptions of the sea taken place on the surface of our continents, they could only have destroyed river and land animals. But, among the marine-animals, we find extinct species. Were there only question, as G. Cuvier wished it to be understood, of the disappearance of a small number of shell-fish, we might suppose, with him, that they had perished through accidental causes, or that they now actually live in places inaccessible to our observation. But the class of mollusks counts perhaps itself alone more lost species than all the others, taken together, and if we add to it the polypus, the crinoides, the echinides, the crustacea, the annulata, the fish, the mammifers and the sea-plants, we shall, doubtless, find, that, instead of appearing exclusively preoccupied by the larger terrestrial species, and of solving the problem by diminishing its proportions, it would have been more philosophical to embrace it in its entireness, and to suppose an extinct general cause, which was

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(1) Prodrome, p. 213.
(2) *Théorie de la Terre*, in the *Revue des Deux Mondes*, 1833, and in the *Annales de la Philosophie Chrétienne;* onzième année, IIIe serie, t. II. — 1840.

able to affect the waters of the deep as well as the dry land. The supposition of this one extinct cause should have appeared the more probable to one who made no account of existing causes, since the disappearance of sea and land species appears parallel and contemporary in the deposits of our surface. It was, doubtless, from this point of view, that Ampère devised his theory. He always keeps in view an extinct cause,—more general than could have been the action of the waters of the sea; and this is the alternate rise and fall of the general temperature, and certain *deluges of fire* resulting from the passage of bodies from the gaseous or nebulous, to the liquid or solid state. We have seen in Buffon the fiery origin of the Earth, and in Deluc its aqueous genesis. Ampère makes us witness its gaseous production. Following the authority of Herschell, and the first ideas of that illustrious astronomer on the nebulæ, Ampère maintains, that all the sidereal bodies have passed from the gaseous to the solid state; that they have successively become comets, stars, planets; and that each nebula is the germ and promise of a system of future Worlds, analogous to the entire of our solar and stellar system. Thousands of Worlds are thus being continually produced above our heads. An interpreter of Ampère's system observes: "this hypothesis of Herschell has nothing which may not be easily reconciled with the text of Genesis,—'the Earth was void and empty.'"

The first reflexion suggested by this summary exposition is, that, in every science, the first principle should be to proceed from the known to the unknown, if we wish to arrive at a true or probable conclusion. This is the natural march of the human mind. But, when we examine the thousand hypotheses which have been offered to account for the origin of the World, we are not a little surprized to find their authors adopt and follow a contrary principle. If we look for the causes of the rise or depression of the surface of our Globe, we are invited to set out on our enquiry from the volcanoes of the moon. If we seek to explain the formation of our solar system, we are referred to the comets, and, thank to our ignorance as to the course of these bodies, the supposition is gravely made, that some of them must have come into contact with the sun! Others, in fine, still more courageous, have passed the limits of our lower World, and applied their faculties to investigate the nebulæ!

Seen by aid of a powerful telescope, the nebulæ presented a new aspect to the eye of Herschell. They are not nascent Worlds, as yet in a state of nebulous chaos; they are, on the contrary, systems of stars perfectly formed, but too distant to be seen by the naked eye; since the increase in the power of our instruments renders them distinctly visible. If there are some which, even with the aid of instruments, still retain their nebulous appearance, like those we see with the naked eye, it is because they are too distant, and our instruments are inadequate to their discovery. The nebulæ, then, cannot be made to aid the hypothesis of Ampère: "all that we can conclude from them, relatively to our Globe," observes Maupied, "is, that this would appear a nebula to an observer living in a nebula."

This theory was made to explain, 1° the strata that have no fossils; and all strata have such, in greater or less number; 2° the distribution of these organic ruins in a complicated order; and this supposed order nowhere is found; 3° the destruction of the lost species, and the lost species have not perished by the general action of a violent cause; 4° the formation of the primitive rocks after the deposit of a portion of the Earth's surface; whereas the primitive mountains existed before any such deposits were made; 5° the strata of the planetary mass of the Earth; but what we know of the nucleus of our planet is found to be massive, not in the stratified state. Ampère's theory, like so many others, brings to mind the history of the golden tooth: it seeks to explain what does not exist.

It is impossible to attribute to the development of these supposed chemical reactions the simultaneous destruction of land and sea animals at so many different epochs, without, at the same time, supposing that these deluges of fire were general, and frequent: and this in fact is implied in the theory. —"At each great deluge, the temperature of the surface of the Globe being considerably increased, *any thing like organization became impossible*, until it once more fell. Hence, we see the beds that contain ancient vegetables and even the first animals, succeeded by other beds in which there are no remains of organized bodies."—According to this, God would have created plants and animals before there were, on land or in the sea, general and enduring conditions of existence for them to live in. Let us overlook this consequence. The chemical actions, imagined by M. Ampère, would have been, on his own shewing, volcanic phenomena. But if the volcanic element, although at present limited as to intensity and place, liquifies all that it touches, changes the nature of the substances on which it acts,—can it be a matter of doubt, that, developed on this immense scale, in the early geological epochs, it would have transformed all our strata into glass, marble, porcelain, and destroyed all vestiges of fossils, and, consequently, have rendered impossible the problem which Ampère endeavours to solve?

Nor is this all; the system is open to the same general objections that lie against the theories we have already examined. It takes the days of Moses for indeterminate epochs: it admits successive creations and general destructions; and, after having disposed the organic remains of the two kingdoms, in the strata, precisely as their classes and families are in our zoological tables, Ampère concludes by saying: "now this order of apparition is precisely that of the work of the six days, such as Genesis relates it." Here is a double error: neither in our strata, nor in the sacred cosmogony, do the classes follow the zoological order. We find in the hemilysian strata all the grand types of vegetable and animal organization; whereas Genesis records the simultaneous production, first of plants, then of fishes, then of land animals. The sacred record does not violate the natural relations of beings, by supposing, as do so many paleontologists, that these classes could have had separate and independent existence.

Ampère is not more happy in the explanation of Scripture-Texts than of phenomena. Who, for example, would have thought that the phrase—"*the Earth was void and empty*"—

indicated the Earth while existing as a nebula?—" The meaning given by the ancients to the word " empty," necessarily implying the absence of tangible matter, may be applied to the gaseous state of bodies."—Be it so; but here it is not applied to the gaseous state of the Earth; for Moses immediately adds, " and the waters were on the face of the Earth;" it was not, then, in the gaseous state. Moses does not exhibit to us the stars, first in the liquid state, then assuming a solid form, and then becoming extinct or falling in pieces; of the fragments whereof planets are formed. God made them: He formed, by a sole act of His will, the sun and moon. These bodies did not then pass through successive transformations, from the nebulous state to their present definite form. Such, according to Moses, is the origin of Heaven and Earth; they were not first sketched and then delivered to the slow and gradual action of secondary causes; but were at once produced, complete in themselves and in their relations.

" The Earth, however," says our author, " was more and more bristling with mountains, formed by the breaking of its crust, uplifted and inclined in all directions. After cooling down, a new sea was formed: it did not now cover all the Earth's surface; some isles, some isolated peaks, appeared above the waters:—the dry land appeared, says Moses."—Moses says nothing of the sort: the sea, which was gathered together into one place, at God's command, was not a new sea, but the same under which, up to the third day, the Earth was covered, and which is indicated by the words,—" face of the abyss."—" above the waters." In retiring from a portion of the Earth's surface, the sea left the dry land, which was necessary for the seat of plants and animals and water-courses, as is proved by the extent and magnitude of the mixed deposits of the first epoch, and of those of the coal-beds. In a word, the retreat of the waters was not a chemical process, but the effect of a command. The Vulgate does not say, " and the dry land appeared," but, " let the dry land appear,"—a very different expression, which precludes every idea of secondary cause, and shews the power of Him whom every thing obeys.

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CHAPTER VI.

C. Prévost, Ami Boué, Elie de Beaumont.

XII. C. Prevost.—While many geologists, extending the idea of Cuvier, formed as it were his school, others, uninfluenced by the authority of great names, and free from all partiality or bias, continued to promote the study of geology, by following the direction which Buffon had given. In this, they had been preceded by Pallas, De La Métherie, Lamark and others. They formed a regular school of real progress. The labours of Prévost consist, 1° of his oral instructions, the substance of which has been given in the writings of many of his disciples ; 2° of several dissertations which appeared from 1809-1835, and which were subsequently collected under the title given below ; (1) 3° of many papers read before the Academy of Sciences, and especially of one which was a partial epitome of his observations, and which appeared in 1845 ; 4° of many articles in dictionaries, encyclopedias, and *le Bulletin des Sciences géologiques*, especially the articles, *Formation*, *Fossils*, in which he traces the rules of geological nomenclature in relation to the principles of the science and natural causes. There are scarcely any subjects on which Prévost has not thrown light. Having seen, at an early period, the necessity of the logical influence of the various branches of human knowledge on each other, he always distrusted those hasty interpretations of facts, which were neitheir in accordance with the course of natural causes, nor with other established parts of general science. Hence, in his very first productions, he shewed himself to be opposed to the school of Cuvier. His contributions towards the history of tertiary rocks, are a solid refutation of that writer's system of repeated irruptions of the sea. Many of the conclusions of this remarkable work have become important principles for zoological and philosophical Geology.

1° The land-fossils, as also those of fresh and salt water,

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(1) *Documens pour l'histoire des terrains tertiaires.*

are the vestiges of the only organized bodies which were enclosed by sediments in the depth of waters through local causes.

2° The land-fossils can only supply an approximate idea of the general character of the animals and plants which lived near the passage of the water-currents of the continents, or on the shores of the sea, and they cannot reveal to us of what kind were the inhabitants of the interior of the continents, the elevated plateaus, and the high mountains.

3° The successive deposits have been formed, either continuously or periodically, at short intervals, and sometimes intermittingly.

In his article of 14 April 1845, Prévost undertakes to demonstrate the synchronism, at all epochs, of the various igneous and aqueous formations. The effects of the action of fire are found at all levels in the series of our rocks.

On the other hand, the sea and the rivers produced at the same time, at the mouths of rivers, on the banks, in the distant deep bottom, and at intermediate points, deposits which, their fossils and mineral substances shew us, were influenced by these different local circumstances. The rocks of every formation furnish illustrations of this fact. The synchronism of the different neptunian formations is the necessary effect of the configuration of the Earth, of the manner in which water acts, and of the natural distribution of the organized beings which supplied these formations with a part, and often, with the whole, of their materials. Deposits, differing very much from these in their character, their extent, their fossils, have been produced at the same time ; and deposits of remarkable identity of character in the same respects, have been produced at different epochs.

To form an idea of this synchronism in its universality, we may imagine a large sea, into which torrents and rivers discharge their waters, after having respectively traversed either lakes, desert lands, wooded countries, and the abodes of wild beasts. While the impetuous, irregular, deluge-like, action of the torrents, hurries along pell-mell these materials, and accumulates them confusedly in the sea basin ; while limestone waters deposit, in the form of concretions and of travertins, the carbonate of lime with which they are charged; while other subterranean sources, by means of the siliceous powder they hold in solution, cement the sands on the border of this sea, and produce there the millstone or sandstone; while the river-waters, after having washed and furrowed the soil of the continent, arrive in every direction, with a rapidity and abundance that vary periodically, carrying as a tribute whatever they may have been able to transport or pluck from the earth, —minerals, plants, animals,—which they deposit at their mouths, and often far beyond, in the most profound depths, where the unmutilated debris of land and river productions are associated, with those of sea animals, wood, crocodiles nautili, crinoïdes, &c.;—the sea, on its part, by the action of its tides, raises from its depths, and carries towards its shores, the beings which have died within its bosom—myriads of mollusks, crustaceous animals, fish, sea-urchins, polypi,—with which it forms large banks; and while by the action of its great currents, it transports masses of broken and pulverized shell, it dilutes the paste of innumerable polypi in progress of development, and deposits these sediments in its deep and tranquil waters. At the same time, the action of fire underneath the sea-bed, which it has upraised in a hundred places, fills, in one place, the cavities it has caused and injects its products through the fissures; in other places rises to the mouth of its craters from which it flows down under the briny waters in successive beds. On one point, the lava alternates with the sea or land-deposits: on another, the sea-currents take up the lava and deposit them elsewhere, under the form of sediment. Moreover, the igneous element modifies the elements already deposited by the water; it tears up ancient sedimentary rocks, melts them in its furnaces, to restore them in the form of lava, or projects them from its craters in solid fragments, which fall around the volcanic mountain.

Thus, we have all sorts of formations: water products, diluvian, the results of torrents and of great overflows;—lacustrine, fluviatile, and fluvio-marine or those formed at the mouths of rivers, littoral marine or those formed near the shores of the sea; *pelagian-marine*, or those formed in the depth of the wide sea, and semi-pelagian: igneous formations by intrusion, by sublimation, by overflowing: pluto-neptunian formations, the materials of which, furnished by the igneous element, are modified by the action of water; and neptuno-plutonian, or those the materials of which, furnished by the water, are modified by the action of fire. All these causes act at the same time: all these effects are synchronous. They are easily distinguished when they are isolated, as in our tertiary rocks; but, for the most part, they are combined, interwoven one with the other; successive, and mixed up confusedly. And because they appear in this successive or alternate order, it seems difficult to admit, at first sight, their synchronism in geology. It is, however, impossible to deny that there is a real synchronism of formations of rock and of minerals; that there is at present, and that there will be necessarily to the end, such synchronism of existence between organized beings of all classes; between plants and animals; between those intended to live on the earth, or in fresh waters and in the sea, on its shores and in its depths.—Consequently, if circumstances resembling those of which we are witnesses, existed, as is certain, in the earlier epochs, the beings which became fossil at the same time could not every where be the same, and beings of the same kind may have been deposited at different epochs. It follows from these considerations, that, if fossils may be used to determine the character of the formations and the circumstances attending them, they are far from enabling us to determine, with the same certainty, the age of the strata. The documents they contribute to the history of the Earth are very valuable, but great prudence is required in interpreting them aright, to prevent them being the occasion of false consequences. Can it be believed, for example, that the land and the sea were universally occupied, at the same time, by the same species, because paleontologists regard, à *priori*, as of the same age, the deposits which contain the same fossils; while it is much more probable, that the same species successively inhabited different regions, and that there were displacements, migrations, desertions, and even changes, by means of the numerous changes of form which the continents and seas have undergone? Every thing seems to shew the geological observer, that the living beings and fossils,—the most recent as well as the most ancient,—belong to one and the same plan of organization, conceived in its entirety, and not executed, piece by piece, and, so to speak, according to chance circumstances, or the wants of the moment.

We may affirm, that when the most ancient rocks in which we discover the first vestiges of organized beings, were formed, the Earth and its surface were in conditions analogous to those which now encompass it; that the fossil animals and plants which have ceased to exist, did not essentially differ in their organization from the present animals and plants; and that the surviving beings must, necessarily, have adapted themselves to the exterior condition of the Earth since that time. In a word, is there greater difference, physiologically and zoologically speaking, between the fossil animals and those which have been preserved, than there is between the species found in America, Europe and New Holland?

XIII. M. Ami Boué.—His observations are contained in *the Geologist's Guide*, his *Turkey in Europe* and the *Bulletin de la Société géologique*, of which he was, for a long time, secretary. Nothing can be more interesting than the analyses he gives, in the last named work, of geological and paleontological investigations, both in France and elsewhere. An unwearied observer, he is, among the moderns, one who has seen most and seen truly. He hesitates not to modify his views, when new facts, or old facts seen in a new light, present themselves to him, because he is free from the spirit of system, and studies geology for itself alone.

While Prévost was announcing the synchronism of water-formations, Boué, Beaumont, Dufrenoy, Hall, &c., established the synchronism of the aqueous and igneous formations, by ascertaining the continuity of the igneous action from the beginning of our epoch down to the transition rocks inclusively. The igneous element, whether by volcanoes, earthquakes, or dislocation of the surface, or by metamorphism,

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has never ceased to change the surface of the Earth on one point or another.

Guided by history, we may follow the plutonic modifications which have given their actual configuration to all the shores of the seas that separate Europe from Asia and from Africa. Boué recognized the traces of extinct volcanoes in the tertiary and chalk-formations of Turkey in Europe. He followed these lines of crevices, filled with matter of igneous origin, which, here and there, flowed over in Greece, the Archipelago and Asia Minor, in Hungary, Croatia, Transylvania, Illyria and Styria. Both geological facts and historic traditions attest the same for the Southern coast of the Mediterranean, towards Africa and Egypt. We behold, now a day, this order of phenomena continued in Italy and Sicily. True it is, that the French shore of the Mediterranean no longer exhibits the fiery element in activity; but between Marseilles and Draguignan we find extinct volcanoes in the *triasique* (1) and cretaceous regions; and further to the West, from Montpellier to Auvergne, the departments of Drôme, Ardèche, Haute-Loire, Loire, &c.,—exhibit a long line of extinct volcanoes, which have traversed all the secondary and tertiary rocks, and a great number of which occur in Auvergne in the primitive rocks. In Auvergne, near Issoire, in the mountain of Boulade, the first strata composed of fresh water limestone, repose immediately on granite; they form the principal rock of the mountain; and after them come fossiliferous sand-layers, which alternate with volcanic tufas. These facts shew that these volcanoes did not act in this locality, until the tertiary strata, which they cover with their products, were formed; and elsewhere after the secondary and transition-rocks were produced. If from Europe we pass to America, we find there precisely the same phenomena;—first a great number of volcanoes yet active, and many extinct volcanoes which traverse all the strata.

Broken strata, upraised in mountain-regions, attest dislo-

(1) The lowest group of the secondary rocks is called on the Continent of Europe *Trias,* because there it is developed in three well marked divisions.—*Tr.*

cations of the surface, which, according to some, an upraising, —according to others, a depression of the strata has caused. Whatever may have been their cause, these dislocations enable us to understand, how marine-deposits are found at so many thousand feet of elevation, while large extents of country, situated much lower down, exhibit no vestige of such a change. These dislocations were always accompanied, as is the case at this day, by copious springs, charged with gaz and salt, and gave rise to new deposits. The course of rivers was changed, as is the case at the present day, in similar circumstances. The strata formed by alluvial matter were no longer the same. When such disorders occur on a submerged surface, the later deposits change their angular inclination and direction: they were deposited on the anterior deposits in discordant strata; whereas strata that have the same direction and the same inclination, are called conformable, and are regarded as the production of the same uninterrupted cause in the successive production of its effects. Now discordant strata are found in all the rocks, and particularly in the mountains. This is an additional proof, that the igneous element was at all times active and disturbed the course of the aqueous products; for fire is not unconnected with earthquakes and these great dislocations of the Earth's surface.

This continuity of action of the igneous element is also attested by a third order of facts, known by the name of metamorphism, by which are indicated the various modifications which the igneous element has produced in the neptunian formations, after their deposit. The saccharoid-marbles of the Pyrenees, of the Alps, of Carrara, of Paros—are limestone modified by igneous irruptions: they contain marine-fossils, and form part of a series of other fossiliferous limestone. The gypsum of the secondary rocks appears also to have resulted from some metamorphication, which changed carbonate into sulfate of lime. The transition crystaline-schist are rocks of aqueous origin, modified by contact with plutonian-rocks, or by volcanic action. In his *Turquie d'Europe*, Boué confirms, by a great number of examples, the igneous transmutation of neptunian-deposits into chrystalline-schist. Around granite masses, in the Isle of Anglesey, argilaceous schists have become macliferous (1), or amphibolic; other argilaceous schists have become jaspoïdes, and contain imbedded garnets, in the neighbourhood of trap-rocks: the superior muschelkalk, and the lower Jura-limestone have passed into serpentine and statuary-marble, near the pyroxenic granite and porphyry of Predazzo. The limestone of the lias, with its arched gryphæa, has been changed into granular limestone without fossils, near the syenite of the isle of Sky, and in the Pyrenees. Studer discovered mica-schist containing belemnite garnets at Mount-Luckmanier: there are talk-schists with belemnites at Nuffenen. In certain volcanoes of the Eifel, as at Hohenfels, Mitscherlich observed mica of igneous origin in modified argilaceous schist. The production of dolomite, or double carbonate of lime and magnesia, in the neighborhood of volcanic rocks, as also of the saccharoid limestone, is a general fact, which has been witnessed in all epochs of the formation of the Earth's surface.

Metamorphism has thus completed the demonstration of the synchronism of the igneous and aqueous formations, and destroyed the artificial classification of rocks introduced by Werner. This geologist divided rocks into five classes: primitive, transition, secondary, alluvial and volcanic. He comprehended in his primitive rocks many schist-rocks, such as gneiss, mica-schist, &c., which are really aqueous metamorphic-deposits, and which cannot belong to the same class as the granite. The volcanic rocks which terminate his series, must be laid aside, because the action of fire extends to all epochs, and because, acting ordinarily from below in an upward direction, it rarely affords the means of determining the relative age of its products. Werner's classification is not based on the facts of the science. There are no general series; there are only local series. Referring to the five divisions of the secondary rocks, Link says: "we generally imagine them to be superimposed, one over the other, in great order, and as if they regularly followed each other on the surface of the

(1) *Macle*, a mineral, called also *Chiastolite*.

Globe. Hence it has been inferred that these different superimpositions were successively formed, so that the deposit of the first formation was ended, when the second began, and thus of the rest. But there is no proof of this hypothesis. Nowhere, in one and the same locality, have the five orders been found, superimposed regularly, one above the other, in such away as to indicate the relative age of each and determine it with precision. These periods of formation have no foundation in Nature: they are means which have been imagined, in order to put some order in the phenomena. They may be compared to those contrivances which the child uses, while learning to walk, and which he afterward throws aside.—Much labour has been employed to find some localities where two formations are regularly superimposed, without reflecting that the superior strata in this locality, might, in other places, be contemporary with the inferior bed."[1]—I would add, to this last observation,—"and without reflecting that the origin of deposits supplies the reason why the inferior strata are always inferior, when they exist." Thus, for example, the transition rocks are always lower than the coal-strata, when they are found in the same place, because the transition rocks are the debris of primitive rocks, which, when once covered by other deposits, could no longer furnish materials for the water to transport.

The demonstration, by synchronism, that the various neptunian formations have had their causes and origin in the various local circumstances of the Earth's surface, of the waters and their inhabitants; and that, in very distant localities, the same circumstances and the same phenomena may have been reproduced, leaves us evidently nothing to do, but to study localities, often independent of each other, without being able to infer either their relative antiquity or contemporaneity;—two conclusions which can only be seriously inferred for formations of the same basin.

XIV. Elie de Beaumont.[2]—*Theory of elevations.*—

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(1) *Le Monde primitif.*
(2) *Théorie d'Elévations.*

From the year 1812, Heim had been led to suppose a succession of elevations in the surface of the Earth. More recently, Jobert attributed the deluges imagined by Cuvier, and the accompanying destructions of animals, to the elevation of the mountains. Deluc, Studor, de Boucq and Boué agreed in admitting many epochs of elevation. Beaumont gave a new character to these theories, when they appeared to be on the point of being given up by their authors. He examined whether their idea and that of Cuvier could be separated from each other, that is, if the mountains might have been elevated without producing on the surface of the Earth real revolutions; and if the convulsions which must have accompanied the uplifting of these enormous masses, were identical with the revolutions of the Earth's surface imagined by Cuvier. This investigation confirmed him in his conjectures; and he ever afterward taught, that the succession of rocks, in which the deposits appeared to have been respectively made under different circumstances, is the result of the change produced in the limits and action of the sea by the successive upraising of the mountains.

He explained his system thus: "the inclination of the sedimentary deposits which cover the sides of the mountains, supplies the proof of the elevation of these latter. These inclinations belong to distinct epochs; but although they are found to prevail to an extent frequently very great, they constantly follow the same direction as the mountains. In every mountain-chain, the series of strata is divided into two classes; the one comprise the more recent strata, which extend horizontally to the feet of the mountain; the other, the more ancient strata, which are inclined at various angles, are more or less contorted on the sides of the mountain, and sometimes reach to their summit."—This distinction appeared to Beaumont to afford the means of determining the relative age of the mountains, which is, at the same time, that of the revolutions of the Globe. He assumed as evident, that the elevation of the mountain must be referred to a time intermediate between the deposit of the inclined, and that of the horizontal-strata: also, that a stratum placed between two mountains, which rises on the sides of one, and extends horizontally to the foot of the other, proves that the first mountain is of later date than the stratum, whose inclination is the effect of its elevation, whereas the other mountain was already in existence at the time of the deposit, because this latter reposes on it in a horizontal position. From the single fact that the mountains have a common direction, he inferred that they have a common system, produced at the same time, at once and by one uplifting cause, the seat of which is placed from thirty to forty-five miles below the surface of the Earth. The number of such systems tells us the number of dislocations which the surface of the country where they are found has undergone; and this number corresponds with that of the changes in the nature and position of the deposits they contain, that is, with the number of the geological formations of these countries: every different direction of the strata, or each independent formation, indicating a system of mountains in a similar direction. Setting out from these principles, the author recognizes twelve different mountain-systems in Europe, corresponding to the number of the different directions which these mountains follow.

Were it allowable to suppose, that this new theory was the expression of what had occurred, it would only establish the relative ages of the different mountain-chains and their corresponding formations; but it could not determine anything as to their absolute age, or that of their deposits. Yet Beaumont is one of those geologists who seek to determine these things with exactness. He has made on the coal-beds and some living plants certain calculations, which I shall not fail to remember when the time to speak of them presents itself. It is almost unnecessary to add, that the author also admits successive creations and destructions.

When he published his theory, the hypothesis of elevation was in general favour. It had been at first applied to the volcanoes, and, subsequently, to the mountains. This portion of hypothetic geology was not, however, long in undergoing change. The volcanoes, when better studied, appeared under a different asp ect; and many great facts of their history passed definitively into science. The falsehood of the hypothesis of elevation, when applied to volcanoes was rigorously demonstrated by many intelligent observers. It was established, that the cones of volcanoes owe their origin to a successive accumulation of lava, and not to a sudden elevation; that the force which produced the matter of this lava did not cause the underlying sedimentary strata to be upheaved; that the starting point of these eruptions, instead of being placed, as had been imagined, at the lower extremity of the volcanic focus, was to be found on the superior extremity of the lava or ascending column, which, having, at this place, become cool and solid, was broken and erupted by the development of gaseous matter; that these solid masses, these phonolites, which were generally represented as having traversed and uplifted all the strata of the surface, having been projected from a depth of thirty or forty-five miles, were nothing else than fragments of aqueous rocks, or of igneous rocks, deposited in a liquid state by the volcanoes: that the pretended star-cones of Teneriffe, Cantal, and Palma, which were said to prove the passage of these phonolites, could not possibly be assigned to this cause, and were, in fact, very different from what they had been represented to be. A cone in star-form on the upper part of the upraised strata, supposes, at least, a rupture in three directions, and that the ruptures are largest at the central point of the star: these two things are necessarily implied. Whereas in all the active volcanoes, or portions of extinct volcanoes, which have been adduced as illustrations, the splits, or dykes, are narrower near the cone than at a distance from it; they do not cut it; they approach it without touching. The facts, consequently, are not in accordance with the theory.

These observations are fatal to Beaumont's theory; for, if the volcanic element has not upraised the rocks in producing craters and cones, still less can it be supposed, that the granite and porphyry, which constitute our mountain masses, were elevated; as their cropping out, over the surface and the inclination of the sedimentary deposits which cover their sides, would be more easily explained by the theory of depressions, an observation that could never be applied to volcanic mountains. Hence, the hypothesis of Beaumont has always had fewer partizans among the class of geologist observers than that which attributes the craters of volcanoes to some upraising cause. Instead, however, of abandoning, he modified it in the French translation of the *Manual of De La Beche*, in which he gives a new view of it.—"The elevation of the mountain-chains cannot," says he, "be attributed to the prolonged action of plutonic causes; we must seek for its origin, with Cuvier and other Natural Philosophers, in the secular cooling, that is, in the slow radiation of primitive heat, to which our planet owes its spheroidical figure. The cooling incessantly tends to establish a relation between the capacity of the solid envelope and the volume of the mass as yet in a fluid state. Now these wrinkles (on the Earth's face) are the result of the diminution of capacity of the solid crust, in consequence of the vacuum created by the gradual cooling of the internal mass." (1)

There is contradiction between the system of elevations and the cause assigned to them.—It must be admitted that this idea of Beaumont is by no means a happy one. The contraction, to which he would attribute the origin of mountains, might, indeed, produce depressions, and relative inclinations, but never absolute elevations. If the volume of the internal mass of the Earth were increased, it might break and upraise its envelope, which no longer could enclose its augmented volume; but in the hypothesis of the gradual cooling of the terrestrial temperature, the contrary would occur. The planetary mass, in passing from the liquid to the solid state, would be diminished in volume: it would have, between itself and its envelope, empty spaces into which this latter would naturally fall. The result on the external surface, would be folds, undulations, disturbances of continuity, relative inclinations by means of libration; in a word, effects which would no more resemble absolute elevations, than the supposed diminution of the Earth would resemble an agent which, under the entire thickness of the Earth's crust, would endeavour to raise

(1) Page 665.

up portions of it. Hence, the theory of elevations, as proposed by Beaumont, is absolutely incompatible with the gradual cooling of the Earth, and the contraction of its surface, which, however, he assigned as their cause.

We shall not play upon words. Beaumont may call *elevations* the furrows of an aged countenance, or the inequalities of a dried orange peel. We would not object to the expression, if the idea was the same as that attached to the word 'depression,' or 'falling in': but it is easy to see, that in his theory, the depressions are relative and the elevations absolute; that is, that there are, according to him, more elevated than depressed parts. Now to produce similar effects, it would be necessary that the planetary mass should be dilated instead of being contracted. His theory is, consequently, in obvious contradiction with the laws of Nature. This is the more unfortunate, as every thing in this theory is gratuitous; beginning from the mountains themselves, in the supposition of their elevation. No one has ever seen the mountains rise; instances of the upraising of coasts, a few feet, by the violence of volcanic action, prove nothing. There is a great difference between such elevations and the chains of the Alps, or the Cordilleras, or the peaks of Thibet. It would be silliness to regard as phenomena, calculated to uphold the theory of elevations, these elevations produced at so inconsiderable a depth, and which are much more like the effects of a pression, which, exerted at one of the two extreme ends of a line, would cause the strata to undulate. The elevations, then, being without support in experience, must needs be sustained by some hypothesis which would at least shew that they were possible.

These elevations are inconceivable.—The subterranean forces to which are attributed the volcanic cones and the mountains, being a chimera, and the hypothesis of the contraction of the Globe, being in opposition to the theory itself, we may be permitted to ask, what may be the nature of this agent, capable of raising, and of transporting so far from their original seat, and to such great heights, such considerable parts of the Earth as the mountain-chains, the superficial contents of which, as of the Alps, may be calculated at thirty thousand square miles? How could this uplifting force have caused to stand out, on so small a line, so numerous parallel parts as form, for example, the Jura-chain? How could it, at the same time, produce mountains separated by immense distances, without simultaneously elevating all their contiguous comparatively small chains. How did it happen that so violent a motion, strong enough to raise instantaneously the mountains, did not precipitate the sedimentary deposits which rest on their sides, and did not, at least, cause to disappear the blocks of rocks which lie on these deposits? How could it be that deposits, solid and adhering to the underlying mass, could have been raised abruptly, to a height of 12,000 or 15,000 feet, without having been broken, as, for example, the thin and fossiliferous cretaceous stratum, which from the valley of Reposoir rises to the top of Fis, a height of upwards of 16,000 feet?

The discordant (unconformable) stratification does not prove the theory of elevations.—The various stratifications are the effect of changes of direction of the water-courses, —a change which may be attributed to any other cause as well as to that of the elevation of the mountain-masses. It may have arisen from the erosion of the cliffs, from the filling up of rivers, from volcanoes, &c. "The discordance among the upper strata is much more frequent in the river-bank deposits; hence it is most frequently observed below, amidst, and above, the coal-beds; also, in the trias, as might have been expected. The currents are more numerous in the neighbourhood of the sea shores, as also more liable to change their directions, by reason of various disturbances,—the fractures of the soil, the washing away of cliffs, the alluvions, the subsidences; as also by reason of the volcanoes which remain in activity while in the neighbourhood of the sea, as we find on the South of the ancient Celto-Germanic sea, in Auvergne; on the North of the same basin, in the mountains of the Lower-Rhine, from Coblentz, to Cologne, Frankfort, Luxembourg, Cassel. There are probable natural causes of the discordance of the strata in all these regions. The Jura-strata, more advanced in this (former) sea, must have been but little affected by these causes, although deposited at the same time with the others. The same observation applies with still greater force to the white chalk, which was deposited at the centre of this sea. None of the numerous Jura-strata present this discordant stratification ; nor has it yet been observed in the sea-chalk. The geologists who favour the theory of revolutions, find in these facts the proof of a long period of tranquillity on the European soil, while the Jura and chalk-rocks were deposited. *We* infer from the same facts that these rocks were deposited in the centre of a vast sea, which was not disturbed by the causes that deranged the currents towards its shores."(1)

The discordant stratifications do not prove an intermittence of currents, nor a revolution on the surface of the Globe.—It is certain that, at all epochs, there have been simultaneous dislocations, subsidences and subsequent upheavals, produced, as it were by undulation in the strata which compose the mountains, or which are near them. These occurrences have successively modified the basins of the seas, in their form and limits. They have changed the directions of currents and have caused them to lay their subsequent deposits in unconformable stratification with the disrupted strata. All this, however certain, does not prove an intermittence in the action of the cause which produced these deposits. On the contrary, the dislocations must have given greater energy to this cause, and placed at its disposal a larger quantity of materials. Besides, these unconformable stratifications are not found in all localities between one series of strata and another ; and as for the broken and dislocated strata, they are limited to very few localities, and by no means authorize the supposition of a revolution on the surface of the Globe.

The elevations are in contradiction with the effects attributed to them, and which they ought to explain.—The principal recommendation of Beaumont's system, is the explanation it appears to give of the successive and general lowering of the level of the sea. Does it explain this pheno-

(1) *Dieu, l'Homme et le Monde,* T. III. p. 540.

menon? C. Prévost will tell us. It was reserves for this able and conscientious investigator to combat, with equal success, the two most distinguished geologists of his time, Cuvier and Beaumont.

"1° If in a basin, the bottom of which is flexible, filled with water, I cause a swelling, by pressing underneath, it is evident that I shall diminish its capacity, and that the level of the water would rise in proportion to the volume of the swell in its basin's bottom. Were there to be produced a depression of the bottom, in consequence of the force which produced the swelling, that depression would not exceed in volume such swelling, and, consequently, the level of the water would not be changed. We cannot understand how any matter contained in a spherical envelope, and which would not press, could raise this envelope, except it were compressed and too much confined,—without occasioning by reaction, or depressions equivalent to the absolute elevations it would have produced.

"2° A series of elevations in the bottom of a basin will then successively elevate the level of the water it contains.

"3° If the bottom of the basin were composed of horizontal leaves, and that some swellings rose above the surface of the water, the parts which emerged would never present any thing but leaves more or less inclined. In no case would the horizontal parts be uncovered by means of the elevations of the bottom.

"Let us suppose that, at this present time, a cause, similar to that which, according to the theory, upraised the Alps, should elevate the bottom of the South sea and cause a new continent to rise above its surface. It is evident, that a quantity of water equal to the volume of the submerged base of the new continent would be thrown on the shores of America, of Asia and of Europe; and that, after oscillations more or less violent, some parts of these countries, which are now dry, would be submerged, but that, in no case, would any part of the Earth now inundated be laid-bare.

"If from these suppositions we pass to the examination of the facts, we find, that, upon almost all the surface of the already emerged lands, there are ancient sea-tracts, and large marine-deposits, which have been laid-bare, *without at all disturbing their normal position.* The general level of the sea has, therefore, been lowered, and in order that this might take place, either the absolute quantity of its waters must have been diminished, which few writers suppose, or, in consequence of the dislocation of strata, there have resulted depressions in the bottom of the sea greater than the elevations which may have been caused.

"If on all coasts, from New Holland to England and Ireland, around the mediterranean basins, as at the circumference of islands, and on the line of all rivers, we discover undeniable marks of the waters having rested, at different elevations, parallel and, as it were, graduated, it is very difficult to attribute these successive and extensive emersions to absolute elevations of the surface, the different parts of which have almost still the same relations to each other, as before the last retiring of the waters. If, on the other hand, we consider as submerged, all the parts of the actual continents and of the isles in which are found marine-deposits that have preserved their horizontal position; if, necessarily, we also consider, as having once been under the water, the greater part of those points of the surface where are seen the mountain-chains, which are supposed to have arisen subsequently to the deposit of these strata, it is easy to see that there remains scarcely any place for the abode of land-plants and animals,—for the great lakes in which have lived the fresh water-plants and animals,—for the great rivers on the banks of which dwelt so many organized beings, the numerous remains of which are found in the ancient deltas.

"Are we not, then, obliged, as it were against our own wish, and in spite of every prejudice, to regard as indispensable that *at the same time* the bottom of the sea was laid-bare and raised above the level of the waters, by means of dislocations of the Earth's surface, still larger tracts of the Earth's surface were swallowed up, so that the depressions thus produced were greater than the elevations, a condition without which, I repeat, the low parts of our present continents would not have been laid-bare;—a condition, the occurrence of which does not require the intervention of the supposed agency of elevation, since this would have produced a contrary effect."(1)

We are, then, brought back on this point to the theory of Deluc, who said, that the present inhabitable land was nothing more than the bottom of the ancient sea, laid bare by the depression and disappearance of the ancient inhabited lands, which were swallowed up,—with this difference, in Prevost's manner of considering the subject, that *the pillar-caverns and masses of dust*, imagined by Deluc, have been replaced by the contraction, the dislocation and depression of the Earth's surface.

The fundamental principle of the system, that all the parallel dislocations are of the same age, is contradicted by observation, and, consequently, cannot lead to the determination of the relative epoch of the uplifting of the strata.—From observations made in England, in the isle of Wight, Downshire, in the Southern parts of Wales, and in the South of Ireland, on greywacké, the carboniferous strata, &c., it appears, that, were we to adopt Beaumont's interpretation of the phenomena, there should have been three elevations of these strata, at a short distance from each other, and in the same direction, from East to West, which, however, occurred at different epochs, as is shewn by the difference of the deposits that repose on their dislocated sides. Sedgwick has also proved, from facts occurring in the same localities, that a deposit might have been elevated at the same time in different directions. Beaumont's system has met with adversaries among the most distinguished geologists in England, Germany, Italy and France; among whom may be named Conybeare, Sedgwick, Humboldt, Lyell, Saigey, Passini, C. Prévost and Boué. This last named geologist has proved, that, according to the different directions and inclinations of the various deposits of the secondary strata, in the valley of the Rhine alone, it would be necessary, in this theory, to admit two epochs of elevation; one for the left, the other for the

(1) Bull. de la Soc. géol., T. II. p. 183.—1839-40.

right bank; that, in order to place the elevation of his seventh system of mountains after the deposit of the Jura-strata and before that of the green sandstone, and of the chalk, as Beaumont does, we ought to find the Jura-strata in an inclined position at the foot of the Erzgebirge, which makes part of this system; whereas observation discovers nothing of the sort. Moreover, Beaumont supposes, that this elevation occurred before the formation of the green sandstone and the chalk, whereas these deposits are found inclined on points of the same system. Boué has in this manner offered to Beaumont a series of facts, which, it would appear, leave no room for a reply. (1)

The determination of the relative epochs is arbitrary.—"The mountain-systems are distinguished from each other by their directions, and a different direction establishes different epochs." This is the law of the hypothesis proposed by Beaumont; who, however, was the first to discover its groundlessness and to contradict it.

"The first elevated system is that of Westmoreland and of Hundsrück; its direction, W. 35° S. E., 35° N., is almost the same as that of the Côte-d'Or which runs by W. 40° S.; however, the cambrian deposits would alone have been elevated in the system of Hundsrück, while the system of the Côte-d'Or would have uplifted even the Jura-deposits, a circumstance which causes this system to be distinguished as the seventh, notwithstanding its almost similar direction to that of the first. On the other hand, the central plateau of France, which does not even contain transition-deposits, is reckoned as belonging to the first system, by reason of the direction of its gneiss-strata. Thus, in one case, the direction of the strata establishes the system of elevation, and in another, it does not, because the elevated strata are supposed to be of a different epoch. What law, then, shall determine the epoch? Is it the mineralogical character of the strata? But mineralogical composition absolutely proves nothing as to the time of elevation, as calcareous strata may easily have been depo-

(1) Journal de Géologie, T. III.

sited in one locality, while in another the only deposits are granitic *detritus ;* and the elevation of the calcareous strata may have taken place in this locality at the same time that transition-strata were elevated in another. The mineralogical composition cannot, then, determine any thing. Will the remains of organized bodies, which are different in the two formations, suffice? But this difference only proves that the conditions of life may have been different in the two places; and hence that different species may have lived at the same time in them. The direction of the mountain-systems being laid aside, as must necessarily be done, the mineralogical composition of the strata, and the remains of organized beings they contain, can determine nothing, and there remain only imaginary causes, for there are no facts whereon to ground a system.

"It is not only in the first system that this arbitrariness and these contradictions occur: all the inconveniences, in the sense St. Thomas attached to the word, *quod est inconveniens*, are found in the other systems of elevation. Thus, in the second system, the silurian-deposits have preserved their primitive horizontality down to our days, in Scandinavia and Finland; but they have been deranged and elevated elsewhere, with the Cambrian-rocks. What means have we to determine epochs in this case? None. Moreover, this system is, by its direction, so near that of the Pyrenees, that there is only a difference of three degrees between them. How are we to distinguish these two systems, one of which is the second, and the other, that of the Pyrenees, is the ninth of Beaumont's systems? The reason assigned is the presence of coal-beds in the former, and the elevation of chalk in the Pyrenees; which elevation, it is said, took place only after the five deposits, regarded as intermediate between the coal and the chalk. Thus we always find the same impossibility to determine any thing for any of the systems, which we have pointed out with regard to the first; and, moreover, all the secondary rocks, from the coal to the chalk, may have easily been contemporaneous in many of their parts

"Another *inconvenience*, no less serious, is the gneiss of the central plateau of France, which presents, in its strata, directions in many respects similar to those of this second system: and we have just seen that it presents directions similar to those of the first. Thus we have gneiss-strata in the same plateau, which may belong to two different systems, by reason of their directions, resembling those of these systems, while the *Côte-d'Or* and the Pyrenees do not belong to them, although their directions are like those of these same systems!

"It would be useless to pass in review the other systems, to shew the same absence of logic, of motives, of causes; and, on the other hand, always the same caprice in the determination of systems and epochs. To avoid such repetitions, we shall pass to the consideration of another contradiction implied in the hypothesis itself. It being impossible to bring all facts into this hypothesis of systems of elevation, which, at each step, is found to be incompatible with them, in order to explain certain elevations of rocks, regarded as belonging to epochs posterior to the elevation of the system on which they lie, recourse is had to the supposition, that after the first elevation, these rocks subsided and then received their deposits; but no attempt is made to determine the mysterious cause which elevated and depressed the same system.

"Thus, in the tenth elevation, the *System of Corsica*, "the accident which befell our planet," says the author, "is "no longer indicated, as in the preceding systems, by an "elevation of the strata formed immediately before that event; "because the rough Parisian-limestone, which would then be "found, does not occur in the place where this new catas-"trophe happened. The absence of this deposit shews, that "the surface was at that time raised above the seas in which "it was formed: but as observation discovers in these same "places, other marine-deposits, which approximate to soft "green sandstone-deposits, and which were subsequently "made, we must conclude, that what was originally above the "sea-level, was necessarily for a time depressed. This is the "principal result of the catastrophe in question. And, in-"deed, a part of the Paris-basin, Touraine, the greatest part "of Gascogny, all Switzerland, the valley of the Rhône, from

"Lyons to the sea, as well as many parts of Italy, of Corsica "and Sardinia, which, not having the Parisian-limestone, "must have been raised above the sea by the elevation of the "Pyrenees, must needs have been depressed, to receive the "deposits of soft green sandstone, which are found there."

"Why" asks Maupied, "insist that the absence of Paris-limestone proves the elevation of this system (that of Corsica) before that of the Pyrenees, and how does the presence of molasse prove subsequent subsidence of the Corsican system in order to receive it? There is really no other motive than that supplied by two suppositions of artificial geology, which are now proved to be false, through all the extent, whether in breadth or depth, of all the strata. The first of these false suppositions rests on the principle, that one species of rock must have been formed at the same time on all the surface of the Earth, which was then covered by water; for instance, in the present case, that the rough Paris-limestone must have been formed in all the extent of the inundated part of the Earth: and hence, it is inferred, as the system of Corsica has not the Paris-limestone, it was not under the water, at that epoch. But this supposition of any species of rock whatever, which was formed at once throughout the whole extent of the immersed surface, is the most erroneous idea presented by geology. The error was pointed out by Lamétherie, and the lapse of time has only shewn its falsehood in still clearer light. There is no species of rock that covers the whole Earth; there are local formations, differing from each other, both in mineralogical composition, and the fossils they contain, and which yet are of contemporaneous origin.

"The second erroneous supposition, which follows from the first, is, that the different rocks superimposed on each other in certain places, although not so in other places, were all successively formed, so that the first was everywhere deposited before the second began to be formed: that this, in its turn, was everywhere formed when the third commenced; in a word, that the artificial classification of rocks is a truth, whereas it is only an abstraction, a generalization, which has almost no correspondence with the facts, such as we find them in nature.

"Let us reflect on the rigorous consequence of these two suppositions, and we shall see that they cannot be seriously admitted. If true, we shall be obliged to admit that, at the epoch of the Parisian tertiary rocks, which are scarcely known, except in the Paris-basin, in that of London and in that of Brussels, the whole Earth was laid bare, with the exception of this small basin, which was the only sea of the Earth. This is rather a serious inconvenience."(1)

Other false suppositions of the theory.—Beaumont has paid no attention to the continuousness of the rocks, nor even to that of formations in the same series. He supposes, for example, that all the secondary formations are regularly superimposed, and are all deposited in successive order. He supposes the trias deposited before the commencement of the lias; the lias terminated before the beginning of the first Jura-strata: the Jura-strata ended before the appearance of the chlorite-chalk; the chlorite-chalk entirely anterior to the tufa-chalk; and this last to the white chalk. This supposition, however, is shewn to be false by the connection and succession of formations of different origin and by the synchronism, at all epochs, of all the circumstances, and of all the active causes. Moreover if, at the present day, by the action of the same cause, which produced the ancient rocks, there are formed, at the same time, pelagian-strata, as of white chalk, in the South sea,(2) and rough littoral limestone in the basins of many of our seas, and deposits intermediate by their position to the preceding, such as the coal-beds in the seas of America, as well as thick-beds of clay and of marl in these same seas, as also in our own,—how is it possible, unless we abandon altogether observation and all the principles of positive geology, to believe that, in the ancient seas of which ours are only specimens, each epoch was limited in its productive powers to one single great formation? A system which separates, as successive and independent, systems which, at least in part,

(1) *Dieu, l'Homme et le Monde,* T. III. p. 668.
(2) Dumont-Durville.

must have been necessarily contemporary, is not the expression of facts as they are.

The theory not only supposes that all the mountains have been raised, but does not allow the first to have been elevated until after the deposit of all the sedimentary strata below the anthracite rock, and during the period that this latter was forming,—a supposition evidently false, and which has no analogy except in the theory of Burnet. Two decisive facts may be opposed to the theory of Beaumont: 1° the rocks of transition were moulded on the granite rocks: their direction and their inclination are the same; and hence they were determined by them; 2° the transition rocks were deposited in a great basin of the sea, by great marine and land-currents. Such currents and such basin suppose pre-existing mountains.

1° The identity of the direction of the transition strata and the chains of granite, has been established by Palasson, Saussure, Humboldt, Ramond, Charpentier, d'Aubuisson, Boué, Breislack, &c.,—in Germany, in Belgium, in the Vosges, in Cotentin, in Tarantaise, in the greater part of the Alps, in Scotland and in the Pyrenees. The same parallelism is observed in the Caucasus, in North America, in Sweden, in Finland, in the Cordilleras of Mexico, &c. The direction, then, of the strata of transition-rocks is not a merely local phenomenon, but a general phenomenon, independent of the direction of the secondary chains, of their branching, of the sinuosity of their vallies;—a phenomenon, the cause of which has operated at immense distances, as, for example, in the old world, between the 43° and 57° of latitude from Scotland to the confines of Asia. What is this mysterious influence of the high chains on strata which are sometimes three hundred miles distant from them? How can we imagine that the deposits, being once formed in so vast a direction, the mountains, in rising, would either have always followed the direction of the strata or entirely deranged their direction, and given them a different one? In both cases, we should find, everywhere, on all the line of the strata thus lifted up and dislocated, contortions, ruptures, as they are found exceptionally in every limited points, where there has been a dislocation of the surface, such as we see every day caused by earthquakes and local subsidences. But on so large an extent, there should be found much more considerable contortions and derangements than actually occur. On the contrary, a general order of uniform direction of strata and mountains, is found throughout the Earth, while the inclination varies with the localities. We must, then, conclude that the direction of the pre-existing mountains has determined the general direction of the strata; for we cannot conceive how these latter should have determined the direction of the mountains, while the other supposition is very conformable to experience.

Thus we find, at the present day, that the deposits of our great rivers take the direction of the mountain-chains which enclose their beds, while shore-deposits take, in our gulfs and sea-basins, a direction determined by that of the rocks and mountains by which they are bounded. Now, as the relations between the actual mountains and the deposits which are formed in their direction, are like to those between the vast primary deposits, or those of transition and the primitive mountains, we should naturally conclude, that the direction of these mountains influences the direction of these deposits during their formation.

The inclination of the strata depends on an analogous although somewhat more limited cause. To be convinced of it, we have only to observe what happens in our rivers, in our lakes, on the shores, or even at the bottom of our seas. The strata of sand-clay, and marl, which our rivers continually deposit, are always inclined from the banks or shores towards the middle of their beds, so that their greatest thickness and highest point is near the land, while their strata become attenuated as they descend, and disappear towards the middle; the inclination being more or less rapid, according to the steepness of the banks. The deposits, which are formed in our lakes, have also their greatest thickness and highest point towards the shores; and the beds, in descending, diminish their inclination and thickness towards the centre. In our large bays, the beds of sand, of pebbles, of shells, &c., have also their summit and greatest thickness towards the shore, and rest on the inclined feet of the mountains which form their sides. These beds follow this inclination, while they diminish, in thickness, for more than three miles towards the open sea. But the rapidity and extent of the inclination of the deposits depend on the height and inclination, more or less abrupt and rapid, of the shores. If these are immense walls, rectangular with the bottom of the sea, there is scarcely any inclination in the beds, or, at least, it is only perceptible at a great distance. On the contrary, if the shores of the sea consist of a series of small hills with an easy and almost insensible declivity, and lie much exposed to the winds, the deposits are found more rapidly inclined. The exposition of bays, and the direction of the winds which most generally prevail there, exercise a great influence on this phenomenon of inclination.

In the open sea-basin, the currents, determined in their direction by that of the basin itself, and consequently by that of the mountains which enclose it and which furrow its depths, act precisely as rivers and leave their deposits on each side of the banks between which they flow. These strata are more or less inclined from the summit of the bank towards the middle of the current. What occurs, now-a-days, occurred formerly: and the conical and generally bosom-elevation of the primitive mountains, shew us the cause of the great inclination of the transition-strata, as also of the secondary rocks. Thus, the extent, the direction, and inclination, of the primary strata; their analogy with what happens at present in our rivers, our lakes, our bays, and sea-basins,—prove that the great primitive mountains existed from the beginning.

2° The transition-rocks necessarily suppose pre-existing mountains. There can be no great basins, nor currents without mountains; for the basins and currents are determined by the mountain-chains. Now the primary epoch exhibits to us large marine and fresh water deposits, produced by the great sea and land-currents: there existed, then, at that time, basins of the sea, dry land, rivers, and, consequently, mountains. Without mountains there would have been an immense plain, everywhere uniform, in which there would be no deposits. If, in the absence of materials furnished to the streams by the mountains, we were to suppose that the waters would have furrowed their bottom, which is not easily conceivable, very thin-deposits, solely of sea origin, would have been distributed on the whole surface of the land: whereas, on the contrary, the transition-deposits are the greatest of all; and, despite their immense extent, they still form local masses no less than those of the other epochs. We can imagine that Beaumont may have believed that the mountains of the first and second revolution, gave occasion to the deposits elevated by the mountains of the third revolution, and of the other subsequent deposits and elevations; but we cannot conceive the formation of the deposits of the first and second revolution, if there had been no mountains.

There are many other objections to this hypothesis regarding the geological epochs by a system of mountain-elevations: but it is enough to have shewn that these elevations are in contradiction with the cause which is assigned for them, and with the effects attributed to them; that this vast elevating force is inconceivable, without analogy in nature, and is moreover a perfectly gratuitous supposition; that the fundamental principle of the theory, that all parallel dislocations are of the same age, is contradicted by facts, and has been abandoned by the author himself, who cannot, however, assign any other; that his determinations are arbitrary; that his divisions into periods rest on false supposition, namely, that each formation must have been deposited at the same time on all the surface of the Earth which was covered by water; that there was a rigorous succession in the production of the different formations, and that animals and plants could have lived upon the Earth, and the vast primary and transition-deposits have been formed on it, without pre-existing mountains.

XV. Hypothesis of Central Heat, and of the original incandescence of the Earth.—The conviction that the primitive rocks, the granite, were not formed by the agency of water; that there is found an increase of temperature in proportion as we descend into the interior of the earth; that fire acts a great part in the volcanoes, earthquakes and dislocations of the surface; that the spheroidal form of the Earth and the other planets, is in relation with their velocity, as if these Globes had been originally in the fluid state; the belief, moreover, that the granite passes, by almost imperceptible shades, into the porphyry and volcanic rocks;—all these considerations have led geologists, in the absence of any general assignable cause which might explain these phenomena, to accept with favor, at least provisionally and as a probable solution of the foregoing phenomena, the theory of a central fire, which others, without any scientific object in view, had imagined. We shall examine this hypothesis, first, in itself, and then in the relations it may have to the results attributed to it.

I.—Some writers have supposed that matter was created in the liquid and gaseous states. In this hypothesis any combination of bodies would have been impossible; and the gaseous molecules imagined by these writers are nothing more, as we shall elsewhere prove, than the atoms of Epicurus. Others have imagined, that the Earth and the other planets, were, all and at once, projected from the sun. This is the system of Buffon, which, however, is irreconcilable with all the actual motions of the planets. Moreover, Buffon took the Earth from the sun, in order to account for its original supposed igneous fusion; whereas all facts and astronomical observations, lead us to regard the sun as differing in substance from the planets and the Earth, which, consequently, cannot have originated in it.

Other writers, again, modifying the system of Buffon, suppose that the Earth and the other bodies of the solar-system, were created in the gaseous state, or,—which is the same thing,—that these bodies had formerly been parts of the atmosphere of the sun. This atmosphere, they say, was originally much more diffused, and has been, successively, reduced to its present limits. The planets were formed at these successive periods, by the condensation of the zones which the solar atmosphere, in cooling, had abandoned. This is the theory of Laplace, which is received with some modifications by many other writers. I shall give its latest exposition. "The Earth, separated from the atmosphere of the sun, first became liquid, and then solid, in its crust, which envelops its liquid nucleus; which crust consists of the primitive rocks. These rocks were produced in four principal ways:

1° By *coagulation.*—One of the first effects of the diminution of heat must have been the formation of a solid crust round the liquid mass, whence resulted a first mode of the formation of rocks, which proceeded from the surface inwards, and which will continue until the whole mass becomes solid. The granite rocks are supposed to have been produced by coagulation.

2° *Atmospheric precipitation.*—At the same time that the Earth's surface began to coagulate, it was enveloped by an atmosphere, which, independently of the elastic fluids of our present atmosphere, must have contained the water we now find on the surface of the Earth, besides a number of other materials in a sublimated state. These materials were precipitated on the surface, while the granite-rocks were forming; they augmented the solid crust, by the addition of new materials, which were added to it in an opposite direction from that in which the granite-rocks were formed, that is from below upwards. These are the talc-rocks.

3° *Aqueous precipitation.*—As soon as the cooling of the surface of the Globe permitted the waters to remain on it, chemical precipitations and crystallizations began. These phenomena were produced with great energy, by reason of the high temperature of the aqueous liquid, in contact with so many gaseous substances. The slate-rock was the result of this process.

4° *Ejaculation.*—Ejaculation or the repulsion, in an outward direction, of a portion of the liquid interior of the Earth, must have followed the construction of its crust, and given place to volcanic phenomena and the formation of mountains.

"The resemblance of gneiss and granite is a result of the first coagulation and of the first precipitation, the effects of which must have been almost similar. In the same way are explained the combination and connexion of these systems of rocks, by the fractures which caused masses of gneiss, of mica-schist and other talc-rocks, while yet soft, to float into the paste which in cooling became granite. The diversity and the mixture of talc-rocks; their resemblance with the granite and porphyry-rocks; the almost universal presence of magnesia in these rocks,—are consequences of their production by precipitation, under extremely high temperatures, which were characterized by frequent sublimations, arising from incandescent materials."

This mode of explaining the origin of the granite and primitive rocks was, a few years ago, that part of the astronomico-chemical theory which was most in favor: but geological observation has refuted this specious system. Fossils are found not only in the slate-rock, but also in the talc-rocks; and it would be absurd to admit, that living beings were contemporary with these rocks, if these were formed in the manner described. It is evident that no organized beings could live in such temperatures. The fossils of the talc-rocks are generally marine; whereas, according to the theory, the waters began to appear on the surface of the Earth *after* the formation of the talc-rocks. Moreover we find at all epochs of the secondary rocks, talc, mica-schist, fossiliferous talc-schist,—in a word, the crystalline-schists are of all epochs. They have not, then, been produced by atmospheric precipitations. Granite is also found superimposed on, or cropping out over, sedimentary strata, and, consequently, was not formed by coagulation. The slate-rocks contain marine, land, and fresh water fossils. They were not, then, produced by chemical precipitations and crystallizations.

The parallel combination of the talc-rocks, attributed in this theory to fire, and of the talc-rocks—which their fossils shew were deposited in water,—would appear to imply the strictly simultaneous action of these two causes in the production of the talc-formation. We should be obliged to suppose, on the one hand, that the Earth was in fiery fusion, which caused the water to assume the vapor-state; and, on the other hand, that it was liquified by the waters which formed the fossiliferous deposits. These are contradictory suppositions. These two causes may, indeed, act at the same time, and even conjointly, but always on a small scale; which permits us to explain the facts in which their action results; whereas, according to the theory we are examining, the igneous cause would have acted, from the beginning, in all the mass of the Earth, and with an intensity that would have rendered the existence of permanent water on its surface, an impossibility. The presence of fossils in many parts of the primary talc-rocks, and the presence, in the higher rocks, of a great number of strata, half sedimentary and half talc, obliges us to consider all the primary talc-rocks as sedimentary deposits formed in the water, and subsequently modified by the local, and frequently repeated action of volcanoes, which had their seat either on, or in, the granitic rocks. In examining this theory still more closely, how many contradictory suppositions does it not involve! We must suppose that matter was created in the gaseous state, without knowing wherefore. The liquefaction and vaporization of bodies by caloric are only exceptional cases; a contest between the repulsive power of caloric and the pressure of the air: and it is in the natural order of things that the equilibrium should be restored by pression. In order to have an antecedent state of the vaporization of the elements of the Earth, we must suppose, contrary to the observed facts, the absence of any exterior cause of resistance, of pression, of gravitation. Then present themselves the suppositions which exhibit to us matter dividing itself, at different times, in different centres of gravitation, and preserving a uniform motion, which forces it to be decomposed into an infinity of substances of different proportions, in order once more to be recomposed, we cannot say how or why. Nor is this all; we must create a new arrangement of materials, a temperature to suit, causes of cooling, a co-ordination of elements in the order of their density, &c. All this we are asked to admit without any proof, and against the evidence of facts which observation furnishes.

Abstracting, however, from these difficulties, let us admit, for a moment, the hypothesis of a primitive gaseous and fluid state. It is heat that retains bodies in the gaseous state;

and, according to the theory, condensation could not take place without a successive loss of heat, sufficient to permit bodies to become liquid, and then solid. Here two suppositions are made, one of which excludes the other. One, that the solidification began by the surface, and that the centre is still in a state of fusion: the other, that the condensation began at the centre, and, consequently, that the cooling process was propagated to the surface. Every one knows, that any mass whatever begins to cool at its surface, and that, when the surface appears to have no heat, the centre continues to possess it. This is an effect of the law of the radiation of heat, and of the equilibrium of temperature. According to this law, two or more bodies, in relation with each other, communicate heat reciprocally until they come to the state of equilibrium, that is, until they have an equal temperature; and even then the radiation continues. Thus, the bodies mutually cool and heat each other. In order that there be a loss of heat in one of them, the other must be at a lower temperature. It follows from this, that the primitive gaseous mass, being at the highest possible temperature necessary to maintain its materials in the gaseous state, must have been placed in a medium to deprive it of all its caloric, and thus permit its solidification. Hence this solidification could not begin at the centre, which retained its heat, while the surface was losing it. The cooling then must necessarily have begun at the surface.

"It may, however, be said that the cooling began at the surface, but that in proportion as the matter of the surface became solid, it was precipitated to the centre, and that thus all the gaseous matter came successively to be cooled and solidified at the surface. To this, there is but one objection, that, as soon as the solid materials came to the centre, or rather before they arrived at that point, they would necessarily be liquified and rendered gaseous once more; and hence all solidification at the centre is impossible.

"But in continuing the hypothesis, may we not say, that, doubtless, in the first times the solid matter at the centre was restored to the gaseous state, but that, according as the gaseous strata lost their heat at the surface, the general temperature was lowered, and that this diminution of temperature caused the liquid to succeed to the gaseous state; that this liquid matter by ebullition gradually parted with its heat at the surface; and that the general temperature being thus diminished, the materials least capable of fusion assumed the state of solids; and that, by precipitation thus gradually caused and continued, the Earth eventually attained its present form? Yes: but in this hypothesis we must suppose millions of ages to have passed—a supposition which may well appal the most daring theorists,—without being thereby sure of the value of our hypothesis. The supposition, then, that the condensation and solidification began from the centre, is inadmissible."

Is the hypothesis that the cooling commenced with the surface and that the centre of the Earth is yet in fusion, more tenable? Poisson will tell us.—"If the observed increase of temperature as we dig into the Earth really came from a central original heat, it would follow, that in the present epoch this original heat would augment the temperature of the surface of the Earth, with the small portion of a degree: but in order that this small augmentation could be diminished by one half, many millions of ages must pass. If we wish to ascend to an epoch when it was sufficient to exercise an influence on geological phenomena, we would have to accumulate ages in a manner to deter the most daring imagination, no matter what idea may be entertained of the antiquity of our planet."(1)

"The learned geometrician does not stop here: he demonstrates the absolute impossibility of the formation of a solid envelope round a Globe in a gaseous or fused state. In this hypothesis, the interior temperature, according to his calculations, would be excessive at less than 60,000 metres (2) of depth, and, at the centre, where this temperature would exceed 200,000 degrees, as in the greater part of the mass of the Earth, the materials of which the Earth is composed would exist in the incandescent gaseous state, and yet, in such a

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(1) *Mémoire sur la température de la partie solide du Globe.*
(2) The metre is equal to three feet and almost one inch.

degree of condensation that their density would be five times that of water! An inconceivable force would be required to hold in materials thus heated and condensed. The solid envelope of the Globe would not be sufficiently strong to resist the tendency of the interior fluids to escape in the form of vapor. These fluids, by their force of dilatation, would burst the envelope of the Globe in proportion as it became solid. The learned Ampère had already been struck by these same consequences. The hypothesis, then, of the external solidification of the Earth is not more tenable than that of its interior cooling. (1)

The supposition of an incandescent planetary nucleus is, moreover, in direct contradiction with an augmentation of density, in proportion as we advance towards the centre of the Earth. Now, astronomical observations, the ratio of the flattening of the poles, the increase of weight, ascertained by the experiments of the pendulum,—all concur in establishing the increasing density of the Earth's nucleus, "The precession of the equinoxes," says Laplace, "and the change of the Earth's axis, indicate a diminution of density in the strata of the spheroid, from the centre to the surface.—If the Earth were originally in a fluid state, the principles of hydrostatics require that the parts nearest the centre should be the most dense."(2)

II.—I pass over, for the moment, a multitude of other considerations, which are conclusive against the hypothesis of a central heat. Let us examine if this theory explains the phenomena.

1° *The central incandescence does not explain the terrestrial temperature.*—When we pass the constant stratum where all the thermometrical variations of the Earth's surface disappear, after a gradual lowering of the temperature, we everywhere find temperatures which increase with the depth: but the results of observation are different for different localities. In France, to obtain an increase of 1° in the Earth's

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(1) *Dieu, l'Homme et le Monde,* T. I. p. 313.
(2) Système du Monde.

temperature, we must descend 15 metres at Décise, 19 at Hittry, 28 in the excavations of the Observatory at Paris, 35 at Carmeaux, and 40 in Bretagne. In Switzerland 21 near Bex. In Saxony 40, for the average of the different mines. In England 25, in Cornwall and Devonshire. There is, then, a difference, sometimes of more than a half, according to the localities, and this even in the same region. We can easily understand that the different substances composing the different soils give different results of the development of chemical heat. But, if this augmentation of temperature were the result of central heat, it ought to be uniform for all places at the same depths ; or we must suppose that the crust of the Earth is thicker in France, at Bretagne than at Carmeaux, at Carmeaux than at Paris, at Paris than at Hittry, at Hittry than at Décise!

2° *The figure of the Earth does not suppose an igneous fusion, but implies the contrary.*—The figure of the Earth is known, at least approximately. It is admitted to be a spheroid of revolution. Now if this form were not a primitive fact, it might have resulted from liquidity, or from an original softness of the Earth's surface. This figure, then, does not prove an igneous fusion of the surface, and, consequently, could not in any manner support the hypothesis of central heat. Moreover, had the Earth been originally in the gaseous state, or in that of igneous fusion, or of aqueous liquidity, it must have assumed the figure of a perfect spheroid of revolution, without any inequality, without mountains, without vallies, and hence, would have wanted the ordinary conditions of animal existence, such as currents and variety of climates.

3° *The granite-rocks are not in connexion with volcanic products ; they do not, then, prove the igneous origin of the planetary mass.*—The ancient volcanic products are intimately connected with each other and with the lowest rocks, on which were placed the foci, and which furnished the materials that were cast forth. On the contrary, the more we approach modern times, igneous products appear the more isolated, foreign to the soil on which they are distributed, and more varied in their character. These differences, more and more numerous, among the igneous products of all the subsequent epochs, after the primary epoch, are explained by the more numerous variety of rocks which the volcano liquifies and projects, or in which it has its focus. This general fact is not favorable to the opinion of a single centre of igneous liquefaction, but agrees very well with that which places the seat of volcanoes at all depths, from the granitic rocks upwards.

Thus, when the Earth's mass was more uniform in its materials, the volcanic rocks were more like to each other and to the primitive rocks; and in proportion as the aqueous rocks augmented the number and variety of the strata, the volcanic products became more dissimilar and diversified; because the igneous element had more materials to combine. Now from the moment that the volcanoes borrow their materials from the inner surface, there can be no inference, in support of a theory of the Earth, from the resemblance of their products with granite and crystalline schist. The volcanoes vomit basaltic rocks filled with hornblende, mica, feldspath, &c., which are not aqueous products. This only proves that the volcanoes have their seat in such rocks, and from them derive the materials of their lava. The crystalline schist or metamorphic-rocks are formations of aqueous origin, modified and affected by the volcanoes in the neighborhood of granitic rocks: hence their resemblance with igneous products. Mitcherlick of Berlin, having found the silicate and bisilicate of the protoxyde of iron, of mica, &c., in lumps in the scoriæ from the great furnaces of Fahben and Carpenberg, thought that he might infer that the analogous crystalline rocks are due to the action of fire; whereas his observation only proves, that the mineral elaborated in the furnaces of Fahben and Carpenberg, contains substances which are reduced to the same state as the volcanic rocks by the action of fire. To suppose that the granitic rocks have been formed as the volcanic rocks, or as the substances observed by Mitcherlick, is to suppose that they were formed from pre-existing rocks decomposed by heat. This is not to solve, but to shirk the question. There are, however, observations on the granite opposed to those of

Mitcherlick. The silica and aluminium which compose the granite, being liquified by heat, give a homogeneous liquid, a vitrification, and not granite.

Thus it is not so much by the similarity of composition in these rocks as by the comparative study of their decomposition, that it is sought to connect them with each other, and to descend by imperceptible gradations, from the most recent lava to the granite. Volcanic products are decomposed by the action of exterior agents: the cinders, cemented by water and the swollen lavas, become compact: the compact lava longer resists the disintegrating action, which at last prevails: thus it disunites the crystals in the granitic lava; in other lavas, it decomposes one of their elements, and reduces them to a kind of clay. It is by means of this series of decompositions, that the attempt is made to reach the granitic rocks, from which time and atmospheric and meteorologic influences have taken the characters of their igneous origin.

But the granite has not such intimate relations with the volcanic products as would enable us to ascribe to them a common origin. There is an hiatus,—the thread of analogy is broken. Granite, exposed to the air, disintegrates, it is true, and changes into kaolin, or porcelain-clay, and clay, but has no resemblance with igneous results. Beneath the very thin part which is decomposed, the granite is very compact; its elements lie extremely close to each other, and without any trace of porosity. It is not pression which has given it this compactness, since in most instances it is not covered by any other rock. Neither have meteorological influences effaced the traces of its igneous origin; since the interior of the mass is protected against these influences by its surface. We cannot attribute the structure of granite rocks to an aqueous origin, as in the case of basalt; because, in the first place, they should, in this case, resemble basalt, and because, in the second place, it is absolutely impossible to admit the existence of water on the Earth during the igneous formation of granite. The pieces of granite and quartz which have been subjected to the heat of a lime-kiln, have their exterior surface vitrified, and their interior more or less swollen. Were granite the result of igneous fusion it would, consequently, exhibit the characters of a homogeneous vitreous mass.

We cannot say so much for the porphyry-rocks. The researches of investigators clearly shew, that all porphyric rocks have a volcanic origin. In the most ancient porphyry-ejections, we discover a series which uninterruptedly connects with that of the volcanoes now in action. The porphyry-rocks differ essentially from the granite. In the granite the elementary minerals are in small mixed crystalline fragments. The porphyry-rocks, on the contrary, have a non-crystallized substance for base, in which are disseminated pieces, more or less numerous, of crystallized-rocks. To the class of porphyry-rocks belong all the substances thrown out in volcanic eruptions, even the most recent, for the ejections of volcanoes yet burning present these same characters in different degrees of development. The granite rocks form long uninterrupted chains of mountains; while the porphyric eruptions only give birth to isolated peaks, of conical form, rarely united together or which, if they are joined, give rise only to very short chains. These peaks are distributed without order, and as it were in zones,—a circumstance which gives them a resemblance with modern volcanoes, which are more easily studied than the ancient ones, and which have been uniformly found distributed in the same way. The porphyry zones or chains have an entirely different direction from the granite mountains, and are frequently found passing through these latter. When this occurs, the mountains attain a considerable height. The primitive granite, differing somewhat from some more recent granite, which has been ejected from the former, constitutes the base of that envelope with which the mass of the Earth is supposed to be covered. On this base have been formed, and on it rest, all the sedimentary and volcanic rocks. By its texture, composition, universality, and regular directions, the granite contrasts with the porphyry and all other rocks: it constitutes the point from which we may follow the action of the igneous and aqueous causes down to our days. Beyond this limit, the Creative and Regulating Power alone can satisfy the reason.

4° *The hypothesis of central heat does not explain the volcanoes.*—In 1819 appeared a remarkable article on *Volcanoes* in the *Dictionnaire d'Histoire naturelle* of Déterville, a joint production of the most distinguished scholars of that time. This article reviewed the most important observations on volcanoes; all systems were subjected to investigation, and there is not a word uttered as to the hypothesis of a central fire, considered as a cause of volcanoes. Since that time, this hypothesis has been enthusiastically adopted by the scientific world; why, indeed, cannot be said, for it explains nothing; and cannot bear comparison with the chemical theory of volcanoes, although this latter is as yet far from being complete.

According to Cordier, the lavas have a peculiar character; they belong to rocks different from those known to us: the elements of the lavas are always the same in every stage, and are recognizable in the new products to which they give rise. Must we, then, conclude that the lava comes from the centre of the Earth? This is an untenable hypothesis. It is, on the contrary, natural to suppose that the lava is formed of anterior rocks, which undergo new combinations under the influence of heat, an opinion which all the facts concur in establishing. Let us merely examine the volcanic results of sublimation, and at first the elastic æriform substances—sulphuric acid gas, muriatic carbonic, nitrogen, sulphurated hydrogen, &c., many of which are derived from water or organic substances; secondly, the inflammable substances—sulphur, the bituminous oils; thirdly, the saline substances—the muriatic ammoniac either pure, or earthy or copperish, muriatic soda, sulphate of soda, sulphate of iron, sulphate of copper, muriate of copper, &c. All these substances suppose a decomposition of water, organic substances and marine salts. They do not, then, proceed from the centre of the Earth. Moreover, if these substances came from the centre, they would be, necessarily, in the fluid or gaseous state; and hence, under the tidal action, and the law of dilatability, they would break the solid envelope of the Earth, as they make passages through the strata which cover the volcanic foci. The Earth's envelope once pierced, the gaseous and fluid substances would escape, and a general falling in of the so-called crust of the Earth would be the result.

The waters of our seas are a necessary condition of the activity of volcanoes. Of the 215 known volcanoes, 117 are in islands, and 98 are on continents, but, in general, at short distances from the sea. There are besides submarine volcanoes, and it is thought that these latter are more numerous than the former; because the sea occupies so much more of the Earth's surface than the dry land. The extinct volcanoes, much more numerous than those in activity, are also situated in isles, or on continents at short distances from the sea. They appear to have ceased to burn, in proportion as the sea departed from their foci, and seem to have been submarine before they were terrestrial. The volcanic substances contained in the geological strata, are the products of submarine craters, as is shewn by their position and the constant absence of cinders and scoriæ, products which characterize volcanic phenomena in the open air. In fine, the salts, the eruptions of water accompanied by fishes, the lightnings produced by the jets of hydrogen gas, the clouds, the copious rains,—all these incontestable facts prove that water has a great part in the volcanic phenomena, and that this water does not come from the centre of the Earth. If, however, it be said, that it proceeds from the centre, it must be admitted, that at the centre there are masses of gas, of hydrogen, of water in vapor, &c., and, consequently, we return to the necessary consequence of beholding the Earth's envelope shivered in pieces by the expansive force of these gases, which must have their daily flux and reflux, like the waters of the Earth, or the layers of the atmosphere. If, on the other hand, these gases are formed in local centres, these difficulties disappear, and we are able to understand how their action melts, breaks and ignites the rocks; and hence the lava, the sand, the scoriæ,—the casting forth of which ceases when the chemical action has exhausted itself; whereas, were an opening once made for the escape of the central fluids of the Earth, we cannot understand the intermittence and cessation of eruptions, because the pression on these central fluids would be so great that they would continually tend to expand, and enlarge the orifice.

We are not, however, at the end of the difficulties which this hypothesis involves. "From the manner in which the lava flows down, it cannot be questioned," says the *Dictionnaire de l'Histoire naturelle*, "that they carry with them a substance capable of keeping up their heat and their fluidity, and that they contain combustible materials which ignite by contact with the air until they are entirely consumed, for the incandescence, heat and fluidity cease almost at the same time." (1)—The lava, in fact, resists all the surrounding causes which might cool it, and preserves for many years a heat which would soon be dissipated, were it not sustained by same inherent principle. Some of the lava of Vesuvius flows for many years a distance of a few fathoms, and in a very thin layer. A lava from Etna in 1614 moved in the direction of Randazzo: during the ten years that the eruption continued, it always had a small progressive motion, and yet it never advanced beyond two miles. Ancient currents of lava have been known to revive as it were, and give forth smoke and flame. Dolomieu mentions a lava of Ischia, which, in 1301, issued from the crater of Cremate, at the foot of mount Eupomeus, which gave out heat, and aqueous and sulphuric acid vapor, when he visited it in 1785. (2) It is not easy to imagine what relation this phenomenon could have to the central fire.

It is at the present day universally admitted, that the volcanic mountains have not been uplifted: they are the result of the successive flowings of lava and other substances from the craters. In proportion as the mountain-cones of the volcanoes rise, the eruptions become less frequent, and it even happens that no more real lava is ejected, as is the case at present with the volcanoes of *Quito*, which are five times higher than Vesuvius. "Were the focus of these volcanoes," observes Humboldt, "at great depths, the melted lava could not be raised by the development of gas to the top of the crater, nor

(1) Déterville. Art. *Volcan.*
(2) Voyage aux îles Ponces.

break the sides of these mountains, which are strengthened by the plateaus that surround them to the height of 8400 feet." —Did these substances come from the centre of the Earth, what would be 8400 feet of elevation for a force which would have had to penetrate 45 miles of the Earth's supposed envelope before coming to the surface. Humboldt, after Buffon, Pallas, Lamétherie, Boué, C. Prévost, rejects the central heat theory, as might have been expected : but it is curious to find those who admit it, and who attribute all volcanic phenomena to it, adopt, as favorable to their system, the explanation given by the celebrated traveler.

The volcanoes of Quito only eject cinders, flames, boiling water, a few isolated stones, and an immense quantity of fish. But there are others, such as the salt-springs, the crater of which is perfectly superficial and which only throw up fragments of limestone, of greywacké, of pyrites, pieces of manganese oxide of iron, all imbedded in the gray-clay which constitutes the mass of their ejections. The globes and jets of gas which escape from their muddy and brinish water, change place and direction, when an obstacle is placed to their issue. When all the holes of a salt-spring are stopped up, others open in the neighborhood. These salt-springs are only found in volcanic regions : they produce smoke, and the ejected substances are analogous to those of other volcanoes. Here, it is not the height of the cones that opposes the rise of the supposed central liquid. All these various phenomena, which are readily explained in the theory of volcanoes, by the variety of electrical and chemical influences, are inexplicable in the theory of central heat. We ask the partisans of this theory to explain how the prodigious force of central fluids can, as in the case of the salt-springs, cause no more than small lubricated craters, boiling and foaming as they are ; and how so weak a cause could produce the other volcanoes.

This immense disproportion between the supposed cause and the effects we witness, is observable in all the volcanoes of each epoch. The power which produces these phenomena is not developed at one single point, and each volcano has not issued from one only crater. There are formed, successively, or, at the same time, many issues, whence the lava-streams flow out, and from which come forth all the substances that the development of gas throws out. It is impossible to conceive why a force, capable of working its way from the centre of the Earth's mass,—through the hardest rocks and all the strata which rest on them,—could not make for itself one sole mouth sufficiently large for the issue of its products;—why it should not destroy the thin walls which separate the tubes of the various mouths in Vesuvius, and a hundred other volcanoes. So great a power, and such great weakness in the same agent, acting at the same time and place, is inconceivable. On the other hand, if we suppose that the focus is superficial, and that it is modified by superficial causes, we easily understand how these causes, in the same as well as in different places, may disrupt, either at once or successively, in various points, the surface which covers the focus.

If the chemical theory of volcanoes is not as yet adequate to the explanation of all the phenomena, there is between it and the central heat theory, this enormous difference, that this latter explains nothing, and is grounded on no ascertained fact. If the phenomena which are certainly produced between the surface of our Globe and the 15,009th part of its radius, since the water, the marine salt and the decomposition of organic substances, are its principal grounds,—yet present to us some obscure points, what rashness is it not to pretend to know, how the interior parts of the Earth are organized, which are ten or fifteen leagues below the surface? The chemical theory rests on a multitude of facts, which have been carefully examined. The causes which it assigns for volcanic phenomena are natural, intelligible, and correspond in every respect with these phenomena, which are always local, varied in their circumstances, and intermittent as these causes. The central heat, on the contrary, is a cause which contradicts all known laws, and which should necessarily be general, illimited, invariable and continual. Our theory is, doubtless, incomplete; there may be other elements in action; but certainly it is not a central fire. This latter cannot be maintained, unless we suppose that the primitive mountains, the terrestrial temperature, the volcanoes, &c., are its results; that is to say, it can only be established by supposing the entire question. Hence, as it does not explain the primitive mountains, the Earth's temperature, the volcanic phenomena, &c., it has not the shadow of a motive for its adoption.

We hope we have sufficiently demonstrated, that the Earth could not, originally, have been in the gaseous state; because in this case, no formation, no solidification, would have been possible; because the primary rocks, and the crystalline schists cannot be considered as results either of coagulation, or of atmospheric precipitation; and, moreover, if the granite was an igneous production, it would be, as so many facts establish, a homogeneous vitreous mass. On the other hand, we have seen that the increasing heat of the Earth's interior is more easily explained by electric influences than by the supposition of a central heat. With Ampère and Poisson, we are forced to acknowledge, that if the centre of the Earth is in a state of fusion, this fluid,—subject to tides, as are our seas and atmosphere, subject, moreover, to an expansive power tenfold that of gas,—would shiver to pieces the Earth's crust, and would be an insuperable obstacle to any degree of solidification. Hence the most cautious writers no longer admit the hypothesis of the igneous fluidity of the centre; they adopt a very modified opinion on the subject,—that a great heat may be felt at the centre, and yet that centre be a solid body; that it may be enveloped with a layer, intermediate between the central nucleus and superficial strata, and which, under the influence of heat, may have the consistence of paste!—But whence this state of things originated, they do not say. The volcanoes cannot be considered as a result of the igneous fluidity of the Earth's central parts; their products cannot be connected with the granitic rocks; the facts to prove such a connection are not at hand. The structure of the volcanic products proves, on the one hand, that they are derived from pre-existing rocks, and, on the other, that they have been modified by volcanic action. The gaseous and aqueous products shew a chemical action, which cannot be admitted to be at the Earth's centre, without meeting all the objections which lie against its igneous fluidity and gaseous condition.

The meteoric phenomena which always accompany eruptions prove an atmospheric reaction on the volcanic foci. We must, then, conclude that the volcanic phenomena give no support to the hypothesis of a central fire, and of the igneous origin of our planet.

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CHAPTER VII.

BUCKLAND AND CHALMERS.—*Hypothesis of successive creations.—Age of the World.*

XVI. BUCKLAND, (1) CHALMERS. (2)—These writers did not propose a theory, but a mode of reconciling the Mosaic narrative with geological phenomena. Convinced that the time assigned by Moses would not have sufficed to form, after the epoch of the six days, all the strata which envelope the Earth, these two English writers sought in the text of Genesis a solution of the difficulty. Buckland rejects every other hypothesis which has been suggested to attain the same end. The deluge does not explain, either the strata or the fossils : the change of six days into as many indeterminate periods, a change to which he says—very inaccurately as we shall see—neither theology nor philosophy has any serious difficulty to oppose, does not accord with the geological fact of the mixture of plants and animals in the lowest of the strata.

According to these writers, the world, the history of which Moses has given us, was made, in great part, of the materials of an ancient world which had been destroyed. This was also the opinion of their countryman, Whiston. The first words of Genesis : 'in the beginning, God created the heavens and the earth,' are not, they say, a summary of the work of six days ; they merely establish the fact, that the heavens and the

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(1) Geology and Mineralogy in their Relations with Natural Theology.
(2) Evidence of the Christian Revelation.

earth, that is, the sun, the stars and the planets were created, without determining the time in which the creative power was exercised. They add, that, between this creation and the world, whose history begins in the second verse, we may suppose that there existed a former world, in which were accomplished a long series of various revolutions, regarding which the sacred historian has observed silence, because they were entirely foreign to the history of the human race. It is in this interval of indefinite length that we must place all the physical revolutions the evidences of which geology reveals. The heavenly bodies were not affected by the awful catastrophes which changed the ancient state of the Earth, and the Creator made use of them in order to prepare this planet to become the abode of man. Our authors were influenced by the theory of revolutions which Deluc, Buffon, and others had suggested.

We are not then to understand as indicating a real creation the texts which regard the stars, the moon and the sun. These bodies were not created on the fourth day; but at that epoch the Creator adapted them in a special manner to certain functions of great importance for man: to give light to the Globe, to rule the day and the night,—(what other function could they have ever had?) to fix the months and the seasons, the years and the days. As to the fact of their creation, it was previously intimated in the first verse, which implicitly records the creation of the whole universe;—of 'heaven,' this word applying to all the stellar systems; and of 'Earth,' our planet being thus the object of a particular designation, because it was the theatre on which the work of the six days was about to be performed.

Such is the system of these writers; it has been adopted by Gervais de la Prise,(1) Gosselin,(2) De Genoude,(3) Desdouits,(4) and other French writers.

If we ask these writers, what relation exists between their

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(1) Accord du livre de la Genèse avec la géologie et les monuments humains. Caen, 1803. (2) L'antiquité dévoilée au moyen de la Genèse, 1807. (3) Traduction du Pentateuque, 1821. (4) Soirées de Montlhéry, 1836.

imaginary world and our fossils, they reply: "the extraordinary conformation of bones, of teeth, or of the shells of fossil animals—the gigantic size of some of them,—prove that they are not the progenitors of the actual races from which they essentially differ, and that they did not belong to the Mosaic creation, to which all the actual living beings belong, (even the cat, the oppossum, the ornithorhynx, &c., which are more extraordinary than the extinct fossil species.) If the imbedding of the fossils did not occur anteriorly to the creation of man, why, they ask, do we never find his remains, or those of his works, among the innumerable quantity of animals—terrestrial, river, and marine—of the geological strata? (Man in the fossil state is found in the geological strata, associated with the most extraordinary and gigantic of the extinct species, with the *mammoth* in Europe, with the *megatherium*, and *chlamidotherium giganteum* in Brasil.) But the principal advantage of this system, is to afford hypothetic geology illimitable time, (which this species of geology cannot dispense with.) It can no longer object that the chronology of the Bible makes the Earth too young; the Earth existed many ages before man, and we can afford the geologist as much time as he may require."

If, as these writers suppose, the time which has passed away really exceeded the limits of the Mosaic chronology; were this proved, it would be necessary to seek in Genesis for a text which might reconcile revelation and science: and this search could not be fruitless; for truth cannot be opposed to truth, and the science which is taught in Genesis is as true as revelation itself. But it would be also necessary, that the fact resulting from the new interpretation of the Sacred Text, should, on the one side, agree with other revealed facts, and, on the other, with the general and certain facts of science. The interpretation suggested by Buckland and accepted by Chalmers does not combine these conditions: science is opposed to it, and revelation necessarily rejects it.

In the first place, the entirely gratuitous supposition, that the light and all the heavenly bodies existed before the work of the six days, implies most important changes in the natural signification of words, and an entire alteration in the general tenour of the text of Genesis. It is no longer the history of the creation that Moses relates: these expressions so simple and so strong: 'let there be light, and there was light,'—'let there be luminaries, &c.,' no longer signify the creation of any thing, as had been hitherto thought by all who only sought in Genesis what was to be found there, without being pre-occupied by the ephemeral systems of their time. In the new interpretation, these words merely signify the new relations which the Creator established between the different bodies of our planetary system; and even these relations are rather the effect of the laws of Nature than of His immediate will. "On the first day the temporary vapours, accumulated on the face of the waters, began to disperse and light was restored to the Earth,—'let there be light.' On the fourth day, the atmosphere was completely clear, and the sun, moon, and stars appeared in the firmament, and had new relations with the Earth thus recently modified, and with the human race." Thus Dr. Chalmers interprets the Scripture. M. de Genoude, or the author of his dissertation on the work of the six days, accepts the explanation of Chalmers, and perfects it after his own fashion. His words are: 'Moses, indeed, says that God made these luminaries, as well as the stars.—He made a greater light, and a lesser light and the stars.'—(He omits the important fact, 'and placed them in the firmament of heaven.')—"But it is to be observed that the Scripture often speaks of what appears externally, and not of what really occurs. Thus Moses could say, that the sun was made, although it was not made in reality, but only in appearance. A flambeau does not exist for those who do not behold its light; we may say that it is made for them, at the moment it casts its light on them."

The Scripture language must be interpreted in the same way as ordinary language; otherwise we could not understand it. Moses should, then, have spoken as we do, and hence he never could have used the language attributed to him. What! The reorganization of the heavenly bodies would have been nothing more than the apparition of the light of the sun and moon; and afterwards that of their disks, produced by the gradual clearing away of the vapours between heaven and earth; and Moses would have spoken of a familiar phenomenon,—this slow and successive apparition,—as he would have done of real and instantaneous creations. What! Moses would have spoken of the light and of the stars, as of things perfectly distinct, if this light were only the first rays of these stars, weakened by the thick mist of the atmosphere, and become by degrees completely visible by the total apparition of their disks. But, in the present case, our theologians ought not to see Moses merely in this narrative. Neither he nor any other man was witness of the spectacle of creation. God Himself vouchsafed to teach our first parents what He had done, and in what order He had done it. Can it be believed that God would have represented to them these transitions from darkness to light as a veritable creation?

Moses places the creation of the stars on the fourth day; but the perception of light,—a phenomenon entirely relative to animals and to man,—could not occur before the fifth day, when the first sentient beings were created. Hence the Scripture does not say that the light *shone* before this epoch, but that it *was;* nor that the sun illumined the Earth, but that it was created for this purpose. What becomes, then, of these explanations which are given of this half translucent atmosphere, that produced the light, and then the entirely transparent atmosphere which produced for the Earth the image and the sight of the sun in the heavens? For this is all that, according to the proposed interpretation, is new in the heavens at the epoch of the work of the six days.

Chalmers found but one word in the whole history of the creation, which might be employed to designate a new arrangement of pre-existing materials:—the word '*He made.*' In the seventh verse, where there is question of the firmament, and in the sixteenth, when there is question of the two great lights, Moses, indeed, uses the word 'He made;' the force of which in Hebrew is generally not so strong as that of the word '*He created*,' the original of which may often be translated by 'He fashioned,' 'He changed,' &c. But when we want to know the meaning of a word in a given circumstance, instead of taking it apart from the context in which it stands, we must take it in connexion with that context. Now in the former of these two places, the words—'He made a firmament,'—are immediately preceded by the word—'let there be a firmament;'—and in the second, the words—'He made two lights,' come immediately after the words: 'let there be lights.' Thus in the two instances where Moses uses the word 'to make,' what precedes this word, clearly shews that it is employed as the synonym of the word—'*He created.*' Hence it is of the creation of light and of the heavenly bodies that Moses intended to speak in the history of the six days. Consequently, there is not a single word in the narrative to authorize the rationalistic interpretation which is suggested.

More than this; the doctrine of the creation is grounded on the first chapter of Genesis; and to understand the texts which speak of the light and the heavenly bodies otherwise than of a real creation, is to take away the foundation on which this doctrine rests. The patrons of this interpretation think that they avoid this consequence by saying, that they understand the first words of Genesis, 'in the beginning, God created the heavens and the earth,' of a real creation. But let them reflect a little, and they will perceive the consequences of their interpretation. The word—'He created'—of the first verse, in which they place the whole force of this proof, does not always signify to produce a thing out of nothing, as all Hebrew scholars know. Why, then, do they agree in giving it this signification in the present instance? Why is it that neither Jewish nor Christian writers have ever otherwise understood it, except that this word is explained by the expression—'let there be light, and there was light,'—'let there be a firmament?' It is, then, evident that, taking from these latter expressions their proper and literal meaning, we deprive ourselves of all means of proving, from Genesis and from the Scripture, the doctrine of a Creator and Ordainer. Nowhere else in the Sacred Volume are found clearer and stronger expressions of this great truth than those under consideration.

This manner of interpretation is then in formal contradiction with the Sacred Text. On the other hand, the hypothesis of a former world, essentially different from our world, and to which belonged our earlier fossils, is incompatible with all positive geology.

When we study the nature and origin of rocks, or observe the fossils they contain, no essential difference between the past and the present is discovered. Everywhere we find analogies between both. However low we descend into the inner surface of the Earth, we there find the effects of the two great causes which produce our contemporary rocks,—fire and water. As at the present day, so in former times these elements had at their disposition sand, clay, siliceous, calcareous and carbonic substances. The first epochs of the world exhibit marine, river, æstuary,—deposits, with alternations. There were, then, seas, rivers, mountains, vallies, plains; thus the same conformation, the same divisions of the surface of the Globe. The existence of alternate deposits of fresh and salt water, implies the fact of rains, overflows of rivers, and sea-tides; hence there were the same relations then as now, of the sun and moon with the waters, the atmosphere, the light and the organic beings of those times. The general disposition of the animal and vegetable species was the same as in our days; they were distributed among the seas, rivers, the air, and dry land. It must, then, be acknowledged that the world which produced all these rocks and all these fossil-organized beings, did not essentially differ from the one we inhabit. Why, then, insist on distinguishing them? Nor can support be sought for the system under-consideration in the extraordinary form of some animals and of some plants; for all these fossil beings enter into the same plan of creation as living beings; they belong to the same classes, often to the same genera, and sometimes even to the same species. The extraordinary forms of some of these fossils are not more unusual than those of many of our present species in Europe, America, New Holland. These extinct forms are found at all levels of the series, and, consequently, do not exclusively belong to the world imagined before that of Genesis. The most extraordinary of these extinct species, as the mastedons, the dinotherium, the megatherium, &c., instead of occuping the most ancient beds, are generally found in those which lie near our surface, or they are associated with living species, and sometimes even with the remains of man. All these extinct forms belonged, then, to the world of which Genesis records the creation.

The *trilobites* of the transition-rocks are referred to by our opponents; but these are not more extraordinary than our limulus or king-crab. If this animal were found only in the fossil state, it would appear more extraordinary than the trilobites. Those ignorant of the history of animals, have dwellt on the absence of paws in the trilobites. The species of the living genus *lerneocera*, are also without them. Moreover, every thing authorizes the belief, that the trilobites were furnished with membraneous and lamellar paws, as are our living *apus*. The general appearance of the trilobites resembles much the species of our living genus *sérole*. Those of the genus *brongnartia*, *trinucleus*, and *otarion*, appear not to have had eyes; but the absence of these organs, or their unperceivable existence, is sometimes found among our living crustacea. In the *Pandaria* the species of the genus *pandarus* do not shew very distinct eyes; and other crustacea, as the *monocles*, have but one eye, a thing no less extraordinary. Reference is also made to the pterodactyls, the ichthyosauri, the plesiosauri, &c., of the secondary rocks; but the forms of these animals are less unusual than those of our cats. Besides, they were inacurately judged of at first; as may be seen in those pictures of the ancient world which were to be seen, a few years ago, on the Quays and Boulevards of Paris, along with the *Juif-Errant*, in which ingenious geologists represented the plesiosauri, clothed in their sensorial envelope—they were probably herbivorous,—seeking to catch the flying ptérodactyls, which, still more probably, never flew.

In his *Reliquiæ Diluvianæ*, Buckland regarded the strata known by the name *diluvium*, as an unquestionable result of the Mosaic deluge. The consequence of this system was, that our three great divisions of rocks were formed before the deluge, in the interval of at most 2260 years, adopting the chronology of the Septuagint. This time appeared too short, and the author of the *Reliquiæ* was in some manner obliged to discover a system which might reconcile his *diluvium* with our chronology. Hence the untenable hypothesis which he adopted and made popular. As for us, who reject the *diluvium*, and firmly believe in the deluge narrated by Moses, we shall not encumber ourselves with systems. We will not compromise with hypothetic geology. We will shew that this fabulous antiquity, which so many geologists have assigned to the Earth, is of the same class as the *diluvium* and the successive creation of groups ; and that it is daily becoming more difficult to establish the insufficiency of the Scriptural chronology.

XVII. Hypothesis of successive creations.—Deluc, Buffon, Cuvier, Brongniart, Beaumont, Ampère, Chalmers, Buckland, with all the French speculative geologists, and most paleontologists, admit successive creations, which they make the foundation of their systems.

Does geology, indeed, prove that the different classes of the animal and vegetable world, or that a part of the species which compose them, have been successively produced, and that there were new creations at different epochs ?

Many hypotheses, accepted at first as undeniable facts by geologists and paleontologists, appeared to establish the opinion of successive creations. 1° Certain strata, which had not then presented any land fossils, were thought to have been deposited after some general revolution, which destroyed life on the former continents. This implied successive creations. 2° The classes of the two kingdoms—animal and vegetable—were supposed to be ranged in the earth's so called crust as they are in our treatises of zoology, that is to say, following each other in a connected series. 3° It was thought to have been proved, that the species of these classes became more and more perfect in proportion as we ascended the series of rocks. 4° And last, that all these fossils were of different species in the different beds. Each of these suppositions appeared to imply new creations, and their union formed a demonstration of the hypothesis, to which it was not easy to reply. Speculative geologists, so much divided on other matters, agreed in this point, and appearances were certainly in their favor. Blainville and Charles Prévost, who, almost alone, maintained the fact of one single creation, found themselves often disavowed by their own disciples. Such was, at one time, the general opinion; but what is now the prevailing impression?

1° Every one, at present, admits that land organisms are to be found in almost all formations of any importance. Hence the hypothesis of general revolutions, which destroyed the preceding creations, and marked a limit between them and the new ones, is entirely gratuitous. Had there been formations without any land fossils, these formations never could be general; they would only prove local revolutions, and not always these. If they were marine, as the chalk, they would absolutely prove nothing; were they fluvio-marine, they might have been produced by rivers flowing through lands which had lately emerged and were as yet not peopled. They would not, then, establish, with certainty, a local destruction and revolution.

2° It is also universally admitted that the classes do not follow the zoological order in the deposits of the Globe. We have already proved this, in regard to the plants. The animals, which should not appear till after them, are found sometimes before them; for instance in the silurian beds of Wenlock, of Dudley and of Ludlow; but there, as everywhere else in the transition-rocks, the various classes of the polypus, the echinides, the crinoides, the mollusks, the annulosa, the crustacea, and fishes, do not appear successively but all at once, and before the spongiæ, which, according to the theory, should appear first. The insects, lower than the fishes in the zoological order, have hitherto been found only after them, in the anthracite and the coal. The fresh water limestone-reptiles of Burdie-House appear before the amphibious animals of the coal-beds. The ichthyosauri, an intermediate class between the amphibious animals and the reptiles, are found only after the reptiles in the muschelkalk. The ptérodactyli, intermediate between the amphibious animals and the birds, are found long after the amphibious animals in the middle oolite. If the distribution of these classes corresponded with the zoological order, we should, first, have the amphibious animals, then the ichthyosaurians, then the reptiles, then the ptérodactylians. Mammalia have been found in the middle Jura-rocks at Stonesfield, and consequently long time before the birds, which are first met with in the wealden strata, for the impressions on the red sand-stone are not the footprints of birds, as was at first believed. Opinions, however, are divided on the two celebrated jaw-bones of Stonesfield. Instead of recognizing in them didelphys with Cuvier, Agassiz, Valenciennes, Owen and Dumerie,—Blainville, after having indeed seen only sketches of these fossils, thought that they should be assigned to a genus of the lower order of saurians. Admitting that the first known mammalia are of our first tertiary epoch, in this case the apparition of birds would be anterior to that of mammalia; and of more than thirty classes, of which the two kingdoms,—animal and vegetable—are composed, two only are found in the zoological order.

These facts have led Alcide d'Orbigny in his *Paleontologie Française* to the following results. He counts 24,000 fossil animal species, contained in 1600 genera, and belonging to four great divisions—the vertebrata, the annulosa, the mollusks and the radiata. He denies that these four divisions appear to have passed through gradations of successive improvement. He denies the pretended general law of the gradual perfection of beings, in proportion as they approach the more modern times; on the contrary, he often finds in them a positive deterioration. These are his conclusions: "Had a progressive improvement taken place we should find all the animals that have no special respiratory organs in the first ages of the world; and the others would successively appear according to their degree of perfection: whereas, from the fact, that all the different modes of respiration appear at once on the Earth, we must infer that the supposed progressive improvement is not a reality, whether we compare the increasing and decreasing periods of development in zoological forms, or the instant of the apparition of the orders of animals with the perfection of their organs, or assume, as base of comparative investigation, the physiological deductions derived from the modes of animal respiration, we always come to the same negative results in regard to the successive improvement of beings in the different ages of the world. We should, then, regard these results as definitive." Blainville has established the same conclusions. "If we consider," says he, "the remains of organic bodies in themselves, there is no law in the order of the appearance and disappearance of species in the strata, whether we follow the ascending or descending scale of animal life. We can only attribute the fossils to circumstances of habitation, and by no means to the order of creation." (1)

Those who take the order of apparition of the classes in our rocks as indicating the order of their creation, are obliged to suppose, that the insects were created long before the birds, and the carnivorous, before the herbivorous, animals, since the insects begin to shew themselves in the anthracite, the birds in the wealden, the carnivorous animals in the lower tertiary and the herbivorous animals in the middle tertiary. But, then, they lose sight of the link which unites these various creations. They forget that the carnivorous animals could not exist without the herbivorous on which they subsist; and that the birds or insectivorous were necessary, from the appearance of insects, to prevent the excessive multiplication of these latter, which would have devoured the vegetable seeds and the vegetables themselves. Were there no obstacle to their increase, the Globe would not have sufficed for them, and the preservation of individuals would have resulted in the annihilation of the whole class. What is said of one group, should be applied to all others : for it is a fact, that each group, each class, each species has its enemies, which make war on it, feed on it, and prevent its multiplication beyond certain limits. The maintenance of equilibrium equally depends on the destruction, and on the reproduction of individuals. The phytophagi, or those who live on plants, are in proportion to these

(1) *Dieu, l'Homme et le Monde,* T. III. p. 511, par Maupied.

latter; the carnivori to the phytophagi. Birds require insects, and carnivorous, herbivorous animals; and these latter, plants; and, reciprocally, each group needs to be restrained in its propagation by proportional destructive causes: insects by birds, and the peaceful by the carnivorous mammalia. We cannot conceive the existence of a single group without a multitude of other specific forms, which maintain life or regulate its increase; which in various ways stimulate it; which maintain, in regard to it, this mutual and universal motion that constitutes the life of the world, as the circulation of the blood, and the functions which keep it up, constitute the life of individuals.

The species of one group of animals being the support for those of another group, we should hence conclude that the creation of various groups was simultaneous, or very nearly so. The zoological order, or that of our conceptions, has not, consequently, been the order of their creation: and hence the successive order of a certain number of classes in the deposits of the Earth's surface cannot correspond with the order in which these classes have been brought into existence. Even in the hypothesis of the successive creation of classes, at long intervals, the succession of fossils would not represent that of creations; or if it represented it on one point, it would not represent it on other points; because different continents having emerged at different epochs, they could not have all been occupied at the same time by the river and land fossils of both kingdoms. The distribution of fossils may indicate the order of occupation, of numerical predominance, a succession of different habitations, &c., but never a general order of creation.

3° The supposed successive improvement is not more real for the genera and species than for the orders and classes. The species most intimately related are collected by zoologists under the name of *genus*. The reunion of the most similar *genera* forms an *order* or a *family*, and a collection of *families* or *orders* forms *a class*. In a natural classification, zoologists proceed from the most simple to the most complex, which is synonymous with the most perfect. Such a gradation should be found in the *genera* of our strata, if their higher or lower elevation had any relation to the zoological order. The most simple generic forms of each class would first present themselves: the succeeding strata would exhibit to us other types, more and more complex, up to the actual epoch, which would contain the most perfect forms or the highest genera of each class. Nowhere, however, is this order observed. Let us take for example, in the order of *échini*, the family of *cidarides*, which are found in all the formations. Agassiz, an advocate of successive creations, has alone, or in conjunction with Desor and Marcor, made most important researches on this class of fossils. These researches, compared with each other, shew very considerable differences in the arrangement of genera and families. I shall take the last of them, that which, consequently, resumes the greatest number of observations and reflexions. If the reader will examine the subjoined table, extracted from Agassiz's *Catalogue raisonné des échinides*, he will be convinced that there is nothing in common between the zoological order of this author, and the distribution of cidarides in the strata of the Earth's surface and in the present epoch. I have only marked for each genus, the rock or formation where it first appears: it would be useless to pursue the distribution of its species in the higher strata.

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Order, ECHINIDES. Family, CIDARIDES.

Genera.	*Epochs.*	*Genera.*	*Epochs.*
Cidaris	Primary.	Cœlopleurus . . .	Tertiary.
Goniocidaris . . .	Actual.	Codiopsis	Chloride of chalk
Hemicidaris . . .	Swassic.	Mespilia	Actual.
Acrocidaris	Id.	Microcyphus . . .	Id.
Palæocidaris . . .	Primary.	Salmacis	Tertiary.
Salenia	Néocomian.	Temnopleurus . .	Chloride of chalk
Peltastas	Id.	Glypticus	Jurassic.
Goniopherous . .	Chloride of chalk.	Polycyphus	Id.
Acrosalenia. . . .	Jurassic.	Aniblypneustes . .	Actual.
Goniopygus. . . .	Néocomian.	Boletia	Id.
Astropyga	Actual.	Tripneustes. . . .	Tertiary.
Diadema	Lias.	Holopneustes . . .	Actual.
Hemidiadema. . .	Green Sandstone.	Echinus.	Jurassic.
Cyphosoma	Néocomian.	Pedina	Id.
Echinocidaris. . .	Actual.	Heliocidaris . . .	Tertiary.
Echinopsis	Jurassic.	Echinometra . . .	Actual.
Arbacia.	Néocomian.	Acrocladia	Id.
Eucosmus.	Jurassic.	Pedophera	Id.

It is evident that the order of the genera of this family shews, not unfrequently, a stationary or even retrograde, rather than a progressive gradation. If the different orders and families of each class be successively examined, both in the vegetable and animal kingdoms, and submitted to the same criterion, they will yield the same results.

These facts, we may observe in passing, radically destroy the pantheistic idea of successive transformations—by means of time and different media of existence—of a small number of primitive types, into species more or less complex. For in such an hypothesis, the primary rocks should contain only the most simple species of the two kingdoms, which would afterwards increase in perfection with the subsequent rocks, up to the present epoch, which should, consequently, contain the most perfect and the most varied forms in all the orders. This, however, is not the case. The silurian strata of the primary epoch already exhibit all the great varieties of the animal kingdom; and the highest forms of these varieties are associated with the simplest in the same families and the same genera. This is also true of the vegetable kingdom; its highest genera appear as early as the anthracite and coal-beds.

4° It is true that, if the complexity and the comparative perfection of organs in the fossils does not seem progressive, this does not, at first, appear, to hold in regard of the number of specific forms. The primary rocks exhibit fewer species than the secondary; and both appear less rich in species than the tertiary rocks. The numerical proportions are even in an inverse ratio of the thickness of the strata; as the tertiary rocks are much less massive, than the secondary, and these less than the primary. But we must add, that this augmentation of species exists only in an almost consecutive manner for five classes; the mammifers, the birds, the amphibious animals, the insects and the mollusks. In the others, the numerical preponderance of the species remains to this day in the secondary or primary rocks. Thus the primary rocks present more crustacea than the secondary and tertiary taken together. The secondary formations yield more reptiles, fishes, crustacea, echinides, polypi, sponges and vegetables than the tertiary. It is not even necessary to combine all the species furnished by the different sections of the secondary formation, to shew its superiority over the tertiary system: the secondary sections,—comprized, the one, between the old red sand-stone and the Jura-limestone, and the other between the lias and the first tertiary strata,—these two sections, taken together, have given more fishes than all the tertiary rocks. The Jura and chalk sections, taken also separately, appear richer in polypi and echinides than the tertiary rocks. In fine, the single coal-rocks have yielded more species of vegetables than all the other rocks together. In view of these facts, what becomes of the pretended law of the numerical progression of species? Is it not evident, that these differences, which, neither in the classes nor in the families, present any gradation, are less proportioned to the ages of the rocks than to the diversified origin of the formations of which these rocks are composed? It is known that at present, the species which live in the open sea, are incomparably less numerous and less varied than those that dwell near the shores, and on the land. It is also established, that the pelagian-deposits in general only receive the remains of the former; because they are formed at too great distances from the shores, and in too tranquil waters for the shore and land species to accumulate there in great number. Now the ancient deposits are in general rather pelagian than littoral; their shore-portions, retaken and destroyed by new actions of the sea, escape observation; and what remains of these great deposits ordinarily only makes us know the species that lived at a greater or less distance from the shore. We cannot expect to find in these deposits many mammalia, birds, amphibians, insects and mollusks. It would be absolutely the same with the tertiary rocks, if we except the lacustrine and river deposits, in the environs of Paris, and at some other points, which exhibit so many species of the five classes just named. It is not, then, by new creations that we are to explain this numerical preponderance of the tertiary species.

The inaccurate observations which served to support this hypothesis have been thus corrected. The numerical progression of specific forms is neither constant, nor consecutive: it is, moreover, explained by the origin of the formations. Neither the classes nor the genera observe the zoological order in the Earth's surface; and these classes being unable to exist separately, their respective creations cannot have been separated by long intervals of time. All the formations contain terrestrial fossils; even the chalk of the plains has yielded some drifted timber. Nothing in this leads to the conclusion of successive creations. This hypothesis has evidently lost its hold on the scientific world. In 1833, Boué, reviewing the progress of the science, said: "thus have vanished all these dreams about the appearance, first of the marine-cryptogami; then of the land-cryptogami; and finally of the subsequent succession of the monocotyledon and dicotyledon phanerogami. All these classes have been developed at the same time. It has been found necessary to modify the opinion, that, in each class, Nature has proceeded from the simple to the composite. Species and genera have only been replaced by others, when the conditions necessary for their existence have, here and there, ceased on the Earth."(1) This idea has, indeed, been so much modified, that it appears, in its present form, to have nothing incompatible with Genesis. According to the Inspired Record, the Divine Power created, in the interval of some days, all the groups, all the classes of organized beings, including even man; but it is not said, that God was never to replace the species that might become extinct, by other new species. Still, this theory of successive creations,—proposed at first for whole natural kingdoms,—rejected afterwards from kingdoms to classes, and then from classes to genera, and from genera to species, and thus gradually reduced to its lowest limits,—is so gratuitous, that it appears more reasonable to believe, with Linnæus and Blainville, that all the species were created at the beginning, and with Pallas, De Lamétherie, C. Prévost, &c., that their succession in the formations, is a fact of natural history, and not a geological fact, indicating new creations.

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(1) Bulletin de la Soc. géol.—1833-1834.

5° "The species," it is said, "are different at different levels of the inner surface: they vary with the formations. Those of each formation are peculiar to it; they are not found either above or below it. The species of the primary rocks are not found in the secondary; nor are those of the secondary identical with those of the tertiary: the tertiary, in fine, shew but a few of the living species, which, for the most part, differ from them, and are thus absent from all the rocks." It is added, "there is only one way of explaining this long succession of different species: the successive disappearance of the one is a phenomenon which is explained by successive extinctions; and the no less universal phenomenon of new species, which replaced them, can only be explained by new creations, corresponding with all the geological epochs."—Such is the reasoning of the partizans of successive creations. I have not weakened the objection, but have rather expressed it in an exaggerated form, to shew in what light the subject is viewed by many geologists. I reply by saying, that the observed facts do not support the view here presented. Everywhere there are species which pass as identical from one stage to another: and everywhere there are some which are common to several rocks, notwithstanding the pains geologists have taken to establish their limits between absolutely independent fauna and flora. A very large number of plants are the same in the anthraxiferous (primary) rocks, and the coal-beds (secondary). Brongniart mentions even some Jura (secondary) plants, which, as far he knows, are no wise different from our living species. The leaves of which he has formed his *zamia mantelli* (oolite) are perfectly like our *zamia pungens*. His *fucoïdes encœliodes* (Jura), in its size and general form, is not different from a species which grows on the banks of the Rochelle. This plant, says he, presents an example of the most perfect analogy in so ancient a rock. It is not possible, he again says, to specifically distinguish the *fucus obtusus* of Monte-Bolca (tertiary) from the *chondria obtusa* of our coasts. Ehremberg has determined a crowd of symmetrical infusoria, the species of which are common to the chalk, to the tertiary rocks, and to our present epoch. The tertiary rocks, from the most ancient to the most recent strata, present, for all classes of the two kingdoms,—animal and vegetable—a great number of species identical with the living ones. In the single class of mammifers, of one hundred and forty fossil species, distinguished by Blainville, fifty-two are known to be yet living. In one of his works (1) this writer has also investigated the relations of all the known fossil mollusks with the living ones; and among the results at which he arrives, is this, that the fresh water and land fossils are scarcely distinguishable from the living ones, in the fresh water formations of all the epochs. The insects appear, from the primary to the most recent rocks. Now, when we consider that of all animals, these most easily assume specific varieties under the influence of climate and of food, we are not far from concluding, that the greater part of the extinct fossil species are only varieties of the living species. We are induced to think so, as well by the insufficiency of characteristics by which a difference of species is sought to be established, as by the small number of interruptions in the species of the actual series.

If, on the one hand, the number of fossil species now living has been diminished, on the other, the number of extinct fossil species has been much exaggerated. Professional zoologists are little disposed to receive the 24,000 fossil species, in composing the catalogue of which Alcide d'Orbigny had less difficulty than he would have had in establishing their authenticity. A species requires to be studied in the whole ascending and descending order of its development; in its productions, in its increase, its decline, and its relations with other neighboring species. From this, it is easy to understand, how difficult must be the determination of species in paleontology, where, most frequently, we have only imperfect remains. Even in the class, where the rigorous determination of species is easiest, —that of the mammifers, the most distinguished zoologists meet with a thousand causes of mistake, as may be seen from the following facts. Blainville has lately reduced to five the

(1) Les Principes de la zoologie appliqués à la géologie.

thirteen species of fossil bears, which are enumerated in the books. According to this writer, the male and female of the same species were taken to be distinct species. Moreover, these species were said to be extinct; and he has found that, with one exception, they are identical with living species. He is of opinion, that all the supposed extinct species of lamellidental elephants may be referred to a species that now lives in India; the mammoth of Siberia, *elephas primigenius*, is of the number. He has reduced to four, the twenty nominal species of mastodons; to twelve, the twenty-eight species of *felis* mentioned in the catalogues; to five, the fifteen species of palæotheriums; to three, the sixteen species of lophiodons, &c. These species, thus rejected by Blainville, had been for the most part determined by Cuvier. Lartet,—whose merit, both as a zoologist and as a writer, Blainville recognizes,—thinks that the latter has perhaps too much limited the number of species.(1) But these differences of opinion between Cuvier, Blainville, and Lartet, sufficiently shew, that, in order to approach the study of paleontology with success, it is necessary to be a profound zoologist. Baile, professor of paleontology at the school of the Mines, considers as simple varieties a very large number of the fossil mollusks which conchologists had regarded as distinct species. Varieties, especially in the lower animals and in the vegetables, are known to result rather from local circumstances than difference of age.

In the mollusks the specification is the more difficult as the details of the skin and even of the whole living animal escape observation. Recourse must, then, he had to the shell, which differs according to age, sex, locality and other biological circumstances. The shell is a product and not an organ; and if the animal did not live in suitable circumstances, the shell undergoes corresponding modifications. Thus, to cite but two illustrations of this principle, in the *venus pullustra* of our coasts, we do not, perhaps, find two shells perfectly alike, unless they dwell in the very same place, have the same exposure, and are under the same wind. Our *murex lapillus*,

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(1) *Noticc sur la colline de Sanson.*—Auch, 1851.

which lives on the donax, has a small and very furrowy shell, whenever the animal is on a river-bank, exposed to the same wind: whenever, on the contrary, its place is sheltered from the wind, and the donax is very plenty, it has a large and almost smooth shell. Hence the difficulty of determining, when we have only the shell, even when we have it entire; and, much more, when we have but fragments or impressions. The contrary tendency has given us thousands of species that never existed.

In the actinia, the organs tend to a simplification analogous to that of plants and hence individuality disappears. The animal, otherwise hard to catch and preserve, is wanting to the paleontologist, who must consequently content himself with the polypus. But the polypus is a stony product, susceptible of undergoing modification of form from a thousand causes; so that, in a great number of cases, it is absolutely impossible to come to specific conclusions. This is still more difficult in the fossil plants, in which we never find the organs of fructification. We only have impressions of leaves, of stems, and sometimes of fruits. It is very easy to know by the wood, or by the leaf, to what great division of the vegetable kingdom, a plant belongs; it is even possible, in many cases, to determine the family, but most frequently, impossible to determine the genus and species. And yet with such elements the paleontologists have not shrunk from creating successive flora!

The paleontologists also easily fall into another error, relative to the succession of fossils. They assign a different age to all the formations of different origins of which a series may be composed. They suppose them to be geometrically superposed on each other, whereas, intermixed only at their point of junction, they preserve their independence at other points; so that, placing in series these successions of species in space, paleontologists willingly make of them, because favorable to their systems, successions in time. Let us take for example, in the later secondary period, the néocomian strata, the chloride of chalk, the marl-chalk, the white-chalk. These formations are found, at certain points, superimposed:

but does this prove that they represent the fauna of different epochs, and that the animals of the chloride of chalk lived before the animals of the white chalk? To assert this, would be to assume, that the sea, formerly much more extensive than at present, received only a single formation at once, where as now it receives many such at the same time; or that the depths of the ancient sea, its shores, and the intermediate regions, were only successively inhabited in former times, whereas at present they are all inhabited at one and the same time. It would confuse many collections, were we to make them correspond with the synchronism of formations,—a fact which common sense alone might have conjectured, had observation failed to establish it. In the present state of the science, it is difficult, or rather impossible, always to determine a natural limit between what was produced at the same, and what, at different times; but this difficulty only shews more clearly the folly of those who seek to draw from their artificial classification of rocks the same consequences which would, perhaps, follow if it were natural. And yet they go still further. Fresh water formations are found in parallel superposition with marine formations, for example, the plastic clays and their lignites with the coarse limestone, and the coarse limestone with gypsum. This alone determines them to refer the fossil species of these two formations to different epochs, as if the sea had had no inhabitants while the deposit of the clays and the gypsum was made; and as if the land were a desert while the coarse limestone was deposited, or that the fishes and horses, sea-urchins and moles, palm-trees and nayades had dwelt together on the continents, at the epoch of the clay, and in the sea, at the epoch of the limestone formation. Is it not evident, that the coarse limestone, the white chalk and the chloride of chalk, should present different fossils? The clay,—a fresh water formation,—will yield river and land fossils; the limestone,—a marine formation,—will be found to contain marine species that lived near the shores; the white chalk,—a pelagian formation,—will have species that dwelt in the depths of the Ocean; the chlorite of chalk,—a semi-pelagian formation,—other species that lived between the shores and the depths of the high sea : but is there any thing to identify these successions of species with successive creations ? And yet, men cling to these original blunders ! While they refer the formations of different origin to different epochs, they make another capital mistake by regarding as contemporaneous, the formations of unconnected basins. It is with the history of formations as with the history of different nations, the epochs of which do not correspond, although analogous occurrences may be found in the history of each people. Every great geological basin has its primary, secondary, and tertiary formations ; but these epochs may not be the same for all basins ; because the emersion of the different continental elevations was successive, and corresponded with the lowering of the level of the sea. Let it be once supposed, that the primary formations of one continent may be parallel with the secondary rocks of another, and identity of fossils does not prove that the formations are of the same age in different continents. Species which have abandoned an old for a new continent, may be perpetuated in this latter for a long series of ages ; and if they become fossil therein, the beds they will occupy will be much more modern than those that received them in the former continent, before their emigration. Hence to say, that one species has ceased to exist, and that another has begun to exist, for example, at the epoch of the coal-beds, is to speak at random ; these formations not being of the same epoch in all countries. It does not follow, because the same fossil plants are found in our coal-beds and in those of the United States, that the coal formations in both countries are of the same age. The plants of the American coal-beds may have continued to live for a long time in our climates, and much later have become extinct here, just as our living species,—at that time not found in our country,—may have lived on other points of the Globe, the ancient deposits of which have not been laid open to our observation. For these reasons, Boué, Prévost, &c., have always rejected the idea of Deshayes, who determined the relative age of the deposits by the character of the fossils alone. To be able to say, as is so commonly said, that species are not found either above or below any particular formation, or level, we should, at least, have a large series of intercontinental superpositions; whereas geologists do not possess even a series of superpositions for the continent of Europe, with which they are best acquainted. General series are abstractions: Nature produces only local combinations. A multitude of species which were extinct in some countries, at the epoch of our tertiary rocks, continue to live in other countries at this day,—the epoch of our quaternary rocks, which are now in course of formation. This has been the case in all preceding epochs. By placing, end to end, independent formations, we arbitrarily introduce into the succession of fossils a much greater number of species than ever existed. No reliable conclusion can be drawn from this artificial arrangement as to the epoch of the creation and extinction of species.

Let us abstract, for a moment, from this consideration: let us forget the synchronism of formations and the independence of different basins: let us admit that the fossil species have been exactly determined, that their succession in the inner surface is as frequent and as real as has been supposed; and let us see what are the consequences which are derived from this succession.

1° The species are different in different formations, hence, it is said, those of the upper formation did not exist when the lower formation was deposited; and those of the lower formation did not exist when the upper formation was produced.—The same argument applies to all the stages of each formation; it can be used for all the formations of each stage, and even for the different strata of each formation; for at all levels there are species which appear for the first time; and others which disappear for ever. This shews that the argument proves nothing, because it proves too much. What may be reasonably inferred from the succession of different species in the formations, is, that the currents of which these formations are the product, were either different, or flowed through parts inhabited by different species—(formations of different origin at the same epoch);—or passed through the same parts, but did not carry off bodies from the same points of their course, at two different epochs—(succession of species in beds of the same formation);—or took them from the same points, but found there, at subsequent epochs, different species, which had come from other places—(formation of the same origin and different age);—or found there the same species, but in very different proportions; those which abounded at the first epoch being rarely found at the second; and the rare species of the first epoch having become numerous at the second,—a circumstance which would be sufficient to explain the presence of certain species at one stage and their absence at another. All these consequences are probable; they follow from an exact idea of formations, from the phenomenon of fossilization, and from the natural history of beings. The argument which is opposed to this is vicious; it is a general conclusion from a particular premise.—*The species differ in different beds:* be it so; but were the species of the upper bed absent from the whole surface of the Globe when the lower bed was deposited? The facts should justify this conclusion in order to afford ground for the system of new creations. This is not the case. Before we can say with certainty, that the species which are absent from one or more formations, nowhere existed when these formations were produced, it would be necessary that each formation represented the whole contemporary flora and fauna. This is not the case, 1° because the formations could not be, and in fact are not, any thing else than local masses; 2° because fossilization is only an accidental phenomenon,—an exception to the law which condemns all material organisms to annihilation. In the absence of certainty and likelihood, the opinion of successive creations might, perhaps, claim a certain appearance of probability, if, in the third place, all the epochs were at least represented in each basin by formations of all kinds of origin,—pelagian, semi-pelagian, littoral, river, fluvio-marine, lacustrine, &c.; because, in this case, a larger number of species being preserved by fossilization, in the different beds, the absence from the beds of the greater part of our living species would not be so easily accounted for by natural causes. This, however, is not the case; each great series contains only a very small number of different formations.

Let us resume in a few words, these three points of consideration: 1° localization of the strata. We have already remarked our different systems of strata are only accidental and local, and have been more or less affected by the subsequent action of water; formed, some at the expense of others, and the last, at the expense of all preceding ones. It would be a great error to regard them as forming deposits, continuous in length and breadth, on all the surface of the Earth. Nothing would less correspond to the general facts of geology; nothing would be more opposite to the manner in which water acts, or to the conformation of the Earth's surface. The formations, then, do not entirely reproduce, in the fossil state, the fauna and flora which were contemporary with their production: they cannot, consequently, serve to shew that any species were absent from the whole Earth at any particular epoch; and, hence, they cannot make known, either the epoch of the creation of these species, or that of their disappearance.

2° Limited extent of the phenomenon of fossilization.—In addition, it may be asked, how could the formations completely represent the contemporary flora and fauna, when fossilization itself is only an exceptional phenomenon? If we abstract from some shell-banks and corals, which may have become fossilized on the spot where they dwelt, running water is the only agent of paleontology: and of all the aquatic and land organisms, those that dwelt near the currents could alone furnish fossils. That a plant or animal might have any chance of being fossilized, it was necessary that it should be carried away by waters which transported imputrescent substances; and that these substances withdrew it from the direct action of the destructive causes that prevailed in the atmosphere, on the surface of the land, in the earth, and in clear water. All the bodies buried in the earth, or lying on its surface, or floating on the waters, quickly decompose and leave no vestige of their existence. The stratified rocks themselves do not always preserve those which they have enveloped. The marl, the sand, the sand-stone and pudding-stone of the ancient formations, as those of the modern formations, contain but few fossils; doubtless, because all the sand-stones were originally sand, and that the sand, before it was cemented by silica, received infiltrating waters, which decomposed the animal and vegetable bodies it contained, and gradually carried away all their elements. All the sand-rocks, which the waters washed before their entire solidification, lost the soluble substances they contained. If the movable condition of many rocks was fatal to their fossils, the excessive solidification of many others was no less prejudicial. In the compact chalk, in the marble-chalk, in all the other metamorphic-rocks, the fossils are in general greatly changed, deteriorated and indeterminable. The fossils also escape us, if the beds on which they lie, are taken up and decomposed by the water. This has occurred to numerous and considerable portions of all the formations: this continues to take place before our eyes. The fossilization of organisms is frequently determined by fortuitous circumstances. According to all appearance, it is to the suffocation and currents produced by volcanic heat that we are principally indebted for our fossil fish. The numerous polypi of the white chalk and of the chloride of chalk have been preserved in great part by the silica which penetrated them; as also the tertiary insects by the yellow amber or succinum of the clay. We may also remark, that, with the exception of the coal-beds, the deposits have not been explored on any thing like a great scale, except in the neighbourhood of the principal cities; that a great number of the fossils discovered by workmen are immediately destroyed and are thus lost to observation; and that, among these which we are able to collect, the smallest number are sufficiently preserved to enable us to distinguish them specifically with any certainty. We may add, that more than two thirds of the Earth's surface are covered by the waters of the sea and of lakes, and are consequently inaccessible to observation; and that of all the continents one only, Europe, has hitherto been attentively studied. Every thing, then, is exceptional in the fossil plants and animals,—their transportation by the waters, their being imbedded, their preservation in the strata, their discovery and their determination. Fossilization, then, can only make known to us a very small minority of the species of both reigns that lived, or now live, on the land and in the waters. Because the immense majority of the living species is not represented in the fossil state, we cannot conclude from the fact, that they first existed after the others had disappeared.

3° And this the more especially, as the formations of each series do not correspond, in number and origin, with the number of the different habitations of the species. What remains to us of the ancient primary and secondary formations, was generally formed in the pelagian marine zones, where the species are fewer, less varied, and where very few land, river, or sea-shore species would be transported. This observation holds even for the mixed formations. Thus of 157 animal fossil species contained in our slate (1), about 60 are pelagian, viz. 26 goniatites, 22 orthocerates, 3 bellerophons,—all animals of the Linnean genus, *nautilus*, which dwell in the depths of the sea; 5 terebratulæ whose living congeners attach themselves to rocks in the deepest waters; 4 crinoides, which have no analogues but in the lowest depths of the Ocean. The littoral species predominate, it is true, but they have been transported by the rivers, with the other materials of the rocks to the places inhabited by the pelagian animals; and the slate-rock, by its position, not by its origin, is a pelagian formation.

That of the anthraxiferous rock is almost the same: it contains the same fossils. We find in it especially the buccinum, the turbo, the turritella, the natica, the cephalida,—mollusks which live as well in the open sea as near the shores: the nerita, which lives as well in fresh water and rivers as in the river-mouths; the helix, which, if genuine, should be a land animal. Among the acephalous mollusks we find the cardium, the cypricardia, the sanguinolaria, the pecten, the lucina, the crassatella, &c.,—animals which inhabit marine bays: the

(1) Terrain ardoisier.

unio, river mollusks and those of brackish water; but we also find pelagian mollusks. The carboniferous elements have also been drawn from the continents or islands, but they have been carried far into the sea with the other littoral and fresh water fossils.

The flora and fauna of the coal formation are of the same character, if we except some coal-beds, which present purely lacustrine and rivers mollusks, and which have been deposited in the basins of lakes.

The different layers of the triasic formation contain reptiles found in estuaries, bays and shores, associated with some other species, which may be considered as belonging to deep water. We find also in it aquatic and land animals. The lias, which is a salt and fresh water formation, contain estuary-reptiles, shore-crustacea, brackish water mollusks, unios, bay-mollusks, remains of vegetables, and, moreover, a still greater number of pelagian or deep water mollusks.

The fossils of the Jura-rocks are, for the most part, deep water sea-mollusks, together with some which may have lived near the shores. Traces of reptiles are even found in them in certain places. The chalk itself contains reptiles and some drift wood; but the greatest number of its fossils are mollusks and radiata of deep water.

Our tertiary rocks exhibit, for the first time, a great number of estuary-mollusks and land animals, in consequence of a considerable change in the basin of the Ocean, which, to all appearance, opened to the animals of the more ancient continents, an entrance to our European continent. It is universally the case, that our tertiary strata appear to have been uniformly deposited in gulfs, near to the emerged land; and that if, in general, we have nothing more than the pelagian portions of the ancient formations, we have only the littoral portion of the tertiary system; the remaining parts being buried in the deep.

Thus, the stratified rocks are nothing more than local and incomplete masses; their formations are not numerically proportioned to the different dwellings of animals and plants: the fossilization of organisms is only an exceptional fact. With such data, it does not appear possible to establish the hypothesis of new species successively created to replace more ancient ones, in proportion as these latter are supposed to have died out.

If we examine the consequences of this hypothesis, it will be found still less tenable. In the history of the original production of beings, we admit but one single week of creative acts. But if the succession of different fossil species corresponds to a succession of new creations, we must admit such acts, not only for all the epochs of the past,—since at all points of the series of our formations we find a number, more or less considerable, of new species,—but for all the points of space in each of these epochs, since the rocks of each country, with species found elsewhere, contain some which nowhere else are to be seen. These long and numerous series of successive creations, would not even terminate with our last tertiary formations; they would continue to augment indefinitely in time and space. At the present moment there is a succession of living distinct species, if we pass from one continent to another, from Europe to America, for example; and even in each continent, in going from North to South, the same observation applies to the lacustrine and marine species. If we are told that the species which at the present day are peculiar to so many regions of the Earth, are the result of former migrations, we shall ask, why may not this observation, which is good for our times, be applied to the past? In fine, as our living species are not more immortal than so many others which have become extinct, we do not see why they should not be replaced by new creations. Moreover, all the animal species constitute a linear series, which descends from the ape to the sponge, following a constant order of degradation. This has been established by Blainville, and, excepting one or two small groups, the distribution of which is probably still undetermined, all naturalists admit the series. Now the fossil species form part of this series; they aid us in interpreting it by completing it: they enter into the same general divisions, into the same families and genera as the living species. They often establish passages, and constitute important transitions between the living classes or between the fossil and the living genera: still more frequently they fill up the void between living species of the same genera. From this it appears impossible to doubt, that all parts of this vast and harmonious collection were created at the same time. If the explanation which is offered of the succession of fossils is the true one, this plan is nothing better than a dream; or if it existed and was such as is represented, it would have been realized not all at once, but piece by piece: not according to an order of serial degradations or an order of successive ameliorations, but as if by hazard and without any other motive than the needs of local circumstances. All the species never having been contemporary, all the parts of the Divine Conception would never have existed at the same time; they would be always in progress, and would follow one another without more sequence than in past times. (1)

XVIII. Hypothesis of the Antiquity of the World.—What I shall say on this subject will be divided into two articles. In the first, I shall point out the exaggerations and errors of all kinds into which the advocates of the World's antiquity have fallen. In the second, I shall present, in refutation of their hypotheses, calculations, based on the most certain data which the present state of geology presents.

I.—The early geologists attributed an exaggerated importance to facts of a negative character, and admitted without hesitation that the order in which the fossils appeared was that of their creation. They imagined, after what at first appeared of this order of distribution, that the seas and the rivers had been long without inhabitants; that the various classes, first of vegetables, then of animals, had at length successively been created; and that each of these creations was separated from the rest by an indefinite period of vast extent. All these periods were made to correspond—how badly we need not say—with the days of Moses, and almost the same

(1) See at the end of the volume a note in which the succession of fossils and their extinction are explained by natural causes.

general order of succession was said to prevail in both. This result appeared so plausible, that some theologians found no difficulty in giving the geologist all the time he wanted, by transforming the days of the first chapter of Genesis into indeterminate periods. On this condition, De Férussac consented to acknowledge that there was peace between Religion and Geology. As may easily be imagined, the geologists did not wait for the suffrage of the author of the Conferences on Religion, (1) before projecting their systems through the immensity of an indefinite past: "but this suffrage," observed De Férussac, "consecrated the interpretations demanded by a conscientious reason;" for, added he, "observation shews that a long course of ages has passed by: 1° between the consolidation of the primitive rocks—granite—of the Globe and the appearance of life on its surface; 2° between the creation of the various species of plants and the different races of animals; 3° between these and the creation of man. The facts, consequently, are incompatible with the idea of days like our days; and we have not as yet any means of determining the length of the epochs in question. It is a calculation of the same nature as that of the distance of the stars from the earth; and nothing is more ridiculous, in the eyes of a man who has given attention to these matters, than to hear the antiquity of the World, the age of the World, seriously mentioned." (2)

Soon, however, it was discovered that this succession of great groups was founded on imperfect observations; that these seas, these rivers, which were said to have so long existed, surrounded by vast uninhabited continents, had, from the beginning, supported plants and animals, radiata, mollusks, fish, crustacea, &c., and that, at the same time, the land was occupied by the different classes of the vegetable kingdom, and by animals of a very high rank in the animal kingdom, as well as by reptiles and insects. Almost all

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(1) Freysinnous.
(2) Bulletin Universel. 2e Section, des Sciences Naturelles et de Zoologie. T. X, p. 193.

classes were found collected in the most ancient strata of our continents; consequently, there was no succession of groups. Observation had not proved, that a great length of time had elapsed between the creation of the various parts of the vegetable kingdom,—or that the animals had been created, many ages after the vegetables. There was therefore no longer any motive for understanding the days of Genesis as indicating indeterminate epochs. Moreover, all these pretended animal and vegetable periods being reduced to one,—that of the co-existence of all the groups and all the species,—there was, then, room to take from the age of the World, the time that had been assigned to their successive durations. This was something; for one author had assigned two hundred thousand years to the period of plants: others demanded thirty thousand years for the period of animals. Beaumont learnedly established the title of the present period to seventy-two thousand years of actual existence, while others assigned sixty thousand years as the period of the consolidation of the planetary nucleus. This last supposition, whether true or imaginary, can no more be objected to us than the preceding ones, because it is not included in our chronology; the Earth being already solid at the moment the history of creation begins.

Let us, however, be just to these geologists; let us not too hastily visit them with the ridicule which they love to heap on the Scriptural account of the World's age; and let us acknowledge that, if the explanation of the paleontological facts did not require their long periods, they were very necessary for their systems. At the time that De Férussac wrote, Cuvier's system was in vogue. It resumed the science of geology for those who look at things with the eyes of others: and Cuvier's system required, indeed, an enormous expenditure of time.

I.–Cuvier, if the reader remembers, supposed four or five invasions of our continents by the sea, in order to explain the tertiary marine strata. Between the retiring and returning of the sea, the rivers and lakes deposited fresh water strata, and various kinds of animals were distributed through, and filled with their generations, these successive intervals. The principle of Cuvier's theory was applicable to all the inferior strata, where the alternations of sea and fresh water deposits are so numerous as to induce the necessity of admitting many hundred marine irruptions on the same points of the continents. He supposed, that the irruptions of the sea were sudden, so as to surprize and overwhelm the land animals: it was otherwise, however, in regard to the retreat of the sea after long possession of the once dry land. Time was necessary to enable it to abandon by degrees the immense regions which it had covered with its deposits. Time was required for these deposits to become a habitable soil,—for this soil to be peopled by new orders, first of vegetables, and afterwards of animals, created successively to replace the plants and animals which had been destroyed and buried by each preceding invasion of the Ocean. Each animal and vegetable species had to wait for its development and propagation until the circumstances of air and temperature of the soil and of the waters accorded with its organization. It was no longer, as in Genesis, the Creative Will alone which acted; secondary causes slowly arranged matters. Time was required that the new lakes and the new rivers, after having scooped out for themselves basins, should accumulate their sediments on the sediments deposited by the former sea; and especially was time required for the repeated renewals of these long revolutions of Nature. The theory of Beaumont, imagined for the purpose of completing the revolutions of the Globe, and that of Ampère,—based on that of Cuvier and on the excellent work of Adolphe Brongniart,—were no less prodigal of time. Can we be astonished, if those who seriously believed these hypotheses, looked on the appreciation of past time as a calculation of the same nature as that of the distance of the stars from the Earth? From the moment, however, that, rejecting these deluges of fire and deluges of water, observation found in the production of the rocks a simultaneous,—not a successive,—action, as Cuvier and others thought, the continued, and, after long intervals, intermitting action of the sea and river water, it was evidently necessary to cut down these millions of ages. The formations, regarded in this light, take their place in an order of phenomena, which are known, and, to a certain point, capable of being appreciated.

To these successive creations of genera and species,—to these successions of seas and rivers, which prolonged so prodigiously the duration of the past, were added other imaginary periods, corresponding to the products of the igneous cause; for the actions of fire and water were regarded as successive. These fiery deluges, these excessive and periodical elevations of heat, were considered by Ampère as the cause of the annihilation of the supposed successive preceding creations, and of the temporary and repeated suppression of the aqueous element in the fluid state: but it is at present universally regarded as certain, that the cause which produced the ancient plutonic deposits, is of all epochs, and that the effects of water and of fire have always been contemporaneous. The waters formed deposits on the primitive surface, and, at the same time, substances that issued from the interior of the Earth, were injected into the fissures of these deposits, or spread over their surface, as we see in the case of the volcanoes. The ancient plutonian rocks have had as much time for their formation as all the sedimentary rocks, and, perhaps even more; since nothing forbids us to suppose that they may have continued to augment since the sedimentary rocks were left free from the water. When we find all our active volcanoes placed on the borders of the sea, or at short distances from it, we may very naturally conclude, that the presence of water is a condition for the production of volcanic phenomena. It is certain that the waters which at present cover more than two thirds of the surface of the Globe, covered a still larger space in the first ages of the World. The igneous cause acted, then, in those ages at the same time on a much greater number of points. Moreover, whatever theory may be adopted on the origin of volcanoes and the nature of the igneous cause, we must come to the conclusion, that, during the first epochs of the Earth, this cause produced the greatest and most rapid results. If we attribute volcanoes to the construction of the Earth's crust, we shall be told by the advocates of the central heat, and by those who modestly content themselves with an interior incandescent zone,—that, in the beginning, the cooling of the earth, going on much more rapidly than at subsequent times, rendered contractions of the crust much more frequent; and that the crust itself,—then much thinner than now,—and the fused interior,—then much nearer the surface,—rendered the products more abundant and luxuriant. If we adopt the theory of the chemical action of the non-oxidized metals, as the cause of volcanic phenomena, we must acknowledge, that, at the beginning there were much more elements in such a state; and that, in this theory, the present results of the igneous cause are nothing more than the weak and last efforts of chemical action in those parts of the Earth's crust which escaped the immense influence of the oxidation which must have taken place when all the elements of the Globe's surface first found themselves in contact. For these reasons, we must subtract from the imaginary past all the time required by the earlier geologists for the formation of the porphyries and the other ancient igneous products.

For those who are not familiar with the study of geology, the most plausible argument in support of the antiquity of the Earth's crust—as it is called,—is, perhaps, that which is derived from the last deluge of Cuvier, or rather from the layer which was supposed to cover it. "Six or seven thousand years," it was said, "were required to form the thin layer which alone contains the fossil remains of man, and which covers the last diluvium of Cuvier. We must, then, count at least three hundred thousand years for the formation of all that underlies this light bed." (1)

How many false suppositions are implied in this single statement!

1° It is assumed that the formation of the strata to which are limited all human fossils, required six or seven thousand years. The contradiction is overlooked, that, at the same time, man has existed for six or seven thousand years, and that the soil on which he moves required that space of time for its formation! If it was in course of formation six or seven thousand years ago, man could not have lived on it: it

(1) Géologie élémentaire. M. Nérée Boubée.—1838.

was buried in the water, or, if all the Earth was not immerged, on what ground can it be denied that man existed in some part of the Earth? How can it be said that the six or seven thousand years which have elapsed since man was created were passed in its formation, when history and tradition tell us, that this soil has been, even in Europe, the seat of vegetation, of animal and human life, for at least four thousand years?

2° It is assumed that the appearance of man on the Earth corresponded with the end of the last diluvium of Cuvier; and that he existed nowhere before that time; because, it is said, this diluvium contains nothing that attests his presence. At the same time, it is acknowledged, that the diluvium of Asia, and of the North East of Africa, is precisely that which has not yet been explored.

3° In directing attention to the Asiatic and African diluvium, as capable of confirming or weakening the results given by the European diluvium, the possibility is implied of establishing the identity of age for the strata of these various continents.

4° As 7000 years were taken for the formation of the layers which cover the diluvium; and since this soil has been inhabited from so ancient a date, it is supposed that what takes place under the waters might take place on the land which the waters have abandoned. This absurd supposition is the only principle which enables the advocates of this system to calculate the time of the inferior strata; the supra-diluvian bed being taken as a measure.

5° It supposes the existence of Cuvier's diluvium or some other such; but if the erratic blocks, which were once supposed to characterize it, are also found in the earlier strata, such as the sand-stone of the Vosges, which is unquestionable; if the bone-caverns are purely fluvial deposits; if the superficial sand and gravel are nothing more than the last deposits abandoned by emptied lakes, or rivers that have changed their beds, or by the sea in retiring,—and which have remained in their movable condition because they have not been covered;—if these lines of blocks, and these various beds of rounded pebbles, of vegetable earth, of gravel, of sand, belong to all the epochs of the Globe—all facts which are well ascertained,—what, then, becomes of the supposed geological diluvium? It disappears, and with it the measure of time which, in the absence of a surer guide, is sought from this chronometer. Besides, it is certain, that human fossils and the products of human industry, are, on many points, inter-mixed with many of the extinct species. Man was, then, contemporary with these species. It is certain that many fossils, identical with those now living, have been found far below the so called diluvium; and even in the middle tertiary strata. Thus the calculations which were based on the diluvium have vanished.

These calculations were also grounded on the artificial classification of rocks, introduced by Werner, who greatly exaggerated the extent, and, consequently, the importance of these formations. It, moreover, supposed, that all the parts had been formed in an order of succession. This double error occasioned a corresponding prolongation of time.

We cannot admit, with Buffon, that the rocks were deposited in concentric layers on the immersed surface of the Globe, and that they were successively enclosed like the different folds of a plum; whose epidermis envelops the pulp; this, the nucleus; and this, the kernel. There is often a break in the series. Deposits do not extend over the entire surface of the sea's basin; but are found only at the mouths of water-courses, or near the shores; resulting from the action of eddies; or, in the open sea, by the action of the great currents. The greatest part of the basin has not been covered with deposits; it retains its primitive surface. The deposits of one epoch cover only partially those of another epoch; and this, not always. They are always of a local character. The primary rocks, the most massive of all, do not everywhere cover the granite rocks: the secondary do not entirely cover the primary; sometimes they repose on these latter, sometimes on the granite; and they are wanting in many countries. The tertiary rocks form only a small number of accidental masses, which are in contact with the secondary, and also with the primitive surface. In a word, these systems are rarely found in continuous series; and never with the complications and the number of layers which each of them presents in merely local series, where they predominate by turns. The ancient rocks were never more than local phenomena, as are still our contemporary formations.

This observation on the rocks, taken in the whole, extends to all the portions of each one of them, considered separately. They never rest on one another in a complete and regular manner, as, for example, the divisions of a building. There is not a single one of them in all the series, which, in many places, does not form part of the upper-surface of the Earth. In one place, different edges of the primary formation crop out successively; in another the carboniferous rocks, elsewhere the trias, or the lias, or the Jura-strata. Sometimes we find the chalk uppermost; and, at other times, the various tertiary strata. In descending from the modern strata to the more ancient, we find an analogous phenomenon. In the valley of the Allier, for example, the tertiary rocks rest on the granite; at Dinan in Bretagne, they rest on granite and primary schist. Elsewhere the chalk covers the primitive surface, without any intermediate formation; at other places the Jura-strata are found similarly situated. Hence it may be said, that there is not, probably, a single layer of any rock whatever, which, at some points of the Earth, does not rest immediately on granite. Nothing, then, is more unreal than the pretended geometrical superposition of the formations: nothing, on the other hand, more conformable to the laws of Nature and to what takes place at present in our seas, than the intermixture of layers, belonging to formations of different origin, and deposited simultaneously in the same basin. Notwithstanding these facts, the superposition of layers, as if they were found united in the same locality in uninterrupted series, has been asserted; and on this ideal continuity of the series divisions and subdivisions of all the formations have been grounded; as also hypotheses of an imaginary series of countless ages.

We have examined the hypothesis of geological epochs, based on the systems of upheaval, and we have shewn that it was untenable. It does not explain what it professes to account for. Like Cuvier's supposition of the irruptions of the sea, and Buffon's epochs of Nature, it is in contradiction with all the known physical laws: it resolves nothing; and its calculations are merely the sport of the imagination, an arithmetical operation without data for its basis.

Among the paleontologists there are some, as Lamarck and those of his school, who derive all the species from one or from a few primitive types by a long series of transformations, by means of diversified media, of inclinations, wants and, especially, by means of time. But these changes of species having never had existence except in their books,—as we shall elsewhere prove,—we must deduct the thousands of ages which they require for the accomplishment of this impossible phenomenon. Other naturalists have supposed, that, at the time when species were created, the Divine Power followed the laws which at present govern organized existences; that is to say, that He created the grain, and not the vegetable itself. In this supposition, we should admit that more time and different circumstances than are found in the six days' history of creation would be required, in order that these various species of plants might acquire their progressive development. This supposition, however, is as incompatible with logic and science as it is with Genesis itself, which tells us that the plant was created. Moreover, the days of Genesis being days of 24 hours, and not indefinite periods, we should conclude that the first individuals of each species of the two reigns were immediately created in the adult or perfect state, even if the Sacred Text had not declared it so formally.

II.—If we now take a general view of the method followed in all the systems, we shall find that the geologists who maintain the great antiquity of the Earth judged of the efficacy of a cause by its least results; and inferred from its productions at one time what it produced at another; no matter how different the circumstances.

What was effected on the uninundated land, which is almost nothing, has been observed; and the standard thus supplied has been used to calculate the time of the formation of our geological strata. This calculation will be found in the writings of Deluc, Cuvier, Buckland, Nérée Boubée, &c. Our great deposits were produced on an inundated surface, in the basin of the seas, by the action of their currents and the concourse of all the continental currents, which discharged their waters into them. It is under the waters of the seas and of the great lakes that we must look for the standard by which to make our calculations; and not on the emerged land, where merely concretions or travertines, turf-pits, stalactites and river alluvions are formed. It is under the waters of the sea and of the great lakes, that the principal phenomena are actually produced; and we can form some idea of their magnitude by the extent of the Earth's surface, which is drained by the rivers, and the quantity of the materials they bear along with them in their course. The waters of the Loire, and of its affluents, including both banks, drain a space larger than the rest of France.

The effects of the present action of our European rivers have been considered, in order to compare them with the effects of those which formed our ancient lacustrine and bay-deposits. This is another erroneous comparison. The waters which produced these deposits, acted on a much larger scale than that of the European rivers, and appear to have at this day nothing to resemble them, except on the continent and in the seas of America. If the atmospheric phenomena of the temperate zone cannot be compared with those of the equatorial regions; if tropical rivers produce effects, of which those produced by European water-courses are but miniature representations;—is it reasonable to attribute the ancient alluvions of England and France to a long series of ages, supposing that they were produced under a climate like our own? An important circumstance is forgotten, namely that these deposits were formed under an equatorial climate, as is proved by the remains of animals and plants which are found in them, and the congeners of which are at the present day generally inhabitants of tropical regions. We cannot, then, compare the effects of sea and river action, at the present day, in Europe, with what the same causes produced at the epoch of the ancient formations: we must look for examples in warmer climates.

The river Amazon,—including both its banks and its affluents,—drains a surface of six thousand leagues, that is to say almost as great as that of the Atlantic Ocean. The quantity of mineral and vegetable substances carried to the sea by the rivers, has been ascertained at several points of the warmer climates. The Ganges carries down seven hundred thousand cubic feet every hour; the Yellow river in China, two millions; the Mississippi still more. Eight thousand cubic feet of wood pass, in a few hours, through one of the mouths of this latter river. The oceanic currents which prevail between the equator and the poles, lay hold of the substances transported by the rivers of South and North America, and bear them to vast distances. They carry the seeds and trees of the new world to the shores of Scotland, Iceland, and even to Spitzbergen, and perhaps some of them might be found at the pole. The length of the course of the equatorial current (Gulf Stream) is 3,800 leagues, and its breadth near St. Helena, 400 leagues.

Much has been said of the time which our rivers require in order to hollow out their beds; and it is not remembered, that they, perhaps, do not now effect more in a thousand years, than they formerly did in a few years, when, the sea retiring more rapidly before them, their currents furrowed deposits which were still soft and impregnated with water. But little effort has been made to calculate the effects produced by the great rivers of America at their mouths, and at great distances in the sea; where the course of their waters, by reason of the discoloration effected in the sea, can be traced for several hundred leagues.

Neither is it considered, that all the causes which produce the deposits had, in ancient times, much more materials at their disposal than they now can command. The mountains, which reduced to an inclination of 40° to 45° are generally of unchanged declivity, formerly inclined much more abruptly, and abandoned a greater quantity of material to the winds, the rains and the torrents. The rivers and streams which now, by canalization and other human contrivances, are, as it were, enchained, in those times carried off a greater amount of substances from their banks. If their course was shorter, their descent was more rapid; and if our torrents, of one or two degrees of inclination, can bear along large masses, it is easy to conceive the more frightful devastations, the transport of the largest blocks and the greatest sedimentary masses, by the ancient rivers, without departing much from the limit of actual phenomena. The ancient forests, more numerous and more extensive, and decomposing on the spot, furnished more mould; the waters, raised to a higher temperature, and, consequently, endowed with a more powerful erosive force, abraded more easily the soil over which they flowed. The animals, as yet unchecked in their development, by the clearing of woods, and the war which man makes on so many of their species, as he extends his power and seizes on the uninundated lands, filled the vallies with their offspring, as also the places in the vicinity of lacustrine basins, and estuaries; and furnished, after their death, more animal substances to the water-courses to bear away.

Neither should we measure the former lowering of the level of the sea by that of our time. These latter changes of level being attributed to the lowering of the bed of the sea, to the removal of obstacles which separated neighboring basins from one another, as is the case at present with many of our island seas and the great American lakes,—we are obliged to admit, in former times, sudden lowerings. It is at least certain that all these lowerings have not been slowly made; the epoch of the white chalk supplies the proof of this fact. This chalk, which exhibits all the characters of a deposit formed in the open sea, and which has been found to extend more than 500 leagues, is immediately covered by river-bank deposits; for the pisolite limestone, which on some points separates it from the first tertiary strata, and these tertiary strata themselves, have been deposited near the shores. Thus what was at the bottom of the sea at the epoch of the deposit of the white chalk, must have suddenly become part of the sea shore to a very considerable extent, a fact that implies a great and sudden lowering of the level of the ancient sea.

As for the dislocations and upturnings produced by the igneous cause, they can evidently suggest no difficulty as to time. All the known facts shew that the effects of this cause are rapid, and may take place at once at a great number of points and on a vast scale.

III.—The disintegration, and transport, of the materials of the beds do not demand as much time as has been thought. After the calcareous organisms, of which we shall speak further on, the most abundant materials in the inner surface of the Earth are the schists, the clay, the sands or sandstone, the grauwacke or psammites, &c. These materials are the detritus of the granitic mountains, more or less mixed, and more or less reduced to fine and homogenous powder. Buffon asserted, from his own experience, and every one may easily convince himself of the fact, that pulverised glass and sandstone change in a short time into clay, merely by resting in water. Still as the disintegration of the superficial parts of mountains was more or less rapid, according to local circumstances, it is not possible to have a measure of time; but it must be admitted, that this was effected the more rapidly, as the mountains were then more elevated, exposed to a warmer atmosphere, and rendered more uniformly moist by the evaporations of the seas, which then covered the greatest part of our present continents.

The elements being thus disintegrated, time was necessary for their transportation, for, with the exception of some shell-banks, some madrepore reefs, formed on the spot where they are found, every thing else has been transported by water. The materials derived directly from the sea, as the marine limestone, were transported and deposited, according as they were abandoned by the animals, as we are led to suppose by what at present takes place. Every day, heaps of shells and other calcareous or silicious debris, are accumulated by the waves on many parts of the shore, and in the great estuaries. As far as regards the land, the transport by the rivers did not take much time. In proportion as, from one cause or another, the waters of the sea retired, they left longer courses for the rivers to pass over, and, consequently, all the layers of the shores,—now become part of the continent,—to be furrowed and transported once more to the sea. Geological observations shew, in fact, that the ancient formations left only on the surface those of their layers which were deepest and most advanced in the seas ; the superficial and littoral beds were once more taken up and returned to the sea, by the water-courses of the continents. But besides these materials, the rivers bore along the constant detritus of the primitive mountains and of animal and vegetable life ; while the seas still gave to their currents the debris caused by the abrasion of their coasts.

The dislocations, by breaking the soil, by creating new currents, or by changing the direction of the former ones, considerably augmented the materials to be transported, as is shewn by the immense conglomerates which are found near the points of dislocation, and by the changes of direction in the stratification.

We may cite a few examples of the transporting power of rivers. The Seine, at Pont-Royal, transports in twenty-four hours from seven to eight hundred cubic metres of sedimentary matter, which gives, for a quarter of a year, the mean time of transport 240,000 cubic feet, and for two thousand years 480,000,000 cubic feet of sediment. The Ganges, in the flood season, transports to the sea 45,000 cubic feet every hour, which, taking three months, as the average of high water each year, gives in 2000 years about 33,600,000,000 of cubic feet of sediment. If such a quantity of sediment can be transported by a single river, even now when the productive causes of the elements of our surface are so much diminished, what must have been the quantity, when such causes as we have pointed out were in full activity ?

Much time has been assigned for the transport of the erratic blocks, the distribution of which on so many points of the continents, has been referred to a single period, namely to that which begins with the last diluvium of Cuvier. But modern geologists suggest no less than eight different explanations of the distribution of these blocks, all of which come back to this general idea,—that we must regard such transportation as belonging to all the epochs of the Earth, a conclusion which must needs be accepted, since erratic blocks are found in the ancient formations, and their history is identical with that of the sand, the gravel and the vegetable earth of the diluvium.

Time also was required for smoothening the pebbles and round flints; but their history, as far as age is concerned, being that of the erratic blocks, of the sand and the gravel, they no longer present a difficulty. An oscillating movement, prolonged for some ages on the shores of the seas and rivers, might easily suffice to round these stones and efface their angles and asperities.

IV.—The thickness of marine limestone, and of the coal-beds, and the solidification of the rocks in general, have also occasioned very exaggerated calculations as to the time in which these were produced.

The strata consist of mineral substances and of organic remains: the mollusks and zoophytes predominate. It is said, that a long series of ages must have been required for the multiplication of such vast numbers. The remains of these animals alone often form more than the half of the thick beds in which they rest: it has even been asserted that the marine limestone is almost entirely composed of the dust and detritus of shells and corals. For those who know the extraordinary rapidity with which mollusks and corals multiply, and the shortness of their life, it will be unnecessary to say, that large deductions must be made from the vast series of ages, which have been assigned as the time of the production of their remains. M. Goubeau of Bilainerie, former president of the tribunal of Marennes, in a work on the development of oysters, says, that each individual of this species multiplies at least seven or eight thousand times. "The abundance of individual in each species," says Buffon, "shews their astonishing fecundity. We have a very remarkable example of this prodigious multiplication in the oysters and in the muscles. In a single day a mass, many fathoms in dimensions, is frequently taken from these shells. The rocks by which they are separated are sensibly diminished, and yet, the year after, we find them as before: the quantity of oysters does not appear to have diminished, and I do not know if the beds in which they naturally grow are ever exhausted. The species of these two genera, although they are as solid as those of any other, are not however, those that most abound in the strata. We must, then, conclude that a multitude of other kinds are still more fruitful, and if we reflect on this prodigious quantity of shells, either bivalves or univalves, which grow in the seas, we shall not be surprized that their remains should have formed our largest marine deposits in the course of a few ages." (1) This observation acquires more force for us, when we reflect that the mollusks are much more abundant and much more varied in the warm seas than in our temperate seas; and that the strata, of which we know the organic remains, were formed under an elevated temperature. The zoophytes are not less fruitful. The numerous reefs and islands of the South sea are composed of calcareous and silicious substances formed by these animals. These secretions pass in a short time from the paste to the solid state, and augment with astonishing rapidity. Every one knows that the waters of the Red sea are now encumbered with coral reefs, which render its navigation very dangerous. If the laying bare the lands which are near this sea, and which have permitted the zoophytes to establish themselves on its shore, was as ancient as is supposed by the advocates of hypothetical geology, this basin would have been rendered completely inaccessible, many thousands of years ago. The quantity of calcareous matter furnished to the rocks in a given time by the zoophytes and mollusks proves rather the newness than the antiquity of the World.

An enormous length of ages has been supposed necessary for the formation of the coal and the anthracite, which were regarded either as vast turf-pits or as forests, submerged in the place they grow in by repeated incursions of the Ocean. According to this hypothesis, after each new irruption of the sea, time was required for the forest to grow and be developed.

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(1) Preuves de la théorie de la Terre.

Now the number and thickness of the coal strata, which are separated from other coal strata by mineral rocks, imply, it is said, the repetition of the same phenomenon at long distant intervals. But the circumstances of position better studied oblige us to attribute to transportation all the layers of vegetable detritus hitherto discovered, either in marine or in lacustrine basins.

There is a great analogy between a marine coal-basin and the group of rough limestone in the environs of Paris. Both systems are formed by a collection of deposits alternately, clay, sand, limestone and carboniferous rock. In the rough limestone, as in the coal formation, vegetable substances are not exclusively contained in the coal or the lignites. They are clearly distinguishable, by the impressions of stems and leaves left in the clay, and sometimes, as at Vaugirard and near Bicêtre, in the limestone, which alternates with the lignites; as also in the sandstone and the schist, which alternate with the coal. Adolphe Brongniart acknowledges, that all the vegetables of our tertiary beds were transported hither. He believes, that plants may have been carried by water to great distances from their original place, and he attributes the deposit of the isle of Sheppay, at the mouth of the Thames, —a deposit which answers to our tertiary plastic-clay, to a cause analogous to that of the Gulf-Stream, which often carries the fruits of the West Indies and of the shores of the Gulf of Mexico to the coasts of Norway. It appears to me, that one who admits the transport of all the tertiary vegetables, and especially those of the isle of Sheppay,—notwithstanding their excellent state of preservation,—cannot, without contradicting himself, regard the preservation of the stems and impressions of the sandstone of the coal-beds, as a convincing proof of the burial of the ancient forests they represent in the place on which they flourished. (1) If in the schist and the coal-sandstone we recognize vegetables by the more or less perfect preservation of their stems, their branches and their leaves, we may, without recurring to extraordinary causes,

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(1) Prodrome d'une histoire des végétaux fossiles.

readily admit that in other beds than the coal, they found favorable circumstances which preserved them from entire destruction; or that the coal, formed almost exclusively of earth and vegetable dust, was furnished by peculiar affluents; or by the same affluents as the sandstone and the clay, but placed in different conditions, as is proved otherwise by the difference of the rocks. Do we not also find, and that in great number, fragments of stems in the clays which accompany the lignites of the tertiary Parisian system, while the lignites themselves most frequently offer no vestige of vegetable organization, or, if any, only impressions of leaves?

As to the presence in some coal-beds of vertical trunks, such as they must have been during life, upon which Brongniart strongly insists, they disprove rather than prove his theory. The trunks preserved by the sandstone of the coal-strata are, as might be supposed, horizontally placed, extended and compressed between the strata. Some have been observed in the mines of Treuil, of Saarbruck, and in some parts of England, which vertically traverse the sandstone and the clay. These trunks, whose position is rather inclined than perfectly vertical, are cut off at their lower extremity; and if, exceptionally, some indicate, by the bifurcation of their base, the origin of roots, the roots themselves are never found. They are merely broken, rounded trunks without branches. How could all the roots have been so uniformly destroyed; especially as they would have been protected by the soil in which they grew, whereas the sandstone, in which these trunks are found, abounds with impressions of leaves and branches? If they were immersed, without being transported, would the vertical trunks have been left bare of branches, roots, and all traces of the parent soil? There are plants whose aerial stems issue from a long subterranean stem; all the species of the genus Equisetum, or Horsetail are of this description. Although this genus is represented in many coal formations, its aerial stems alone have been discovered. Found at all heights of the coal-sandstone, often the vertical trunks that are almost contiguous, occupy such different levels, that the feet of some occur higher than the head of others, which implies a singularly contorted surface. The mineral substance that envelops them is so similar, above and below, in nature, composition and stratification, that we must suppose the plants vegetated in sand absolutely identical with that which afterwards enveloped them.

An argument in favour of the hypothesis of Deluc, Brongniart and Beaumont, has been derived from the vertical trunks of an earth-bed in the Portland-rocks : but this mould is, at certain points, so thin as gradually to disappear ; and there the trees would have been placed on the solid limestone which supports the black soil,—a situation in which they could never have developed, or even maintained themselves. Everywhere, the trees are plainly broken ; and it is difficult to understand, how, if they had been rooted in so thin a soil, they would not have been torn up rather than broken. In fine,—and this remark is decisive,—the mould in question is formed of a succession of small layers, a circumstance that clearly implies transportation by water. The position also appears to indicate the circumstances which presided at this deposit ; for before the layer of vegetable earth, we meet a layer of rounded pebbles, the presence of which suggests that the waters, coming from a more elevated point, bore along, at the same time, the vegetable earth and the trunks of trees, which preserved in descending the vertical position,—a position which we now see taken, at the mouths of rivers, and especially of those which carry sand, by trees the roots of which are heavier than the trunk. This is all that results from an examination of the supposed unanswerable arguments for the burial of forests and bogs on the spot whereon they grew, by irruptions of the sea. There are, however, other reasons which conclusively refute this hypothesis.

1° All the coal-basins are not marine ; coal has been deposited in the lakes. The coal of the marine basins is not always in contact with marine strata. Much more frequently it is covered by mineral substances derived from the continents,—sandstone and fresh water-clay.

2° Never has there been found a single layer of coal alone. The number of layers varies from 30 to about 80. Now it is not easy to understand how the sea, having been able to invade

40, 50, 60, 80 times some ancient forests or bogs, should never have invaded others more than about 30 times. What can have caused the number of sea-irruptions on the ancient forest surface to be precisely limited?

3° We must count as many invasions as there are layers, that is to say, from 30 to 80. But the totality of the alternate deposits of coal, sandstone, clay and limestone, sometimes exhibits a thickness of 2400 feet; and the consequent differences of level did not, it would appear, prevent the sea from returning so often to inundate the bogs and the forests!

4° There is no perceptible difference between the deepest and the most elevated coal seam in the basin: the plants of the latest sand and clay strata belong to the same species as those of the first, as Brongniart himself acknowledges. There are the same relations between the different strata of sandstone and the various beds of clay-schist. To explain these effects, often repeated at such different levels, we must admit, that, as far as the land is concerved, all the circumstances remained invariably the same, during the long series of ages necessary for the production of the whole phenomenon. After the retreat of the sea, which submerged the first forest, and the draining of the rivers, which are supposed to have covered its remains with their sands and clay, a new forest, formed of precisely the same species of plants, was in time developed, precisely over the site of the former one; there to await another irruption of the sea, which should destroy and overwhelm it with deposits equally composed of sand or of clay: which, in turn, being left dry, became the theatre of combinations absolutely analogous to those preceding; and so of the rest, to the last submarine forest and the last layer of sand on the coal-bed! These changes were repeated, in the same order from 30 to 80 times, in the same place, and that not only at a single point of the Globe, but on many points—in France, Great Britain, Germany, in India, the United States, New Holland, in all countries, in fine, where coal is found!!!

5° The coal-beds frequently contain a great number of sand and clay deposits, superimposed alternately; and between these deposits, the coal is found. But there is a mixture, a transition state of these three kinds of rock ; and the divisions are never clearly marked. Consequently all have been formed in the same basin by a continuous cause.

6° Since the coal-beds have been worked, no vestige of a soil which had ever been exposed to atmospheric influences has been discovered.

7° Every stratified layer supposes transport: now the anthracite, the coal, the lignites, and, in general, all the carbonic rocks, are of this character. They have been, then, transported, no less than the sand and the clay. But the sand and the clay are of continental origin, and they contain none other than river or land-plants. We infer from this, that the plants and the mineral substances were transported by rivers. The sea, then, has not come in search of the plants, but the plants have been carried to seas and lakes.

8° The position of the plants in the other rocks is the same that they have in the coal, in the schists, and in the coal-sandstone. They lie horizontally, and at all levels of the strata : they are scarcely ever whole ; are only found in isolated portions. The trunks are found cut off, separated from their branches, their leaves and their roots. Never do we find the lower parts of the plant, although, in certain species, they ought to adhere strongly to the soil. Plants which could not have flourished together are found together,—fresh water plants with land and sea plants. This is ordinarily the case. Those of the penean limestone, of the variegated sandstone, of the shell limestone, of keuper, and of the higher tertiary sandstone, alone appear to form an exception. While species of different places are associated in the same deposits, species which are generally found growing together often occupy different layers.

Thus the position of the fossil plants, their uniformly incomplete character, their associations, the stratification of their layers, and the number and thickness of the mineral layers which accompany them, the connection of all the parts of this system, &c.,—every thing, in a word, concurs to shew that these vegetable species did not live in the places where we find them, but that they were transported thither. The transport by the same rivers, furrowing, at a certain period of the year, the same uncultivated forests, and bearing along each year, a new layer of carboniferous substances, requires an obviously shorter time than the long succession of different forests and rivers, which has been imagined as necessary to explain the formation of our coal measures.

A considerable time was also demanded for the stratification of the sedimentary rocks after their emersion. It is now known that solidification is frequently the effect of causes which act while the rocks are still under water. The accumulation or pressure of the upper on the lower strata; the introduction of a cementary element by the silicious or calcariferous strata,—afford a satisfactory cause for this result. Thus we find on the coasts of the Mediterranean marl and silicious rocks, the recently emerged portions of which are already solid. The lakes of the island of Java, those of Scotland, the marshes of the great plain of Hungary,—produce limestone as hard as that of the most ancient rocks. The chalk-marble, the deposits of gypsum, the slate-schist and all the metamorphic-rocks, owe their solidification to the influences of the igneous cause. Many clay, calcareous and marl layers remain soft while in the bosom of the earth, but quickly harden when exposed to the air. In the section of the rail-road between Paris and Versailles, white marl has been found, which offers a remarkable illustration of this statement. It was at first so soft, that it might have been cut without breakage; some months after, it was found sufficiently hard to be used as facing for the sides of the road.

V.—If from the rocks, formed before the emersion of our continents, we pass to what has been since effected on the uninundated land,—to the volcanic products and the river alluvions, we shall have to signalize remarkable errors, a complete absence of special studies, and so injudicious an application of mathematical calculation as would be incredible, if it were not known what influence the shadow of a great name exercises on our learned men.

The lavas accumulated in such great masses round the craters of volcanoes have been compared to the products of the same volcanoes during the last period of their history; and the inference has been drawn, that they implied a very long succession of ages. Whoever considers the variations of intensity in volcanic action, the variations of quantity in its results and of time in its intermittences, will scarcely regard these masses as elements of calculation. Mountains of lava, islands of the largest size, may have been formed in less time than cones comparatively very small. It is certain that volcanic action has, in a short time, raised masses in the midst of the sea, on points where before three or four hundred feet of water were found. A few days and a single eruption have formed cones, 1000–1300 feet high, as Monte-Nuovo, Monte-Rosso, Jorullo, &c. Dolomieu cites a lava-current, issuing from Etna, which was thirty miles long. In 1794, Vesuvius produced a lava-stream 14000 feet long, from 400 to 1300 feet broad, and 25–35 feet thick; and, in 1787, Etna gave out a mass of lava four times greater. In 1793, Iceland was covered to an extent, sixty miles long and twelve broad, by a current of lava, 25–30 feet thick. The lava of Kaptaa-Jokul and Kaptaa-Syssel, discharged by three mouths, eight miles distant from each other, made a way for itself across the country and covered this large surface of the isle.

The igneous action is not continuous in volcanic phenomena, and there is no rule in its intermittences. Vesuvius was covered with trees to its summit in 79 A. D., the epoch of the disastrous eruption which buried, in its cinders and scoriæ, Pompeia, Stabià and Herculaneum. From 79 to 1631 there were only twelve eruptions. From this time, there were five in the seventeenth century and seventeen in the eighteenth. From 1160 to 1169 Etna was continually in activity. In the 15th century, Iceland was only visited by a single eruption in 1422; but from 1716 to 1783, it witnessed thirteen eruptions. The Gunund-Api, in the Moluccas, experienced, during sixty years, eruptions which only ceased in 1696. In Mexico, the eruptions of the Arizaba were continual from 1545 to 1566.

A single observation will shew, to what serious mistake men expose themselves, in calculating on the past from the data furnished by the last period of a phenomenon. The eruptions are fewer in proportion as the cone of the volcano becomes higher. It sometimes happens, that no real lava is ejected. This occurs in the volcanoes of the kingdom of Quito, whose elevation is five times that of Vesuvius, because the column of melted matter cannot be raised by the development of the gas to the top of the crater. The lava-issues, then, were much more frequent and more abundant, in the first period of each volcano, when the craters were on a level, or nearly on a level, with the surrounding surface.

"Let us imagine," says Desdouits, "that the method of our men of science were applied to certain natural phenomena, the origin of which is known: we should arrive at same remarkable conclusions. Let us take, for example, a man of the ordinary size, and of the age of thirty. It may be, that in his thirty-first year, his size would be increased by a small quantity, a half line,(1) for example. Let us reason as our geologists do, and propose this problem. The increase in height of a man being a half line in a year, how many years have passed since this man was four feet less; or what comes to the same thing, when was he born? A half line in a year gives an inch in 24 years, and 48 inches or four feet in 1152 years! Hence our man would be of that age and perhaps more. The half line might be the increase in ten years as well as in one year; and by their calculating, our streets would be filled with men who would have lived more than 11,000 years, and yet would not have seen the deluge. Thus it might be scientifically and mathematically proved that the deluge never occurred." (2)

Rivers have been treated as were the volcanic cones. Their alluvions have been measured, not for the purpose of ascertaining their dimensions, but with a view to learn their age. This process has given 60,000 years to the accumulations of the Pô, and as many to those of the Ganges, and Yellow River of China. A member of the Egyptian Commission, Girard,

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(1) A line is the twelfth part of an inch.
(2) Les Soirées de Montlhéry, p. 193.

ascribed 50,000 years for the formation of the delta of the Nile. "As soon," says Desdouits, "as the extent of a phenomenon of this kind appeared to reveal itself in a given time, the rule of three was invoked to solve the problem of its antiquity. It was said: so much has been formed in 100 years; hence ten times this result must have required a 1000 years for its production! It was not thought necessary to enquire, whether the causes of accumulation were always acting in the same manner, and with the same intensity; whether circumstances do not insensibly modify the phenomenon; whether, what has already been effected, for example, does not exercise an accelerating or retarding influence on products of the same cause; whether the cause itself is not modified by the succession of its products, which would completely and continuously violate the law of formation that these philosophers have imagined. If the Indian Peninsula, for example, is the product of the disintegration of the mountains of Thibet, the detritus of which was brought down by the Ganges, it is more than probable,—and that for many reasons,—that the matter taken from the mountains in primitive times, was formerly much more considerable, in a given time, than at the present day. How, then, can any calculation be made as to the past from data supplied by present circumstances?"

Girard is the most famous of those who have studied the alluvions. His observations are consigned in a memoir, read at the Institute in 1817. Girard caused excavations to be made at several points of the Egyptian Delta near the river, where he thought that the alluvial soil would be the thickest; and although the want of tools did not permit him to dig down to the solid rock, which underlies the alluvion, he was able to observe, on a section more than 50 feet deep, a continuous series of alternate layers of mud and sand, each one of which was not more than a half line in thickness. He at once concluded, that these layers were products of the overflow of the Nile; each overflow, he thought, had produced one of these layers; and as the river overflows but once a year, he inferred that the surface of Egypt was raised a half line each year, and 1,260 metres in a thousand years; so that 12,000 years were required for the production of these 50 feet of layers. May we ask a few questions?

1° How did Girard ascertain, that each overflow of the river, formed no more than one of these small layers? Why may it not be supposed, to have formed two or more, even at the highest point the waters could reach? What forbids us to suppose, that the sand and the mud, held in suspension at the same time by the river, may not have been deposited in the order of their specific gravity, first, the sand,—then, the mud? In this hypothesis, we would reduce, by one half, the number of years assigned for the production of the phenomenon. This explanation should appear the more reasonable, as it accords with the opinions of ancient and modern writers, without excepting the members of the Commission or even Girard himself, on the importance of the inundations of the Nile in relation to the soil of Egypt. They uniformly say, that the river inundates and enriches the soil, by annually coating it with its fertilizing mud. If the alternations of mud and sand belonged to two different inundations, the Nile would have impoverished the land of Egypt as often as it had enriched it. Every two years, it would play, although in a less destructive way the same part as the west wind, which renders sterile certain portions of the surface by burying them in sand.

2° From the moment, that Girard considered all these layers, half a line thick each, as the annual product of the overflowing of the Nile, he ought to have admitted, that each inundation had formed more layers in the low parts of the valley than in the elevated points. The waters of the Nile gradually enter into their bed, after a succession, more or less prolonged, of successive lowerings of their level. With these should correspond so many small distinct deposits, so that a single inundation might have produced, in the low parts, a great number of small deposits for one or two it might have left on the higher parts of the country.

3° I have been reasoning on the supposition that the layers observed by Girard were the result of the inundations of the Nile; but this supposition, which is the fundation of his calculation, is a manifest error. Were the fact such as he imagined, there would be, between these small sedimentary deposits, the product of the vegetation of the year preceding each inundation, the debris, and roots of plants, in fine, some indication of a soil which had already been exposed to atmospheric influences: By what miracle, then, has a cause which superimposed so regularly all these small strata, without ever effacing or furrowing its former products before adding to their number,—which has not deranged, or swept away, during all the time of its successive action, leaflets of so slender thickness, that the difference of color alone enables us to distinguish them, how, I ask, has such a cause swept off and annihilated all trace of vegetable detritus not once, but at every renewal of its action during ages? On the other hand, how has it happened, that, on the same points, but at the actual surface, extrinsic to all these small layers, a thick layer of vegetable earth, as Girard himself informs us, is found, except it be, that all the small sedimentary layers were deposited on a surface which was constantly under water, and on which, consequently, vegetation could not be developed? Why did so simple an observation not occur to Girard? True, it destroys all his calculations; for as, from the deposit of the first leaflet to that of the last, the place they occupy was constantly under water, it is necessary to acknowledge that this long series of small deposits is not the result of the inundations of the Nile, but that it was produced otherwise by the great current of the river, or by its eddies. And such is, at present, the rapidity and the quantity of the alluvions of the Nile on its shores, and along the prolongation of its course, that it would be absurd to suppose, that this great river should not have formerly deposited, each year, on the surface of its bed, more than a layer of a half line's thickness.

These small layers are nothing else than various leaves of one and the same massive layer, formed without any interruption; or if they are different layers, they present at the point where they have been pierced their interior extremity, a point where they finally disappear, towards the middle of the river.

These layers observed by Girard have not, then, been deposited by the inundations of the Nile. Were they the result of this periodical cause, it would be very absurd to consider each of these leaves, half a line thick, as representing all the product of each annual overflow. And these are the only plausible observations of Girard on the soil of lower Egypt.

At the very time that some geologists were led to these fabulous exaggerations by a capricious calculation, Deluc and Dolomieu, the men who at the time had most carefully studied the progress of alluvions, instead of finding in them an objection against the chronology of the Bible, were unanimous, —notwithstanding the difference of their geological theories,— in recognizing in them the proofs of the recent emersion of our continents: and they had taken as illustrations the alluvions of the Pô and the Nile. In their calculations, they followed the lights which observation had shed on this subject. Still Cuvier thought that this chronometer of alluvions,—as all the others employed by Deluc, to prove that our continents had formerly emerged from the waters,—left room for arbitrary calculations; and this indefiniteness, according to him, might extend to two thousand years. Let us not be astonished at these differences, or at these contradictory conclusions. None of these geologists had attained the truth. It is as impossible, with such data, to ascertain the approximate age of the ancient phenomena, as to predict that of those which may yet occur. In all these calculations, we are obliged to regard as unchangeable a multitude of circumstances which are constantly changing. The products of the two great general causes of the interior of our surface are consequently too variable in their quantity; and these variations depend on too many circumstances of indifferent character to be susceptible of solution by calculation. In this movement of the waters of our Globe, continually carrying the elevated portions of its surface to lower levels, a thousand causes might modify a phenomenon effected on so large a scale, from its initial to its final point. The causes of error are especially great and inevitable, when we wish to judge of ancient effects by those now produced. On all the water-courses, and before their discharge into the Ocean, changes of level have taken place, which have often varied the proportion of the materials distributed by these currents, between their own river-beds and that of the sea. In the early epochs, the continental currents were as different from those of our times, as the Gaul of Clovis differed from the France of to-day.

VI.—Beaumont endeavoured so rest the antiquity of the World on Natural History. In his lectures, at the College of France, he appeals to the instances of longevity, in plants, and thereupon raises the following singular argument. "In America is to be seen a baobab, 5150 years old, and a plaxoria of more than 6000 years. Now, he adds, we cannot admit that beings were created which could not fulfil their entire career. On the contrary, we must suppose that all beings have many generations; and if we give but twelve generations to these whose duration may exceed 6000 years, we have already 72,000 years for the duration of a single period! Beaumont counts six periods in the history of the formations.

"Let us suppose," says Forichon, "that the plaxoria of America is 6000 years old—a figure which leaves us 2000 years less than the chronology of the Septuagint—but where did Beaumont learn, that trees have an absolute existence, the duration of which is determined by the individual of the species which has lived longest; and that this duration should be taken as an average vegetable generation, so that, in his hypothesis, the plaxoria should not have begun to germinate before eleven of its ancestors had respectively lived six thousand years?

"There is no more reason for attributing to it ancestors of 6000 years than to suppose that the last buds it will leave on dying will survive it 6000 years. This long series of aged predecessors which are assigned to it, is, then, a purely gratuitous supposition; and if the plaxoria in question has lived 6000 years—a fact which is not established—nothing can be inferred, except, that some trees are in conditions very favorable to longevity. It is absurd to assume, as the general measure of the generations of their species, the extreme old age which certain individuals have attained, which are an exception to this general measure, and are referred to as prodigies in the natural history of plants.

The longevity of a tree can no more enable us to calculate the age of the Earth, than the first dentition, to estimate the age of a mammiferous animal. Were there a real relation between the age of any vegetable and that of the Earth, or rather of a geological period, the result of the calculation would be almost the same in all times. Now suppose that the plaxoria were to live 1000 years more, according to the principle of Beaumont, it would give 84,000 years, instead of 73,000, according to his actual calculation. A thousand years ago, the age of the World would have been only 60,000 years!" (1)

Others have brought astronomy to the assistance of hypothetic geology, and they have established the antiquity of the stars, which, however, are not included in our solar system, by the thousands of ages during which their light must have been travelling before reaching us. Maupied thus abridges the observation of Auguste Comté and Aube, whose astronomical investigations are amongst the most esteemed of our day.

"The causes which have influence on the variations of refraction, or the aberration of light, are numerous: they arise from our atmosphere, from that of the stars, from the state of the interval that separates us from these stars.

"1° Our atmosphere consists of numerous layers, the density, chemical composition, and especially the refracting power of which are completely unknown to us. 2° Is the interval which separates us from the stars void, or is it, as is more probable, occupied by fluids? What is the rapidity of light in these spaces? To know it, we should know at least how much time it takes to pass through the lower part of our atmosphere, and this we do not know. What is the refracting power of the fluid which fills these spaces? We know nothing whatever of it. Must we, with certain philosophers, believe, that the hydrogen of the upper region of the atmosphere produces the effect of a mirror, in which the stars are reflected? What is the condition,—what the nature,—what the chemical com-

(1) *Examen de plusieurs questions scientifiques.*—1837.

position and density of the atmospheres of the various stars? What is the extent of these atmospheres, their power of absorbing light, their action on light? These are so many elements of the problem, which will be for ever unknown to us; and as in astronomy every thing depends on the motion of light in the Universe, and on the different modifications effected in it by all the preceding causes, we must hence conclude, that we have no certainty of astronomical facts, even in our World. Notwithstanding the inextricable fundamental difficulties of the problem of astronomical refractions, we can easily understand how the effective and useful result of observations may attain a degree of sufficient mathematical precision. The apparent, and not the real, state of the heavens, is the only thing we require to know; and our ignorance of the modifications of the refraction of light, conceals indeed from us the real state of the heavens, but not its apparent state, which depends on the laws of refraction itself. These laws being constant should present to us an apparent state of the heavens almost constant, with the exception of the atmospheric variations, which we are enabled to correct at least in part. The practical result is, then, substantially the same, and if our astronomers are mistaken, both as to the motions and distance of the stars, which is possible and, according to Aube, probable, this does not affect our practical knowledge: their calculations would nevertheless be correct, as these are grounded on their supposed distance.

"If such is our inevitable uncertainty, as to the real distances in our solar system, what shall we say of the stars that do not belong to it, and which we cannot in any way approach? We have no means of ascertaining either their distance, or their figure, or their condition, or their nature. On these subjects, we can only make arbitrary conjectures, derived from the knowledge of our system; and the knowledge of our system giving us only its apparent state, the conjectures derived from it may only give us the apparent state of the astronomical Universe, accompanied, however, by the numberless errors which the difficulties, increasing with the augmented distance, must necessarily produce.

"What, then, are we to think of the statements of astronomers, who gravely advance that such and such stars are at so great a distance from the Earth that the light they emit takes thousands of ages before it reaches us, and who hence infer that these stars were created millions of ages since?—These astronomers neither know the distance of the stars, nor the time that light takes to traverse the spaces beyond our planet. None of the elements of their calculations are known: consequently their result is unknown. Genesis makes known to us the epoch of the creation of the stars: none of the sciences, considered in their positive and demonstrated results, can convict it of error: and yet these calculations are incessantly dinned into the ears of the uninitiated, and faith is denied to Genesis on the credit of such exaggerations." (1)

II.–Before going farther, we must draw some consequences from the foregoing observations. 1° Nothing but ignorance of the facts, or great weakness of mind, can make men receive with entire confidences the age assigned by geological calculations to our Globe. 2° The question of geological periods is not solvable in these hypotheses: because they do not explain the phenomena, are contradicted by observation, and are opposed to the laws of Nature. 3° This question has lost its former exaggerated importance, as the facts involved have become better known; such as the continuity of action of the two great productive causes of our surface,—their synchronism,—that of their various formations,—the localisation of rocks, and, as a consequence of all this,—the certainty that their classification is purely artificial—the greater volume of the ancient currents which produced the deposits,—the abundance of materials at their disposal under a climate of higher temperature than ours,—the distribution at all epochs of the diluvian layers and erratic blocks,—the solidification of rocks in the depth of the waters,—the rapidity of igneous formations by expansion in the early periods of the history of volcanoes, &c. 4° The solution of the problem of the World's history has hitherto belonged exclusively to historic monu-

(1) *Dieu, l'Homme et le Monde,* T. 1. p. 411.

ments. If, indeed, we can also derive from positive geology, in its present state, an approximate estimate of the past, it is certain that it must be sought elsewhere than in the comparison of the known products of any one period with those of another, for the reasons already adduced. The action of general causes on all points of the Earth's surface, combines with almost an infinite number of circumstances and of local causes, which are essentially variable in their intensity and duration, and which vary the quantity of their products. Under the influence of weak and slow causes, a century may in one place be necessary for the production of a result, which more powerful and energetic causes would effect in a few days. Even on the same place, powerful causes, after having produced vast results, produce only insensible effects, when a level has been attained. There is, then, no possibility of comparison between products of the same cause, at different epochs, in the same locality, nor at the same epoch in different localities. Hence no calculation is possible. Have our calculating geologists studied the laws of the multiplication and increase of the beings which furnished so large a part of the materials of our rocks? Have they found the limits of the ancient basins, to be able to judge of their shores, of their cliffs, of the direction of the winds on their waters, and that of their currents? Have they discovered the beds of the ancient rivers, which contributed to fill up these basins, their extent, their breadth and the dimensions of their affluents? Have they measured the height and other primitive dimensions of the ancient mountains; and calculated the measure of the mineral materials furnished by them to the continental currents, &c.? No: they have not solved any of these preliminary questions, for a single basin; and, to tell the truth, these questions, for the most part, appear incapable of solution. Upon what data, then, have they made their calculations?—Their proceeding is very simple. They have divided the rocks into different groups, and they have said: such a group requires so many ages for its formation, and thus of others. They have always given large round numbers, without saying of what smaller figures it was made up. This has been wise on their part: for when they condescended to give the elements of their calculation, they gave figures which can scarcely be heard without laughter; as are those on the last diluvium of Cuvier, on the baobabs and millenarian plaxoria of America, and on the overflowing of the Nile. They had not deduced the estimation of time from the facts of Nature, but from the principles of their systems. I might stop here, especially as these systems have been refuted. Still as at the first sight of these immense deposits of mineral substances, and this innumerable quantity of organic remains which form the surface of our Earth, many persons, while they reject the exaggerations of this imaginary geology, can scarcely persuade themselves that the time assigned by our chronology could have sufficed for these accumulations. I find myself bound to offer, in my turn, calculations, which are not indeed rigorously exact, which the subject does not admit of, but which are based on positive data, on natural laws and analogies. I shall follow Maupied as my guide, or rather I shall abridge and condense his observations. This writer does not attach much importance to these calculations, although grounded on physical facts, and not on hypotheses. Calculations have been made to puzzle and confound the unlearned; he has made other calculations to restore tranquillity to minds without prejudice and without party. The reader will judge of their value.

We must put out of the calculation the planetary mass, because this mass—with its mountains, its vallies and its vast primitive basins—must in all reason be referred to the direct will of the Creative Power; and, besides, it does not enter into our chronology, since Genesis shews us the World already formed and inundated, at the beginning of the first day of the first week of the World. The question is, then, to ascertain how much time was necessary for the formation, in the primitive granitic basin of the sea, of the sedimentary deposits it contains. Maupied seeks the solution of the problem, first from certain physiological terrestrial causes, and from the alternation and number of the strata of which the surface is composed.

I.—*Calculations on marine limestone.*—The Earth's surface is composed of vegetable, animal, and mineral substances. The calcareous rocks, which alone forms a considerable portion of it, are produced in great part by mollusks and radiata. "The shell," says Buffon, "is seen to increase, to strengthen itself by rings and layers, in proportion as the animal is developed; and frequently this rocky covering exceeds fifty or sixty times the mass of the animal that produces it. Let us imagine, for a moment, the number of these shell-animals, or, to include them all, of those animals that produce rock. They are, perhaps, more numerous than the insects on land. Let us, then, reflect on their rapid increase, their prodigious multiplication, the short duration of their life, the mean term of which, however, we shall suppose to be ten years: let us remember that we must multiply by fifty or sixty the almost immense number of individuals of this kind, in order to have an idea of the quantity of rocky matter produced by them in ten years. In fine, let us remember, that this mass of rocky substances must be increased by as many similar blocks as there are ten times ten years in all the ages which have elapsed since the beginning of the World." (1) Maupied adds some facts still more precise. 1° In general, the fossil mollusks are larger and more massive than the living ones. Such are the ammonites, which sometimes have more than 3 1/2 feet in diameter, the enormous cerites, the great buccinum, &c. 2° The extinct species amount to more than 6000, not to speak of the living species, about 4000 in number. 3° The individuals of each species are certainly many thousands; and we shall be below the mark in saying ten thousand. We must, moreover, remember that this number decuples itself every ten years.

On these suppositions, we may calculate that there are a quadrillion of individuals that produce on an average, a cubic foot of rock in ten years, the average term of their existence, as remarked by Buffon. In two thousand years only, we would have two hundred quadrillions of cubic feet of calcareous

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(1) Introduction à l'Histoire des Minéraux.

matter. The uninundated surface of the earth is about eight million of square leagues, or, neglecting the smaller figures, a quadrillion of square feet. Consequently, in two thousand years the mollusks might have covered all the uninundated earth with a layer of limestone, two hundred feet thick!

To the limestone furnished by the mollusks must be added that produced by the polypi. While sailing in the archipelagos of Polynesia and Australia, we can scarcely proceed a league without meeting a coral bank or isle. The banks rise perpendicularly from a depth of the sea which the sounding line has never reached, and the madrepore-islands form different stages—from the rock lashed by the waves to the fertile soil covered with large trees. 'I have seen,' says Dalrymple in his Researches on the formation of isles, "coral banks of all kinds; some entirely under the water, at a greater or less depth; others rising above the surface of the sea; many beginning to assume the appearance of isles, but still without any thing like vegetation." I have also observed a great number of them, whose summits are carpeted with wild grass, while others support fine trees: and all this when no bottom can be found at the distance of a pistol shot from the isle.

"The detroit of Torres is almost blocked up with such islands, and with others whose formation is more or less advanced.—The time will come when New Holland, New Guinea and all the numerous groups of islets and rocks, to the North and North-East, will form one immense continent." "There is," says Captain Flinders, "along the Eastern coast of New Holland, a chain of coral banks, through which we sought, for fourteen days, a pass to the open sea, and we travelled five hundred miles before finding one." (1)

"The zoophytes which elaborate the calcareous matter of which these islands are composed, raise very quickly their fragile habitations, the ruins of which occupy a space whose limits have not been ascertained; and the thickness of their productions is very great. Captain King travelled 700 miles, coasting a coral-reef, the few interruptions of which did not

(1) British Review. T. IV, p. 105.

exceed thirty miles. These reefs which extend from the North-East coast of Australia to New Guinea, surpass, in length, the greatest secondary chains in Europe.

"The Southern Ocean contains many thousand isles, especially in the Indian archipelago, and all around New Holland, which owe their origin to various species of polypus, such as the cellépore, the isis, the madrepore, the millipore and the tubipore. It is incredible with what rapidity these animals accomplish their work. The results are seen, in considerable masses, in places where, a short time before, they were not observed; and it is remarked, that the navigation of the seas where these animals abound, becomes daily more difficult, by reason of the indefinite number of reefs which rise on all sides, and which in time will form new archipelagos and perhaps new continents. As soon as the top of the reef is on a level with the water, and that it remains uncovered at low water, the corals cease their operations." (1)

All these facts have been confirmed by a great number of navigators. It is scarcely two hundred years since New Holland and these islands were discovered and explored. Thus in this short space of time, these seas have become blocked up, so as to render navigation more and more difficult; and not on a small scale, since some of these coral islands are 500 and 700 miles in circumference. They surpass in length the greatest secondary chains in Europe. On the other hand, the same phenomenon presents itself on the shores of the Red Sea, the corals of which have rendered its navigation difficult if not impracticable. The coral rocks are quarried for materials suitable for building, and after a dozen of years the hollows formed by this quarrying are filled up, and may be quarried once more.

Not to exaggerate any thing, but to take the most moderate figure, let us suppose that such hollows, ten feet deep, are filled up ten years, blocks of ten cubic feet may be extracted therefrom. Transfer this measure to the 900 hundred miles of coral chains, in Polynesia, we shall have in ten years only,

(1) British Review, t. V.

calcareous mountains of from 1800 to 2000 feet in thickness, and this on a length of 900 miles. If we join the calcareous products of the mollusks to those of the corals of all species, it will be seen, that the accumulation of the limestone-varieties of our surface did not require a very long time.

Taking the lowest figure, we have seen that the mollusks could have covered the uninundated portion of the Earth with a limestone-layer of 200 feet thickness. From the relations of travellers, it would appear that the corals produce still more calcareous rock than the mollusks; and we know that they are more numerous in species and individuals. Let us suppose, however, that they do not produce more than an equal quantity in the same time, they will give us in 2000 years another calcareous layer, 200 feet thick, on all the uninundated portion of the Earth's surface. Joined to that produced by the mollusks this immense calcareous rock will be 400 feet thick. There are not, however, any limestone, or, indeed, any other rocks, spread over the uninundated earth. Were we to suppose that our calcareous layer of 400 feet thick was uniformly accumulated on a third of the uninundated surface,—this calcareous mass, covering one third of the uninundated Earth's surface would be 1200 feet thick.

Some observations must be made on the first of the foregoing calculations. The corals of the Red Sea, and of the South Sea, have not been transported, like our geological formations. There are, doubtless, in the Jura and other strata polypes-corals in place; there are also some of them in the rough limestone of Paris, at Vaugirard and elsewhere. These are insignificant local facts and merely exceptionable. To have analogy between the coral limestone of our rocks and the immense coral masses of Polynesia and Australia, we must suppose these latter disintegrated by the action of marine, or continental currents, and transported into the depressions of the sea's basin in a sedimentary state. We should, then, perhaps, reduce to one half of their volume the two layers of mollusk and coral limestone mentioned by Maupied, by reason of the pressure upon them and the various accidents to which they are exposed.

The results of the calculation will not, however, be diminished by this great reduction, if we add to the marine limestone a number of strata which Maupied has omitted: 1° the carbonic rocks, and especially the anthracite and coal; 2° the pisolite-strata; 3° the clay schists; 4° the sand and the sandstone; 5° the pudding-stones; 6° the calcareous and silicious substances, borne to the basin of the sea by subterranean waters, &c. These different substances, pure or mixed,—the sources of which were formerly more abundant than they are at present,—must have formed, during the two thousand years to which Maupied has limited his calculation, numerous and massive layers, the dimensions of which cannot be determined by figures, but which must have been sufficiently great to compensate for the reduction effected in the limestone of the mollusk and coral formations.

With these modifications we may accept the great layer, four hundred feet thick, the product of two thousand years, the equal distribution of which on the third part of the uninundated earth gives a layer of 1200 feet in thickness. Such a uniform distribution of the surface does not indeed exist, and could not exist. There are many localities where no strata are found; others where but few and these extremely thin; others, where their depth does not exceed a few hundred feet, and others where the thickness varies between one and more than six thousand feet. We are without any data as to the length, breadth, and depth of the formations. We cannot then reduce them to cubic feet, in order to distribute them in thought over one third of the Earth's surface, and hence ascertain if the results of calculation are conformable to natural facts. And again, how are we to distinguish between what was effected in two thousand years, and what has been produced in a longer series of ages? We here evidently approach the unknown. Hence Maupied contents himself with comparing his layer of 1200 feet thickness with the vague data we possess as to the depth of the formations in our most perfect geological basins, which appear to embrace all the duration of times past, and not to have terminated in our country before the Roman occupation of Gaul. (1) The known facts as to the thickness of the most complex of these formations are generally in accordance with the result of these calculations.

Maupied observes, that he had limited his calculations to 2000 years, although the geological formations have been going on without interruption from the creation, that is, between seven and eight thousand years according to the Septuagint. In taking, however, six thousand years as the basis of calculation, we must replace our layer of 1200 feet, distributed equally over a third of the Earth's uninundated surface, by one of 3600 feet. This decides the question as to the possibility of the formation of our soil in the time assigned by Moses for the World's creation.

II.—*Calculations on coal.*—The greatest number of the ascertained vegetables of the coal belong to the vascular cryptogami and to the phanerogamous monocotyledons. The vascular cryptogami of the temperate zones, now living, are, for the most part, low and creeping plants: those of the coal-beds are, on the contrary, distinguished by stems of very large dimensions. The greatest of the fossil *equiseta* may be from 25 to 30 feet long. The calamites, so abundant in the coal, and which Brongniart refers also to the equisetaceous genus, have stems forty feet long, although the extremities are, for the most part, broken. The ferns, which alone appear to have formed a great part of the flora of the ancient formations, are still more gigantic. In the Bonin islands, situated to the East of Japan, arborescent ferns rise to the height of fifty feet. The truncated stems of the fossil ferns have often more than ten inches diameter, and more than 40–50 feet long. The species of the fossil genus lepidodendron, of the family of the lycopodiaceæ, are sometimes 3 feet in diameter at their base, and 64 feet long.

The flora of the coal-beds approaches nearer to the insular flora of the torrid zone than to any other, as well by the nu-

(1) In the bone-cavern at Miollet, a human statuette, with six copper bracelets, has been found.

merical proportion of the species of the different classes as by the development of these species. It is principally composed of plants which are of rapid development under favorable circumstances, of which the elevation of the temperature, by the greater extension of the sea, and the humidity of the soil are the principal. This similarity suggests to the mind that, at the epoch of the coal formation, our countries were not only exposed to a higher temperature, but also that, instead of forming parts of great continents, they formed islands of greater or less extent in the middle of a vast sea. This consequence receives additional confirmation from the general absence of terrestrial mammifers in our ancient formations, and also from the position of coal-beds round isles of primitive mountains, at the feet of which they are always found.

Although our vegetation, once insular and aquatic, has become, by the emersion of the soil, chiefly continental, we find, even at the present time, examples of a great transportation of vegetables by the waters. "The rivers, and especially the great rivers," says Lamétherie, "uproot the trees which line their banks, especially in the flood-season, and transport them to a greater or less distance. This is the reason why we find fossil wood in all the vallies of our great streams. The most part, however, of this wood is carried to the lakes and seas. All the great rivers, which traverse countries but imperfectly cultivated by men, and covered with forests, transport immense quantities of timber when their waters rise: such are the Amazon, the Orinooco, the Mississippi. Most frequently in the Northern Ocean do we see timber floating on the water. Travellers astonished by the prodigious quantity they have seen, are never tired speaking of it." He refers to Eddege, Ellis, Crantz, Phipps and others. In the virgin forests of uninhabited countries, the soil which results from the decomposition of the leaves, the fruits and the dead-branches and trunks, increases rapidly. We sometimes find, at certain seasons, the rivers of America black with the vegetable dust with which they are charged, and which they sometimes transport as far as six hundred miles into the sea, while at other times they bear along enormous quantities of floating

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timber. This appears to have been the way in which most of our ancient coal-beds were formed. Rivers, traversing vast and virgin forests, bore away considerable quantities of detritus, and entire portions of trees, to the great marine vallies. When the season for the *detritus* was past, these same rivers, at the time of floods, brought branches and trunks of trees, with sand and clay, to the place of the preceding deposit; or the waters of the sea or of the lake spread their contributions of mineral over these vegetable substances. In years of storms, of heavy rains and deeper furrowing of the soil, the vegetable detritus was swept away still more completely from greater parts of the great forests; they were transported for a longer time and in greater quantity by the river and its affluents; and they formed coal-beds of greater thickness. At other times, drought or other causes diminished the quantity of the *detritus*, and a small layer was deposited. In fine the terrestrial, river or marine mollusks, as also other animals, such as fishes, crustacea, insects, and reptiles, &c., were carried along and buried with the vegetables, or in the mineral layers which alternate with them. In this situation, the vegetable substances were carbonized without much loss. The clay, sand and calcareous strata, closing the passage on the gaz and the entrance of atmospheric air, prevented an excessive consumption of the materials. The gases were absorbed by the vegetable and bituminous matter and combined with it, since we find them in it, as also the debris of pyrites and the sulphates of iron, which give to some coal a bright lustre that every one may have observed. Such appears to be the mode of deposition and carbonization of coal; and what now takes place in the great rivers and vast forests of America may enable us to ascertain the time necessary for its accumulation.

It has been found that more than 8000 cubic feet of vegetable substances pass out of one of the mouths of the Mississippi in a few hours. Taking for the basis of our calculations the lowest figures, those which the partizans of indefinite series of ages in the past accept,—which calculations, however, were made on wood, taken from our copses, reduced to the state of coal in the air, and, consequently, having no analogy with the material of our coal-beds,—the following results have been obtained. These calculations shew that the coal-deposits are not more than 22|100 of the primitive substances of which they were originally composed; and this, making no allowance for combustion without considerable diminution of volume, such as we have indicated, because the carbonization which forms the basis of their calculation is supposed to have been made in the open air. Taking, however, this basis, and supposing that 8000 cubic feet of vegetable substances pass in twelve hours out of one of the mouths of the Mississippi, this gives 16000 cubic feet in a day; in three months about 1,600,000 cubic feet, which would give about 352,000 cubic feet of coal. Suppose this process going on at all the mouths of the Mississippi, which are four or five in number, and that this continued for the space of five hundred years, we would have a mass of coal of 76,000,000 cubic feet. Let us now remember, that similar phenomena are accomplished at the same time on 150 or 160 points of the Globe, where great forests are traversed by large rivers, flowing into seas or lakes, and we shall have 150 or 160 coal-beds, the formation of which did not take more than 500 years. This is, however, a greater number of coal-beds than are known to exist.

The greatest part of the coal-basins repose on primitive rocks, and bring us back to a period when vegetation was the more vigorous and active, as the temperature was elevated; when the lands recently inundated were islands, environed by large seas; when the warm humidity was more abundant; when man, limited as yet to some points of Asia, had not been able to clear the forests as he has done since; and when the lakes and marshes were not yet filled up. We must be convinced that these primitive times were most favorable to the formation of the coal-beds, and to the development of the vegetable species which most frequently occur in them; and that four or five hundred years after the creation, the most of the coal-basins were filled up, and that all those that are ancient may have been filled up at least after a thousand years.

Maupied does not attach an exaggerated importance to his calculations, although they are based on positive data, supplied by the very nature of the vegetable substances most generally found in the coal. The millions of years which certain writers assign for the formation of the coal-deposits are based on our copses and our forest trees—which have not as yet been found in the coal, although they may hereafter be met with—and moreover on wood carbonized in the air, whereas it is certain that the coal was not carbonized when in contact with the atmosphere. Maupied's calculations are, therefore, more in harmony with known facts, and consequently more rational and logical than those we have referred to.

I shall add a few observations, which appear to prove that the coal has not been slowly deposited. 1° The vegetables of the lowest as well as those of the highest coal-beds belong to the same species. These same species are also found in the first as well as in the last sandstone, or clay, between the coal-strata. This fact is attested by Brongniart and the English Botanists. On the other hand, the clay and the sandstone, taken separately, present throughout their whole series the same mineralogical composition. In a word, all the parts of the coal-formation in the same basin, connect with each other by numerous oscillations and gradual transitions. Each coal-basin was consequently filled by the same river and its affluents, which took up their organic and inorganic materials on the same points. From the beginning to the end of the phenomenon, the circumstances were unchanged both on the part of the river and the region through which it flowed. This conclusion harmonizes but badly with the supposed antiquity of the World, especially when we must, as in the present instance, refer the effects of which we speak to the early epochs, when the waters of the continents, but feebly enclosed, frequently changed their directions, and hence must necessarily have varied the character of the substances they transported to the bed in which they were to be deposited.

2° This, however, is not all, and we shall see that each coal-basin must have been filled up in less than a century. There is no river known which, throughout the whole of the same year, always transports similar substances to the sea. This would not be in accordance with the periodicity of the seasons. We cannot, then, regard each seam of coal, or each layer of sand or clay, as the product of an entire year. To ascertain the annual product of the river which transported the coal and the other mineral strata, we cannot take less than one alternate series composed of a layer of coal, and a layer of mineral substances,—either sandy, or argilaceous, which covers it, or which is covered by it: and hence the number of alternate series will give us the age of the coal-bed. Now, among all those that are known, there is none in which the number of coal-seams is more than from 80 to 90; and hence, all the known coal-basins must have been filled in less than a century. The alternations correspond with those of the seasons, and indicate their influences on the currents. At the time of high water, when the rivers probably overflowed its banks, the currents transported the heaviest substances, the sand and the clay, to the coal-strata. When the waters re-entered their beds, after having inundated and furrowed the neighboring lands, they deposited on the clay or sand previously transported vegetable detritus, and formed a new layer of coal. In the dry season, the river encroached less on the sea; and this latter was enabled sometimes to deposit a calcareous layer over the last coal-deposit. Thus, either the ancient currents which transported the coal had at their disposal a larger quantity of materials than the Mississippi, or the reduction of the vegetable material to 22|100 by combustion—a reduction which Maupied generously accepted from his adversaries, is an erroneous supposition. Far from exaggerating the facts favorable to his views, this writer has rather diminished their real character.

I pass over his calculations on the bogs, because they are based on data which observation has not yet established. The bogs may, in many cases, have furnished vegetable materials to the coal-beds. Their soil, always very marshy, retains the rain-water, which, when considerably augmented, raises the entire mass. If it is situated on high and inclined places, it descends like the glaciers in the mountains; it spreads out, in this way, over a large space; and its progress can only be stopped by digging ditches which will permit the waters to flow off. In low grounds, the turf is also raised so as to form floating islands, which are sometimes carried out to sea. At the epoch of the coal-beds, the low and marshy portions of the numerous islands with which the sea was covered, were very favorable to the growth and development of the bogs. The aquatic plants which prevail in them, are horsetail, rushes, the typha, the confervæ, &c.; and in several of the coal-beds we find many plants analogous to these species. These plants grow with great rapidity, and increase every year very considerably the volume of the turf. What takes place in Holland may give us an idea of the rapid augmentation of the bogs. That country, as is known, contains a great number of them; and art has succeeded in daily renewing them. There, as elsewhere, the natural bogs are formed by the decomposition of plants which grow in marshy grounds. A section of the bog is cut for use; a ditch more or less extensive, is thus formed. The water flows in, or is conducted thither; the *conferva rivularis*, and afterwards mosses and lichens are developed. These plants are in time decomposed; and, at the end of six or ten years, a new turf, occupying the site of the section which had been taken for use, is found equally serviceable.

In the time of high waters, the bogs of the coal-epoch, raised by the waters of the overflowing rivers, must have been carried into the currents of these rivers, where they formed floating islands, which the currents might transport to the sea at the same time that it bore away the detritus of forests which the inundation had laid waste. In this manner, the turf may have contributed to fill the coal-basins. It does not appear possible to admit, with Deluc, Lamétherie and Brongniart, that the coal was formed, as was the turf, on the very spot where its vegetable materials grew. This opinion appears irreconcilable with observation. Everywhere, in the different geological formations, the coal is found in a stratified state, and nowhere in the coal-beds have been found the soils in which the plants could have grown, and which would have been subjected to the immediate influences of the atmosphere.

III.—*Calculations on the superposition and alternation of deposits.*—In the beginning of this century, Ami Boué, dissatisfied with the boundless calculations which were made on our Globe's age, pointed out a method which was much more conformable to the laws of Nature than those theretofore employed to attain that object. "Might we not," he observed, "regard each of the seams of a strata, as the product of a tide-wave or movement of the waters? Might not the thickness of some of them, arise from the fact, that they are the deposits of the highest tides, that is, of those of the equinoxes? This hypothesis would appear probable from the resemblance between the undulations of the surfaces of the strata with those produced by the waves on the soil and sand of our banks.

"In the case of the alternance of different rocks, may we not divide them into groups, composed of two or three species of deposits, and, with Jobert and Saignez, regard each of these groups as the product of a single year? These alternations of limestone or of marl, of clay or of sandstone, being generally very regular, would appear to indicate a periodicity in their being deposited. A year appears the most natural as well as the longest time that can be assigned for their production. The clay, the sand, and the flints—could only have been brought to the sea in great quantity, at the time of high water in the rivers, in the tempestuous seasons of the year." It is, then, from the number of the layers, he thinks, that we can establish the chronology of the deposits of our surface.—"This object will be attained thus more easily than in taking as terms of comparison the annual alluvions of certain rivers, or the rate of decomposition of certain rocks. The learned have as yet arrived at nothing but contradictory conclusions from the river-alluvions, which fact shews that this *datum* is not available for the enquiry. As to the decomposition of rocks, it neither does, nor can, tell us at what geological epoch the action of the disintegrating cause commenced. Moreover there are decompositions, as well as alluvions and vegetable soils, which may date, either in whole or in part, from the most ancient geological times, these products having been in course of formation since there was a surface left without water : but we have no means of distinguishing between what belongs to one epoch and what belongs to another. Geologists ought not easily believe, that the whole Earth is modelled on the divisions and subdivisions of rocks on a comparatively small part of our continents."

Notwithstanding this rebuke to the advocates of the artificial divisions of our formations, we find Boué himself seeking in them a weak support, in answer to the objections derived from discordant stratifications.—"A series of strata superimposed, the one over the other in concordant position, indicates a continuity in the deposits. To meet with all the stratified deposits of the Earth's crust in concordant superimposition, would be to have, before our eyes, the details of the operations of Nature. Nowhere, however, is this found; because expansive elements and igneous causes have, at certain times, deranged the strata of every country. We are, then, obliged to combine as well as we can, various intact series of strata so superimposed, observed at great distances from each other." (1)

More than once we have had occasion to observe that the dislocations of the surface and the effects of igneous action, did not stop the deposits of aqueous origin. They only caused them to change somewhat their direction, while furnishing them with more abundant materials. The discordant position does not, then, indicate an irruption in the deposits of the same rock, but only a change of direction in the cause of the deposits and greater rapidity in their formation. Thus considered these local accidents could not materially interfere with the chronology of rocks of the same locality. The chronometer, then, proposed by Boué, retains its value, and it is better than that proposed by theorizing geologists; because it is grounded as well on geological facts as on the facts we witness. It embraces the problem in its two principal and continuous facts:—the uniform marine-deposits, and the alternating deposits found at the mouths of rivers.

"And first," says Maupied, "with regard to the sea-deposits, the series of leaves—whether in concordant or dis-

(1) Guide du Géologue, t. I.

cordant stratification—gives the number of the tides which have deposited these leaves, and consequently the time which the entire formation in the same locality required. We do not here speak of the daily tide, which ebbs and flows twice in twenty four hours, but of that which causes the waters of the sea to rise to an unusual height during several days, and then causes them to fall. This double movement, caused by the moon lasts about fifteen days, and, consequently, there are two such tides each month. Admitting, now, that each tide, in the sea where deposits were formed, deposited a seam or layer of two inches' thickness; and it very often happens that the deposits of a tide are, at some points, several feet thick, —2 inches, each tide, will give us four feet each year, and in two thousand years, a thickness of eight thousand feet. All the known rocks united do not exhibit such a result; as the whole secondary formation only gives in Germany a thickness of 6020 feet.

If we allow only one inch to each tide of fifteen days; 2000 years will give us 4000 feet. If we give three inches to each such tide—which is by no means of rare occurrence,—we shall have a depth of 12,000,—a thickness which is no where found in the strata of the Earth's surface.

"In the case of deposits of the mouths of rivers, or alternations of salt and fresh water origin, a year appears to Boué the most that can be assigned to them. Geological facts as well as natural causes, shew, indeed, that we cannot extend beyond a year each alternation of two layers. Supposing them to have a mean thickness of three feet on each alternating layer, we shall have six feet for the two layers each year, and 12,000 feet for the 2000 years. Nowhere on the earth has been found an alternating series of 2000 layers of marine and river origin, nor 12,000 feet of strata at any one part.

"Hitherto we have only considered the rocks in the causes productive of their materials and in the causes of their deposits, but we must not forget to bear in mind the great law of synchronism. There is always synchronism of the aqueous and igneous causes, that is to say, these two causes have acted at all epochs simultaneously and, very often, concurrently.

There has been synchronism in the aqueous causes: the sea and fresh water have acted simultaneously, each on its side; and they have reunited their results on a great number of points. Thus, for example, while the coal was deposited at the bottom of certain vallies with the schists and sand, marine and river alternations took place on other points; shore-deposits were elsewhere formed; farther out in the sea calcareous rocks were deposited; and coral-reefs rose up at the same time that the washing away of the corals and the debris of shells formed the chalk towards the centre of the great deep. Thus the five grand secondary divisions should be regarded as in great part contemporaneous, and not as successive in their formation.

"But, while these phenomena were accomplished in the same basin, similar analogous results were produced in other basins. We cannot, then, add up all the series of all the basins, in order to have the duration of their formation, as is done in the artificial classifications. They are to be considered as parallel, and the most perfect basin in the series of strata is that which gives a measure of time that contains all the rest. But in this perfect basin, we cannot add all the strata, or all the rocks, since a great number may have been contemporaneous; and synchronism may have had place between a part of two different rocks. We can, then, only regard as true measures of time, the number of strata in superimposition; and the absolute thickness of the whole thickness of layers thus superimposed in the same basin, from the primitive to the most recent formations. The law of synchronism thus understood adds a new and very great probability to our calculations of time.

"Thus the facts and geological data do not appear to have required more than 2000 years to form the thickest of our geological series. Whatever chronology we adopt, there is no difficulty presented to us. The Septuagint count from the creation to the deluge 2242, the Hebrew Text only 1656, and the Samaritan 1300 years. From the deluge to the Birth of Christ there is, according to the Septuagint and the Samaritan, about 3000, or 3100 years, and according to some copies of the Septuagint 3500 years. The Hebrew counts no more than 2357 years for the same period. The Church has not determined any thing regarding these chronologies. That of the Septuagint has been a long time in use, and may be adopted. In taking the lowest figure of this chronology, we have 7080 years from the creation to the present day. According to another calculation we would have 7600, or even 8000 years. Nor can it be said in reply that the Jewish years were lunar years ; for it is ascertained that their civil year was solar. Moreover, to place themselves at all times in harmony with the seasons, they added at certain times, a thirteenth month, called embolismic, to their ecclesiastical year, which was lunar, which made it agree with the civil or solar year.

"Counting, then, with the Septuagint, 2262 years from the Creation to the Deluge, there would have been sufficient time for the formation of the primary and secondary rocks. In prolonging, if we wish, the formation of these rocks to 3000 years after the Creation, we shall still be 2762 years before Christ, a chronological epoch the most remote of the greatest part of the ancient peoples, who arrived then in countries partly covered with waters, in which the tertiary series were in progress of formation." (1)

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CHAPTER VIII.

Recapitulation of the Review of the Geological systems, considered in themselves and in their relations to Genesis and Science.

I. None of these systems rests on observation ; they are supported by hypotheses more or less singular, unproved, or proved to be false or absurd. They mutually destroy each other, although they exhibit in their leading features a very striking family connexion. The earlier English writers on

(1) *Dieu, l'Homme et le Monde,* T. III.

the subject appear to have passed over the whole course of hypothetic geology. Some of them framed geological hypotheses, and others of them advanced zoological and philosophical systems. Burnet makes his oily cortical envelope of the Earth fall into the great abyss. Woodward covers this supposed envelope with the water of the abyss, and blindly accepts all the conjectures of his predecessors. Leibnitz wished to establish that the Earth and planets had been suns; and, Whiston arrived at the conclusion that the Earth had been a comet. Buffon united both hypotheses, and derived the Earth and the planets from the sun, which a comet had struck. This is substantially the same system he himself ridiculed in Leibnitz and Whiston, and may be refuted by his own observations on the fancies of these writers. Deluc borrowed from Buffon his indefinite periods and successive creations; from Burnet, his caving in of the Earth's crust; but the great abyss, which owed its origin to an unscientific interpretation of the Scriptures, is replaced by this hypothesis of subterranean walls and pillars. Cuvier changed Pallas's sea-wave into a regular series of marine irruptions: he borrowed from Buffon and Deluc their successive creations and their long periods of time; which latter, however, he criticized severely. His views have especial affinity with those of Deluc. For him, as for the Genevese geologist, the causes which produced the formations are extinct, or their action has been suspended since the emersion of our continents. Both admit that the sea often and suddenly invaded the abode of land animals and engulphed them in its waters. Ampère accepts the successive creations and the epochs of Buffon, and the successive destructions and extinct causes of Deluc. He takes from Cuvier his periods of animalization, and from Brongniart his periods of vegetation, while supposing them to be much more definite and consecutive than they appear in these authors. A nebula was, for him, the germ of the Earth and of all other sidereal bodies. He explains the effects of heat, which are found in our strata on a very small scale for each epoch, by deluges of fire which destroyed all pre-existing life. But the theory of Beaumont is the richest in hypotheses, and appears to be the receptacle of all those that have had currency,—the primitive incandescence of our Globe of Leibnitz,—the central fire of Whiston —the contraction of the terrestrial envelope by cooling and the primitive surface without mountains of Burnet—the upraising of the mountains of Deluc, Heim, Jobert, &c.,—the epochs and successive creations of Buffon—the successive destructions of Deluc,—the deluges of Cuvier—the artificial superimposition of strata of Werner, &c. This geology is not only essentially hypothetic, arguing from the unknown to the known: it is also an eclectic geology, receiving from every quarter its principal data, and, consequently, not having, and not being able to have, a generative principle, without which it is impossible to construct a science. Hence so many contradictions, and the absence, more or less, of connexion, of logic, and of good sense, which characterizes all these theories.

It is not, then, to their scientific worth that we are to attribute the favour with which some of them were for a time received; but to the extraordinary and accidental disposition of the public mind, the social position of the author, his reputation, persuasive style and imposing influence. It was to the elegance of his style that Burnet owed his success. Whiston treated the hypotheses which are part of his system "with so much ability," says Buffon, "that they cease to appear absolutely absurd. He bestowed on his subject as much genius and science as it would admit of; and it will be for ever a matter of astonishment, that he could construct a dazzling system out of the absurd and incompatible ideas on which it is based. It is not so much to the vulgar, but even to the eyes of the learned that it appeared such; because the learned are more easily surprized by the show of learning and novelty of ideas than are the mass of mankind."(1) Buffon's *Epochs of Nature*, in which the writer displayed more genius, talent and ability than are to be found in Whiston, had for a time great celebrity. They were so well adapted to the dispositions of the Encyclopedists. Buffon acknowledged their futility with a frankness which his plagiarists have not imitated.

(1) Preuves de la théorie de la Terre.

Deluc's system appeared favorable to Genesis, and was, for a time, accepted by some of the clergy. The political and scientific position of Cuvier; his ability as a writer; the eclat of his other works, which imparted their lustre to his geological labours—explain their success. Cuvier founded a school. In such circumstances any theory is sure to survive, at least for a short time, its author. If it be based on truth, so much the better; if not, it will however be accepted, but will disappear with the enthusiasm its author was able to inspire.

II. Not only is there nothing in common with these theories and the recital of Moses, but there is, on all sides, evident incompatibility between them, as we have sufficiently shewn. Such of our speculative geologists as did not wish to reject Genesis, tortured their ingenuity to give its narrative a new interpretation, which was unnatural and contradictory; and made the text an echo of their own thoughts. When we interpret a passage, we must take it as it is. By changing its obvious meaning it is not on the text, but on our own notions, we ground our argument; and as these opinions, being mutually contradictory, are in their turn replaced by others, it happens that we make Moses say yes and no, in the same sentence, and while using the same terms. If I direct attention now to the manner in which the harmony of the history of Creation has been disturbed by these unmeaning interpretations, it is not to blame the intentions of the interpreter; it is to express the disgust of their geologico-theological systems which is felt by all who have taken the pains to study them. The first chapter of Genesis is as clear as any other historical page of Scripture. Hence the sacred writers after Moses—the Fathers of the Church—Hebrew scholars whether Jew, Protestant or Catholic—all have understood it, and have explained it, in the same manner; and this uniformity of interpretation is so necessary, that as soon as we depart from it, and give his words another meaning, the narrative becomes contradictory and unintelligible, so close is the connexion of its different parts, so great the unity of the whole. Genesis has been tortured into a different meaning from its litteral signification, from motives extrinsic to the text ;—it is to make it harmonize, in spite of itself, with the successive modifications of our physical theories. This is frankly avowed, and the imputation of error is brought against all the ecclesiastical interpreters "who blundered, because they were not sufficiently instructed in the physical sciences." (1) Thus the sacred writers, and the Septuagint interpreters, are convicted, of not having known the meaning of the word, "day" in their own language, because they did not know geology! Whiston tells us, that Moses has always been misunderstood; that the ideas he is believed to have expressed are absolutely false; and that the Earth originally existed in the chaotic state in the atmosphere of a comet. This comet's tail, which no one before had seen in Genesis, Whiston discovered, with his astronomical glance, in the words—"darkness was upon the face of the abyss." This was not the only extraordinary discovery he made, as the reader may remember. Ampère, beginning from the beginning, reduces Whiston's comet to its simplest expression—a nebula; which he gives as the first germ of the Globe, the brilliant hope of the World that was to be. This notable discovery Ampère found in the text: "and the Earth was void and empty"—where neither Jewish nor Christian interpreter had ever suspected such a meaning to be hid. Buckland and Chalmers inherited from Whiston the antegenesiac existence of the Earth and the other sidereal bodies. When our world was organized there was merely a change in the relation of the various bodies of which it is composed. There is, consequently, no creation of inorganic matter recorded in Genesis: all interpreters have blundered in translating the words, "let there be light,"—"let there be a firmament," "let there be lights,"—as if they signified creations properly so-called. The two English writers, Chalmers and Buckland, thought themselves bound to recur to this far fetched interpretation, in order to find the time which their geological hypotheses seemed to require. They attempted to reconcile

(1) Géologie Elémentaire, par Nérée Boubée, p. 4.

Science and Religion by the self destroying concessions which they require the latter to make.

If we go to the bottom of the philosophical doctrines which have presided over the birth of these different theories, we shall find a kind of bastard eclectic pantheism seeking to intrude itself,—whether its authors are or are not aware of the fact,—between avowed pantheism and the Mosaic, Catholic dogma of creation. According to this latter, the World was created and ordered by the immediate Will of the Omnipotent. According to pure pantheism, the World is eternal; it is God; whatever exists is the result of the laws of matter and of Nature. Organized beings themselves are the products of these same laws in their highest manifestation. Like the Earth, they have passed through a process of general development, from the chaotic state to that of the monad, to that of the coral, to that of the mollusk, &c.,—even to man. Such is pantheism plainly stated. It is equally absurd and false: but the thesis is at least consistent; it has the logical merit of being faithful to its principle, which is the negation of a first and intelligent cause; and it adapts itself to this principle in all its extent, even to the most remote consequences. But the systems to which we refer are incomplete and inconsistent. The absurdity of the pantheistic principle, rigorously applied, being so evident, it was necessary to conceal it. It has been divided into two, three or four theses, according as it was found desirable to recede from, or approach more closely to, pantheism or catholicism. All these intermediate shades of doctrine betray the common vice of their origin. The laws of logic bring them back irresistibly to their source, and Genesis invincibly spurns their contact.

I.—LAMARCK.—This name is not connected with any of the systems we have reviewed, because the system he proposed is a zoological rather than a geological theory. The age of Buffon and Lamarck looked down contemptuously on the science of theology. With the exception of a few sound minds, who foresaw the terrible catastrophe which society was bringing on itself, and who pointed to Religion as the key-stone of the social arch,—as the only hope of safety, all the rest, hurried away and overwhelmed by the torrent, either neglected it, or even endeavoured to prove its teaching false. This was even sometimes seen in men of upright minds and virtuous instincts, who were influenced by a strong although blind conviction, that a more universal and complete system of education could replace Religion. Experience and facts have shewn the futility of these hopes. Had these men listened to the echoes of the past, the plaints of agonizing society and of ruined empires, they would not have stood in need of any other monitor. Under the influence of this illusion of their times, Buffon and Lamarck were led to create a World after their own ideas. The former, it is true, avowed that his plan was a pure supposition; the latter, while introducing some slight modifications into the theory of Buffon, maintained it with a conviction which was as sincere as it was erroneous.

Lamarck constitutes the nearest approach to undisguised pantheism. He admits a Creator-God; but only a Creator of primitive matter and of Nature; and recognizes in these creatures alone the power of organizing all things, and of producing animals and plants. This is the pantheism of the naturalist. But, in the first place, matter does not exist, it has never existed; there are material beings whom we comprize under the abstract name of matter. Observation and experience never shew us matter except in the form of compound or elementary bodies. To whatever extent we may carry the analysis of elementary bodies, which we must regard as simple, their ultimate elements will be bodies, because they will always have some qualities characteristic of bodies, without which they would be nothing. Matter is, then, inseparable from bodies, and bodies are matter. Bodies, compound or simple,—and there are none other, nor can we conceive of any other,—are matter. Matter has not, then, been created independent of bodies. Lamarck himself appears to have perceived this. "We only know matter," says he, "by means of bodies." But if matter cannot be conceived except in the form of bodies, God, whom Lamarck recognized as the Creator of matter, is the Creator of bodies.

Lamarck himself will tell us what Nature is. "Nature," says he, "is in some sort a mechanical power, which uses as means universal attraction and repulsion by subtile fluids.—Nature is an order of things that could not have given itself existence. We must, then, recur to its Divine Author, whose Will is everywhere expressed by the existence of Nature's laws, which come from Him. It is an order of perpetually active causes, which is extrinsic to the parts of the Universe.—Nature consists of motion distributed among bodies, of the laws of all the orders which establish order and harmony in the Universe.—Nature is immutable, unalterable, and has no other limit than the Will of the Creator. It is not God,—it is not even the soul of the Universe. It cannot, then, have an end, an intention in its operations. It is only an instrument, a partial mode employed by God to place all parts of the Universe in the changeful state in which we behold them. It is a sort of intermediary between God and the parts of the Universe, for the accomplishment of the Divine Will; it is a subordinate power. It produces but does not create, for this is the exclusive character of the Divine Power." (1)

Thus Nature, this second creation of God, this power in some sort mechanical, which employs universal attraction and repulsion as its instruments,—this natural power,—since it is neither a universal soul, nor God, but only the expression of His Will,—is, doubtless, itself a body or a collection of bodies, or of the qualities of bodies. How otherwise could it act by means of attraction and repulsion, which are properties of bodies, and by subtile fluids, which are evidently bodies? No, replies Lamarck; Nature is an ever active order of causes, extrinsic to the parts of the Universe, an order of things which could not have given to itself existence. But an order of things, extrinsic to things, an order of mechanical causes, extrinsic to bodies of which they are the properties, what is this but an abstraction to be placed side by side with primitive matter? Of what is this inconceivable Nature composed?—It is composed of motion distributed in all bodies, and of all

(1) Histoire des Animaux sans vertèbres : VIe Partie, p. 250.

the laws which establish order and harmony in the Universe. But motion is an abstraction; it does not exist independently of bodies; and the laws which maintain harmony in the World cannot be any thing else than the effects of the Divine Will, or the result of the qualities of the bodies of which this World has been formed. If this order of the World is immutable and unchangeable, it is because these qualities, being essential to bodies, shew themselves always the same in the same circumstances. These qualities have no existence, and never could have existed, without the bodies in which they are inherent. The proposition that there are properties of bodies, supposes that there are bodies; and if there be different bodies, there must be bodies having different properties. The Divine Will, in creating bodies, consequently created at the same time the properties which were to maintain the order He established, and which constitute the laws of the World. This proves that creation could not be the result of such laws; since these laws are the result and not the cause of creation.

If neither matter, nor Nature, nor the laws of the World, can exist without bodies, it necessarily follows, that all bodies have been created; otherwise there would be neither matter, nor Nature, nor laws of the World. This thesis of Lamarck—that bodies are produced by matter and by Nature—is consequently contradictory and absurd.

Yet it is from this crude notion of Nature and matter that Lamarck derived not only inanimate bodies but even plants and animals. According to him, the primitive type by which Nature commenced the animal series is the monad limit, developed in a liquid globule. He does not determine whether Nature commenced the vegetable series by two or three types. "If Nature," says he, "had not already produced animals, she could still produce them in the same manner and by the same ways." In this he differs from Epicurus, who represented Nature as barren and effete. He admits as undoubted spontaneous generations at the present moment; but only for the simplest organizations. After spontaneous generations, which commenced each particular series, the animal species, by successive transformations, proceeded, one from the other. He does not, indeed tell us, how? It is sufficient for the present to observe, that the transformation of species, one into the other, is proved false in all the degrees of the animal and vegetable kingdoms. The species are fixed and determined. They are organized with strict reference to the circumstances and media in which they are to live. They have not, then, been produced by a blind and mechanical cause.

As may easily be imagined, Lamarck admits no species, but only individuals. This is a gross error: the species is as real as the individual, since it produces the latter, and, in the present order, the latter can only arrive at existence by the former. Lamarck mistook a reality for an abstraction, after having so often taken abstractions for realities.

The clays, according to him, are evidently the detritus, or residuum of vegetables: moreover, all the inorganic matter, minerals and metals, result from the action and the decomposition of organized beings. Hence we must infer that there were no mountains anterior to the existence of organized bodies, since all inorganic bodies derived their origin from living bodies, both animal and vegetable. On what did these organized bodies stand? What did they rest on,—where was their abode? But we have said enough of this contradictory and absurd theory.

II.—Buffon.—When investigating the first cause of the motion communicated to the stars, Buffon said, "this impulsive force was certainly communicated in general by the hand of God, when it set the World in motion, but as we should, as much as possible, in natural philosophy abstain from recurring to supernatural causes, it appears to me that in the solar system we can account for this impulsive force in a way sufficiently probable, and that we can assign a cause, the result of which is in harmony with mechanical laws." We have already seen that the effects of the cause, assigned by Buffon, is in complete disaccord with the laws of mechanical forces. I wish here, however, to direct attention to the anti-scientific principle of this writer, a principle so entirely false, when understood and applied in this way, that Buffon himself could not express it without contradicting himself in the very phrase he employed. On the one hand, he recognizes God as the certain author of this impulsive force; and on the other, he seeks to find another cause in Nature, as if there could be two real and immediate causes of the same effect, or that the same cause could be at once natural and supernatural! He makes it a duty to abstain, "as much as possible," from recurring to supernatural causes; and he does so, when it is impossible for him to do so, and when he ought not to do so, since, according to himself, the certain cause in the present case is not of the order of Nature. It is not allowable to refer scientifically the effects of a recognized cause—acknowledged to be the real cause—to an hypothetic cause, were it even a probable one, except for the purpose of arriving at the confirmation of the certain cause by the argument *ex-absurdo.* Buffon, indeed, attained this result, but contrary to his intention, and so far he deserves blame. We ought always seek to ascend to the causes of things, and especially to primary and general causes, wherever they are to be found; this is the condition on which alone science can be attained. This great principle was proclaimed by Aristotle, the most profound of Naturalists, and Buffon should not so often have forgotten it. The false principle of Buffon led Lamarck astray; and it is the prevalence of this principle in different degrees that characterizes the different shades of doctrine we are now examining. What efforts have been made to create the World without God!

Buffon admits a Creator of universal matter and of Nature, that is, as he explains it, of the system of laws established for the existence of things and the succession of beings. He then personifies Nature; gives it all power in this World, except that of creating and of annihilating; afterwards he thinks he can dispense with a first cause which has the inconvenience of "being placed outside Nature." His Deity is the God of Epicurus: He reposes in the recesses of the empyræum, without troubling himself about the World, of which he has merely created the elements, and handed them over to Nature to be elaborated, modified, changed and altered, and of them to form the various beings. We have already seen this in Lamarck, his copyist; and all the difference between the doctrine of the disciple and that of the master, is, that in Buffon, the organic molecules, placed at the disposal of Nature to enter into the composition of living bodies, were immediately created by God. But from the moment that Buffon replaces the free and intelligent action of a First Cause by the blind and mechanical operations of Nature, he destroys, one after another, all the grounds of philosophy; and the laws of inflexible logic drag him, in spite of himself, into all the errors of pantheism.

He neglects the theological object of science, and the intellectual progress,—moral and religious—of man, to embrace exclusively that of material utility and the gratification of his readers. "Man," he says, "will study beings in proportion to the utility he derives from them." (1) Of all imaginable methods, this is the most unfavorable to philosophy and the development of science.

Meanwhile God, having been thus removed from all parts of the Universe—which may in future do without Him—will no more be mentioned in the philosophical studies of man. "Poetry, History and Philosophy have all the same, and that a great object, Man and Nature." (2) "Natural History taken in its entire extent, is an immense study; it embraces all the objects of the Universe." (3) Here is the conception of science and philosophy; God is excluded from them; and the circle of science is consequently broken. Hence follow absurd consequences. "Physical and mathematical truth is the only real truth: physical truth is absolutely truth; mathematically truth, relatively so: but moral truths are nothing more than propriety and probability." (4)

Such is the moral law, in the system of Buffon. Will the laws which govern the inferior beings be better respected?—"In general, the more we augment the number of the divisions of the productions of Nature, the nearer will we approach to truth; since individuals alone exist in Nature; and genera,

(1) Discours sur l'étude de l'Histoire naturelle.
(2) Discours de réception à l'Academie.
(3) Discours sur l'étude de l'Histoire naturelle.
(4) Ibid.

orders, and classes, exist only in our imagination." (1) Consequently, the plan of the Creator is void: the animal and vegetable series incapable of proof; the transformation of species and spontaneous generations are realities: and it is for this purpose that "the living organic molecules existed from the moment that the elements of a gentle heat could incorporate themselves with the substances that compose organized bodies. They produced, on the elevated portions of our Globe, an infinity of vegetables; and, in the waters, an immense number of crustacea and fishes, which were subsequently multiplied by generation." (2)

God being thus excluded, and every thing made to proceed from material Nature, where will man find his place? "The first truth that results from this rigid examination of Nature is perhaps a humiliating one for man. He must take his place in the class of animals, which he resembles by all that is material in his being; and even their instinct will appear to him surer than his reason, and their industry more admirable than his arts." (3)

The state of Nature is a consequence of animal man.—"It is from society that man derives his power.—Formerly, he was, perhaps, the most savage and least dreaded of all animals. Naked, without arms, without shelter, the Earth was for him a vast desert, peopled by monsters of which he frequently became the prey." (4) The golden age of morality, or rather the age of fable, was the iron age of Nature and of truth. Man, at that time, still half savage, in number few, and these few scattered abroad, did not feel his strength. The treasure of his intelligence was buried: he knew not the force of united wills, and dreamed not that by society and its combined and persevering labours, he should succeed in impressing his ideas on the entire face of the Universe." (5)

Thus materialism flows from the fatal principles admitted

(1) Discours sur l'étude de l'Histoire naturelle.
(2) Troisième époque de la Nature.
(3) Discours sur l'étude de l'Histoire naturelle.
(4) Histoire naturelle de l'Homme.
(5) Epoque de la Nat. prélim.

by this great naturalist.—"But, says Blainville,—from whom I have taken these passages,—"the negation of theology is carried in them to its extreme limit by the negation of final causes, and the entire abandonment of the search after causes in general. This principle of finality, without which it is impossible to arrive at any demonstration in science, was the object of the repeated, and often the ignorant attacks of the great Buffon; because final causes are intimately connected with method, and he rejected it. By this fault, which we can scarcely pardon to his genius, he flattered the worst tendencies of his age, and contributed to hold up to ridicule this indestructible truth to such a degree that those serious minds which yet admitted it received the ironic appellation of "finalists." (1)

According to Buffon, God created two things, matter and Nature. Terrestrial matter is two-fold; organic and inorganic. The sum total of this matter thus originally created constitutes part of the sun, of which the Earth is but a projected fragment. Nature is the system of laws established by God for the existence and succession of beings; it is not a thing; it is not a being; it is a Power. Attraction and impulsion,—two laws which are in fact one,—are its principal instruments. With these means, Nature is all powerful, except to create and annihilate, which God has reserved to Himself. By means of attraction and repulsion, Nature produces every result in inorganic matter. With attraction and heat, it produces every effect on organic matter. From the combination of the molecules of organic matter result organic beings, the first of which were formed by the sole force of Nature. (2)

Now these principles, as is obvious, are veritable ontological creations of the imagination of the author. I shall only dwell on that which constitutes Buffon's pantheism. Was organic matter created in the state of elementary molecules, which afterwards combined and organized of themselves, to form ve-

(1) Histoire des Sciences de l'organisation. T. III.
(2) De la Nature, première vue; Epoques de la Nature; Introduction à l'Histoire des minéraux; Histoire naturelle des animaux en général.

getables and animals, as Buffon asserts? This proposition is absolutely untenable. Organic substances, in effect, can only be produced by living and active organized beings. The species are alone capable of reproducing themselves: one species does not produce another. Each species is determined and organized for a special and definite end. If, then, the species were not created what they now are, they would not exist. It follows from these truths that matter was created what it is, in all its perfection; that nothing has organized itself, or has been organized by the pretended laws of Nature, which is not a power. Organic matter being incapable of acquiring existence except by vegetables and animals, was necessarily created; for the vegetables and animals were created, since they are born and die, and they are only reproduced by themselves, each one in its own species.

In justice to Buffon I shall add, that he himself elsewhere refuted the greater part of his paradoxes. No one has demonstrated more eloquently the reality, the creation, and the stability of species; the impossibility of the state of Nature, the unity of species of the human race, the dignity of man and the spirituality of his soul.

"It was impossible," observes Blainville, "that placing himself as he does in the point of view of the harmony of organized beings among themselves and with the soil, the genius of Buffon should not discern the grand and beautiful idea of the animal series. He was consequently struck with it: he demonstrated many of its principles; he always pointed out the order of degradation; this he did in his Epochs of Nature, in his Discourses, and in many histories of particular animals. Doubtless he did not demonstrate it; he had not attained its law: but his mind took in, beyond the animal series, the whole concatenation of being, from elementary matter to matter united with intelligence in man, whom he took for a term of comparison. He even marked out some of the parts of the series, determined them accurately, and ranged them in the natural order, by pointing out the transitions and shades of difference between one sort and another, so that it was only necessary to take up his work and put it in its place." (1)

Cuvier does not materially differ from Buffon, whose ideas he adopts. In his view of things, the species is a pure hypothesis ; various centres of creation appear probable ; beings may have been autochthonous, or earth-born, that is, the product of the media in which they lived. From this to the transformation of species, to their negation, and to spontaneous generation, there is but one step ; and the language of Cuvier is always so indefinite, it cannot be said, whether or not be made it. He regards material well-being as the end of science ; the moral and philosophical object is entirely omitted. In the Aristotelian philosophy, Albert-the-Great and his successors had placed man outside of and above the animals. Buffon made him an animal : Lamarck and Cuvier followed his errors ; they ranged man among the animals, and regarded him as the most perfect of all. Hence all that passes in man as a physical, intellectual and social being, is the result of his animal organization. "Man," says Cuvier, "has a tendency for society, which his natural weakness renders absolutely necessary for him." (2) He appears to suppose him to have been originally in the savage state ; and attributes his development to his more perfect organization. There is, however, no precise statement of opinion in his exposition. We perceive the predominance of an idea, and nothing more. It is a species of eclectic indecision.

III.—M. Ampere.—Ampère was profoundly religious and avowedly Catholic. The philosophic theories which he adopted, despite of his religious convictions, appear to me the more dangerous because least open to suspicion. He represents the school of the chemical geologists. This differs from the preceding one, in as much as Ampère admits the immediate creation of all organized beings, and that of matter in the

(1) Histoire des Sciences de l'organisation. T. II.
(2) Tableau élémentaire de l'Histoire naturelle des animaux. Ch. IV de l'introduction.

state of elementary bodies; with these elementary bodies he attempted to form and organize the physical World. The vegetable and animal substances are for the most part formed of integral parts of organized bodies. Before such substances existed, it was necessary that organized bodies should exist to produce them. But organized bodies themselves are alone capable of being developed and reproduced by their equals. Hence the first must necessarily have been created. The elementary World can effect nothing like this, and we are forced to admit the creation of plants, of animals, and of man in the perfect state. As for the Earth and the heavenly bodies, it was said, the principle that was denied with regard to organized living beings might be maintained. The laws of elementary matter and of motion have done all. Let us see on what this assertion is founded.

"The chemical geologists admit a creation of bodies, but of bodies in the elementary or simple state alone. According to them the general laws of the Universe acting on simple bodies formed at length all the composed bodies, the great masses, the stars. Chemistry recognizes from 40 to more than 50 simple bodies; but science is likely to reduce this number considerably, by shewing that many, such as sulphur, chlorine, &c., hitherto regarded as simple, are in reality compound. Of these elementary bodies, the number of which will continue to be reduced, some are permanent gases in the simple state, as, for example, oxygen and hydrogen: others are found in the solid or liquid state, but may, by the application of heat, be placed in the gaseous state; or, combining with other bodies, form new compounds. Phosphorous and fluor form gaseous compounds with hydrogen; boron and silicium, with fluor and chlorine. In carbonic acid, carbon is in the gaseous state. In order that simple substances should combine they must almost always be in the gaseous, or at least in the liquid state. If then the first act of creation was the existence of simple bodies, subject to the general laws that govern them, let us see what should occur conformably to these laws.

The great and universal law of the World—attraction— is of a two-fold character, according to the nature of the bodies on which it acts. On large masses it acts at considerable distances, and always in direct proportion with the mass, and in inverse proportion of the square of the distance. This attraction is supposed to exist between the sun, the moon, the Earth, &c., and is called planetary attraction. Molecular, or atomic, attraction, on the other hand, acts on the atoms or molecules of bodies, whether combined or isolated, and only takes place at inappreciable distances.

"In the hypothesis of the chemical geologists, planetary attraction evidently could not take place, since, in the original creation there were only simple bodies.—Molecular attraction is the only one we can imagine. Now this law acts in two different ways; 1° between atoms of the same nature, and then it is called cohesion. This force keeps the molecules of solid bodies mutually united. In the air or in the aeriform fluids, and in all bodies in the gaseous state, it is not sensible. The law of cohesion is then almost nothing for these bodies. The second mode of the action of molecular attraction is the affinity which causes atoms of different nature to tend to unite with each other. Its action on simple bodies implies two conditions,—heat and pression;—heat to reduce them to the gaseous state, and pression to cause the molecules to approach each other.

"The law of affinity alone acting on gaseous bodies so as to combine their atoms, and all the simple bodies being gases, or being convertible into such, and requiring to be made such in order to combine with other elementary bodies,—since in the gaseous state this combination is most frequently and most easily effected,—what must have occurred between these original elementary bodies?

"In our laboratories, we may secure all the circumstances required for the production of the different combinations of bodies; we may liquify them and reduce them to the gaseous state, and subject them by means of our instruments to the required pressure. But let it be remembered, that in supposing the elementary creation, we destroy all these conditions. There may, indeed, have been fusion, liquefaction, or even gasification either by electricity or heat or the action of the luminous fluid. But no pressure is possible, for pressure implies the possibility of resistance. We can conceive, for example, a body like the Earth, or any other solid mass, environed by an immense atmosphere of gaseous bodies; the superior bodies exercising a pressure on the inferior ones, and the inferior ones experiencing a resistance on the part of the solid mass;—we then have the conditions necessary and sufficient to produce a combination. But in the hypothesis of elementary creation, there is no solid mass; consequently no pressure possible; and, hence, the law of affinity, wanting one of its indispensable conditions, could not have effect. Hence no combinations would be possible, and simple bodies would eternally remain in their simple state.

"Let it not be said with Laplace that there may have been great masses of elementary bodies in the gaseous state, suspended in space, and that between these masses the pressure may have been sufficient to give occasion to some combinations, and thus form a central nucleus, which, by its reaction on our atmosphere, would have produced the entire result. Such masses could neither have been formed by planetary attraction, because it acts only on bodies already formed; nor by the molecular attraction of cohesion, which acts only when the atoms are in contact, a condition which can only be verified in a mass already formed. Gases and gaseous bodies, however, are especially subject to the law of dilatability or indefinite expansion in every direction, as long as they find space in which to expand and meet with no resistance. This is an insuperable obstacle to the law of cohesion. Gaseous masses were then impossible; consequently there was no pressure; and the law of affinity was without effect on the original elementary bodies, in producing a possible combinations, as were also all other laws.

"We may then conclude, by a most rigorous deduction, that the World was not created in the elementary state, or by virtue of the laws which preside over its actual condition. These laws are effects, not causes; they are merely phenomena, the result of the existing order of things." (1)

(1) *Dieu, l'Homme et le Monde,* T. I, p. 153.

Thus the defect common to the chemical geological theories and to that of Buffon, is to build with abstractions, and to employ in forming the World laws which could only exist in a World already formed. In admitting the creation of the organic kingdoms and that of elementary bodies, the theory of Ampère appeared to approximate more closely to the Catholic doctrine: but in its consequences, it will be found to identify itself with his system. The power and intelligence which ordered the Universe, cannot be replaced by the laws of blind matter without rejecting with Buffon the great law of final causes. As soon as the production and arrangement of the material World are left to the mere laws of attraction, there is no longer any object, any end in creation; and as Lucretius says, things serve such and such a purpose because chance made them fit for it. The general creation is an ensemble, of which all the parts are co-ordered for the same end. It is then necessary that the same cause—supremely intelligent and powerful which conceived every thing even to the minutest details—should also have executed every thing from the beginning even to the end. We must admit final causes in the form of the Earth, in its relation to the atmosphere, its waters and the other bodies of the solar system, as with the organization of the living beings who were to inhabit it.

The theory of chemical geology is then badly conceived; it has no result, because it lacks a general and organizing principle. It loses itself in the vacillations of eclecticism. The dogma of the creation is one of these truths which we must admit or reject entirely; because to attempt a division of it, is to reject the very principle of revelation. And yet this theory affects to retain this principle, while it rejects a portion of the dogma, and modifies very considerably that part which it accepts. Genesis exhibits to us the heavenly bodies created in their perfect condition; this theory supposes them to have been created in the elementary state. It accepts the immediate and instantaneous creation of each organic species, a thousand times more worthy of our admiration than the brute masses for the formation of which it demands such innumerable ages: but contrary to the teaching of Genesis, it separates the various groups of the two kingdoms by an indefinite number of ages; brings them successively to existence, and by that means, violates the natural relations which render them necessary to each other; and thus destroys all the harmonies of their simultaneous creation and existence. More imprudent, in some respects, and less reverential than the preceding theories, it mixes the sacred with the profane, and its baseless conjectures with facts which are the foundation of the moral law. If goes farther, and affixes an unnatural meaning to the Sacred Text; and after having attempted to make the Divine Word the echo of its errors, it abandons it to discussion, at the risk of compromising Genesis in the mind of those who should only know it through its erroneous interpretations.

IV.—Deluc.—Deluc was religiously inclined, but was in religion an eclectic, and was led by his geological ideas to attempt the work of creating the World anew. Like the preceding writers he admits a Creator, and, what is more, a regulator of the World: and by this last mentioned principle he differs from them, and appears to approximate more closely to Catholic truth. But this principle has no application in his system; and when the Creative Power pronounced the word: "let there be light,"—all the elements of the Earth, confounded in the great abyss of watery liquid—thus Deluc understood the Sacred Text,—disengaged themselves and combined in the present order by virtue of physical laws. Thus his theory is almost identical with that of Ampère; it is open to the same objections, and leads to the same false and destructive conclusions.

Deluc, indeed, maintains that God continues to operate, but slowly and by means of second causes. Here he is mistaken. Physical laws are the result, and not the cause, of the order of things in which they prevail: and even, to make an impossible supposition, if they existed prior to the arrangement of the World, they would none the less be blind causes, acting without design or consciousness. Why should we imagine that God made use of such agents in establishing the order of the World, when His Will would have sufficed; and for Him to Will is to produce a thing. Moreover, the idea of law involves the idea of permanence and invariability. One of two things must be said: either God conformed to this law, and in that case it is no longer God, but the agent which would have ordered the World; and find ourselves brought back in the systems of Buffon and Lamarck; or God would have bent this law to His Sovereign Will, and then this order or law would not have been law. There is no possible medium between the creation of the World by the direct Will of the Creator, and the arrangement of the World by the laws of matter, that is to say, by an abstraction of the mind; and as Deluc uses the laws of matter in the ordering of the World, his theory is substantially identical with that of Ampère, and can no more be maintained than those we have reviewed.

All that he gains by putting second causes in the hands of God, as an instrument in the hands of an artizan, is to make of the All Powerful God, an astronomer, a calculator, a naturalist, a manipulator,—like man, and reduce Him to the same feeble resources;—an inexperienced workman, who preludes the complete realization of his idea by imperfect sketches; who produces with labour, and successively destroys, five or six Worlds before happening on that which he thinks worth preserving.

The theory of Beaumont comes to the same thing as those of Deluc and Ampère. There are the same principles; the planetary mass, its waters, its mountains, its atmosphere, &c. —are organized by the laws of Nature. There are also successive creations and destructions, indeterminate periods, &c. I shall not dwell on Buckland and Chalmers. The confidence which these two writers have in the theories of hypothetical geology, is so great, that to render the cosmogony of the Bible conformable to them, they have not scrupled to set it entirely aside, with the single exception of the first verse: "In the beginning, God created the Heavens and the Earth."

Thus the leading idea in all these theories is to endeavour to solve the problem of the existence of the World by its own laws, while excluding as much as possible a first cause; but as human reason can no more content itself with chance than the passions can with God, they leave Him the title of Creator of matter while they take from Him the title of its Disposer. The World, the work of blind causes, has no longer an end: finality is rejected; man becomes an accident; his relations with the Creator are arbitrary, and the moral law, a fiction. I do not say that any of these writers intended to destroy this law; but even those of them that were animated by the best intentions, were under an influence hostile to religious truth; and they did not see that all the sciences, from that of Religion to that of chemistry or geology, are intimately connected; and that the consequences philosophically deduced from the false principles of their theories, re-act on faith and moral duty. These desolating hypotheses have served as ground-work for rationalism and naturalism; they have pervaded the instruction of our schools, and a considerable proportion of our youth has imbibed them. It is, then, the interest of society, that scientific truth should vindicate itself; for when it is studied in its principles, demonstrated by facts and the progress of the human mind, it is always found to harmonize with moral truth. Have not those who have read these pages already clearly seen, that in the systems we have reviewed there are wanting the principles which proclaim the great Catholic thesis, that God created all things and disposed the World in its entirety and in its details? The systems referred to in the preceding pages are all hostile to this truth and therefore untenable; and they are untenable in proportion as they depart from the narrative of Moses; while, far from weakening this narrative, they confirm it, by the proof they supply that every system opposed to this narrative necessarily leads to absurdity. When we shall place the scientific and revealed truths in juxta-position, the reader will not fail to be struck by their agreement, and, will pity the credulous and blind enthusiasts who fall down and worship the theories—more or less materialistic—of our times. In this they imitate those who formerly received the theories of Whiston and Buffon as demonstrated truths. Had these men lived in our time and could have met each other, they would not be able to surpress their laughter at the blindness and devotedness of their admirers.

SYNOPSIS OF THE SYSTEMS IN THEIR RELATIONS TO SCIENCE. —Hypotheses are not proofs. Their authors, however, are not embarrassed by this circumstance: they propose them with a dogmatic air, and imagine that their authority should supply the place of demonstration. The works of many men occupied with scientific researches are full of such hypotheses; the grounds of which are not always given, because, perhaps, there were none such to produce. By substituting for principles a thousand suppositions which cannot explain facts, every idea is confounded, and science finds itself replaced by an inextricable chaos of absurd opinions, the contradiction involved in which is well calculated to discourage those who would seriously apply themselves to scientific studies. Who would imagine, for example, that there is a science of geology, after having seen the number of systems which have successively assumed its name? At first they may be taken to represent its different phases, its successive developments, and may be supposed to serve as memorials of its history; but, on nearer view, this error is discovered. In his "Epochs," Buffon renounces the fundamental principle of positive geology, which he was the first to propose in his "Theory of the Earth."—namely, that the causes which produced our surface are yet in operation. Deluc, Cuvier, Brongniart, Ampère, Buckland, Beaumont and others accept more or less entirely the erroneous principle of unknown or extinct causes. There is, then, between their systems and geology all the difference which separates these two principles: and as the assertion—under different forms but always without possible advance—of the principle of extinct causes, and the successive developments of causes now in operation have been contemporaneous, a continual antagonism was inevitable; and the systems have in fact more or less impeded the progress of science in proportion to the talent with which they were proposed and the reputation for learning which their authors enjoyed. There are indeed more observations and facts made and recorded in these systems, in proportion as we pass from ancient to modern authors; but besides that their observations are not science, they are, for the most part, due to the author who cites them and who not unfrequently falsifies them by excess in their application. Some systems indeed have special excellencies, such as the botanic paleontology of Brongniart; the animal paleontology of Cuvier, &c. But we are now speaking of principles which are the ground-work of these theories; and these principles are refuted either by geological observation itself or by other sciences. Hence to present a synopsis of the progress of positive geology, I am obliged to add to the review of the systems, an analysis of the labours of geological observers, who, by introducing new facts or new principles into the science, have successively brought it to the perfection which it now has attained. I have therefore now to present this progressive advance of geology from the days of Buffon to our times.

V.—In his "Theory of the Earth," Buffon founded positive geology by distinguishing from the mass of the Earth its surface,—the sole object of geological science; and by laying down the principle, that present causes and effects explain those of ancient times. He analyzed the aqueous causes in marine products; the igneous causes in the volcanoes. He shewed in the limestone the product of the mollusks and corals; in the coal, that of vegetables; and he established the true principles of paleontology, equally applicable to terrestrial and aquatic animals.

Pallas followed the same course, and accepted still more clearly the creation of the planetary mass with its granit-mountains and vallies. He introduced the distinction of primitive mountains—the highest of all, of schist-rocks—the result of the decomposition of the former, and resting on their slopes;—of secondary mountains lying next to the primitive rocks, and of tertiary rocks overlying the chalk. He contributed numerous facts to paleontology. With Buffon he rejected the Central Heat-theory, and the exaggeration of those who maintained that all the fossils were extinct species.

Werner extended observation on the rocks even to details for those of Germany. De Lamétherie, after the example of Buffon and Pallas, analyzed all the natural causes and sought in them the explanation of our surface. He introduced the synchronism of the aqueous and igneous causes: he proved that all geological phenomena are local, and dependent on variable circumstances; and that the productive causes of our surface have never ceased to operate. On this rational principle he recognized one, and only one, creation of fossil and living beings. He explained the fossils and their disappearance by known natural causes; and rejected, even in the time of Cuvier, every periodic or other revolution which no physical cause could have produced. Lamétherie acknowledged the fact, that geology from the nature of its object, could never be reduced to a strict system.

At the same time, Lamarck applied himself in a special manner to the paleontology of animals without vertebræ, of which science he was the founder. He first laid down the principles which distinguish fresh water from marine species;—principles which—verified and augmented by many other naturalists—led Prévost to recognize three principal modes of formation in the sedimentary rocks—fresh water deposits, marine deposits, and deposits partaking of both characters; as also the alternance of both. This was an immense progress, which refuted the pretended revolutions of the Globe, by establishing the fact, that all the fossils, whether of land, fresh water, or marine origin, are the remains of organized bodies alone; which by local circumstances, were carried away by the waters and covered with sediment; that they are an exception, and by no means the complete representation of the state of life on the Earth at the period when they perished; that the successive deposits were formed in each basin continuously on certain points, and periodically, at short intervals, or intermittingly, on others.

While the principle of synchronism was taken up anew, and demonstrated by Prévost, both as regards the aqueous formations among themselves and the aqueous and igneous causes, Boué and many other geological travellers established the metamorphism of aqueous rocks by the action of fire at all periods of the formation of our surface. By these excellent researches, it becomes more and more manifest that the various formations have had various causes—in the local circumstances of surface, waters and the beings that inhabited both; and that, consequently, in basins separated from each other by great distances, the same circumstances may have produced different effects at the same epochs, and similar effects at different epochs. Hence, we have no longer to occupy ourselves with basins which, for the most part, are independent, because we can draw no inference as to their comparative antiquity, or as to their contemporaneousness; both these conclusions being no longer possible, except for the formations of one and the same basin.

In fine, Blainville has lately established the animal series, and has shewn that all living and fossil animals belong to one and the same conception, and are of one and the same creation. He took up and continued the paleontology of the mammals, which Pallas had begun and Cuvier had developed. He shews that a great number of the fossil species of this class are yet living; that the greater part of lost species belong to genera yet in existence, and fill up gaps in their series; that the small number of genera entirely extinct supply transition links between living genera; that the greater part of the fossils lived near the basins where we find them, and in circumstances analogous to those of the present epoch; that the extinct species lived at the same time as man; that they have disappeared, and continue to disappear, by natural causes, the principal of which apparently is, the multiplication of the human race and its destroying influence.

Such has been up to the present the logical advance of geology. It is always the same principle of positive observation, receiving developments in the course of time and by the successive efforts of men who proceed from the known to the unknown, and all advance in the same direction.

The sedimentary surface consists then of deposits which were successively made; and which originated in various causes, identical with those now in operation, since the effects of the one are perfectly analogous to the results of the other.

All these masses of our surface were once covered with water; subsequently they emerged; all have been produced by water and by heat; and when we knew the manner in which springs, rivers, lakes, seas and volcanoes operate, we are able to imagine the general history of the formations of all ages.

The formations of our aqueous system at the present day are of three principal kinds: marine, fluviatile, and lacustrine. Seas, rivers and lakes also produced all the preceding formations, and we meet with these three kinds of formation at all epochs of the surface. Consequently at all epochs there was the same aqueous system, the same causes, the same general organization of the Globe.

At this moment, the effects of the marine and fluviatile causes are simultaneous in their respective basins, and alternate at their points of junction. In our epoch various formations, lacustrine, fluviatile marine, littoral, semi-pelagian and pelagian, are produced at the same time; and like formations at different times. The strata of all ages shew analogous combinations; and hence we infer that the aqueous causes have operated in a similar manner during all periods.

With regard to the nature of the rocks, the history of the action of water for all times past, as well as for the present time, may be expressed in five words: calcareous, sand or sandstone, clay, coal, marl. In all the ancient epochs, as at present, the limestone is generally marine, and the other rocks are derived from the continents. The waters which form these deposits find their various elements in the same sources as formerly.

There is the same analogy between the actual flora and fauna, and those of all the strata; these are land vegetables, river, sea and estuary vegetables; land animals, fresh water, estuary, sea-shore, semi-pelagian and pelagian animals. Consequently, during all epochs there has been the same distribution of organic life.

There is no fossilization except by water and in water. The fossils were not buried alive, nor on the place in which they dwelt; they were borne away after their death and transported by flowing waters to greater or less distances. They may have been brought from afar as from the neighborhood. This in the general law. There are a few exceptions to it, and they are susceptible of explanation. The same law and the same exceptions are of present daily occurrence.

The fossil animals and plants are few when compared with those which were not exposed to fossilization. We only find in this state the beings that lived either at the mouths of rivers, or on the borders of lakes, or in the vicinity of sea and continental currents. The ancient fossils do not then give us an approximate idea of the fauna and flora of their time. So it is with the beings that exist at the present day. The immense majority die without leaving a trace of their existence; and if the remains of those that are now carried off by our currents and enveloped in their deposits, shall be hereafter discovered, those who find them will be justified in believing that, individually and specifically, they are incomparably less numerous than those who, living at the same time, were not placed in circumstances so favorable to their being preserved as fossils.

Our igneous system manifests itself at the present day by volcanic products, by the transmutation of pre-existing aqueous rocks, and also, according to many naturalists, by earthquakes. The formations of all ages present unequivocal indications of the same effects. In the mountain-regions we find, at different depths, discordant stratifications brought about by a change of direction in the currents, a change which only could have been effected by very considerable, although local dislocations and subsidences, apparently occasioned by earthquakes, whether produced by volcanic action or by the piling of the strata. In Europe and America volcanic products have been met with in all strata, from the primary formations, up to those which are now produced. On the other hand, observers have traced in all strata the modifications which the igneous causes effected in the sedimentary rocks, in their color, stability, structure and chemical composition. Hence the inference, that in all the ancient epochs there were the same general effects of the igneous cause as at the present day.

At this moment, the effects of the igneous and aqueous causes are contemporaneous; and we have just seen that they were so in all past time.

Such is the constant analogy between the ancient and present phenomena. This intimate connexion, merely perceived by Buffon, but now satisfactorily established, if not rigorously demonstrated in all the details, reveals itself with an evidence so much the more irresistible as the strata are better studied, and the observations are multiplied on the customs and habitudes of beings—on the volcanoes and their manner of acting—on the oceanic currents both in the middle of its basin and near its shores.

Whatever may be the ulterior progress of geology, we may be assured that it will never attain the dignity of an exact science. The present surface of our Earth, which is its object, is nothing more than a new distribution of the materials resulting from the destruction of organized beings and of preceding surfaces. This destruction and new combination are the result of local and accidental secondary causes, so variable in their number, their intensity and their duration, and consequently so little appreciable by human intelligence, that there cannot be found a principle to connect and subordinate their divisions, facts and phenomena. Without a principle there is no possibility of forming a system; for a system in any science whatever, is merely the concatenation and relation of facts, phenomena, and beings, by aid of a principle sufficiently comprehensive to embrace and control them all. When such principle exists, and is accurately applied, it leads to rigourous consequences, which supply foresight, the last link in connected science.

For want of such general principles, geology of itself cannot advance, but must continually lean on paleontology, or rather on zoology and botany, of which paleontology is a division, as also on meteorology, chemistry and the other physical sciences. It is because this necessity was not recognized, and also because zoology was not yet sufficiently advanced, that so many geologists attempted to create systems. By recognizing it, we hope in this work to arrive at a rigorous demonstration of revelation by the physical and natural sciences: being persuaded that science must bring back men to the principles of life, and convince the most incredulous of the immutability of the foundation on which the Catholic Faith rests. Such also is the opinion on the mission of science at the present day, expressed by the most profound naturalist of our times. "When we examine," observes Blainville, "Society at the present day, we find all its efforts directed to industrialism, and the examination of the surface and of all the elements that surround it. In such a direction the sciences can alone illumine its path; alone they point to the future combinations which will lead to success, more likely to be found in them than elsewhere. The high teaching of our colleges devotes a longer time than ever before to the study of the sciences. They are placed within the reach of the most humble intellects, by the profusion of elementary works of all kinds which circulate among our working classes, and which compel even these classes to follow blindly a movement the direction of which has wherewith to appal the reflecting observer. The whole of Society is thus caught in the meshes of science; it judges, hears and sees nothing but its principles. Philosophy, properly so-called, is nothing in its doctrines as well as in the principles which it now-a-days professes: pure theology is rejected by the masses: science alone remains; because it is essentially connected with material interests. The ruin of the moral World would involve the ruin of the physical World, and God cannot permit that His work should perish. At all times, the history of the sciences of organization shews us salvation resulting from the continual struggle between truth and error. Moreover, science having for its object, God and His works—man and his nature—it possesses in its very elements all the means of returning to sound principles. Because its progress is logical like the human mind which has produced it; and, on the other hand, the works of God, which are its elements, are links of a chain which reaches back to the Creator, it must needs result, despite the indisposition of those who cultivate it, in confirming the great principles of the moral order and of Society. Its progress, attentively considered, leaves no doubt on this head. For a time it may have led captive by the enumeration of facts, the discussion and observation of phenomena. This was even necessary. But when this laborious operation has prepared the elements, the force of science has burst the barriers and constrained the human mind to express its doctrines. These doctrines must have been, and have been, in the direction we have pointed out, pantheistic materialism; which, however, has vainly attempted a re-organization—of which it possesses neither the power nor the secret. And yet one only alternative was possible: either the World explained by the Catholic Faith, or the World explained by pantheism; all the other shades of error being comprized in this last one. This last solution leads, however, to absurdity; the Catholic solution is then the only true one, or we must reject all the principles of logic. Such is the advance which science has made, and such the mission which the World expects to see her accomplish:—not to introduce a new religion, a new moral law, a humanitarian Christianity. This would be an absurdity; but to confirm the truth of Catholic Doctrine and strengthen its demonstrations. There can be no doubt that such is the mission of science, since it comes from God, and holds the empire of the World." (1)

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(1) Histoire des Sciences de l'organisation. T. III, p. 21.

NEPTUNIAN OR AQUEOUS FORMATION.

Tertiary rocks resting on the primitive rocks and on various parts of the secondary formation........

Chalk

NEPTUNIAN OR AQUEOUS FORMATION.

Terminal strata covering all the lower strata......
- Coral, Bog, detritus, alluvian, tuffa.
- — diluvium = sand, mud, gravel, flints, erratic blocks, bone-caverns, osseous breccia, (alluvian iron, plusiac deposits.)

Tertiary rocks reposing on the primitive rocks and on various parts of the secondary formation.........
- 1 *nymphean* = sands, sandstones, millstones
  silicious lime, lime and marl
  salt, sulphur, gypsum
  white limestone.
- 2 *tritonian* = molasse, lime
  shell sand, downs
  white sandstone, marl
  rough limestone.
- 3 *nymphean*..lignites and clays.

Secondary formation of which the different groups are partially superimposed, and
- Chalk
  - 1 white.........
  - ....2 tuffa, chlorite or glauconieuse, sands.
  - ....3 marl.
- Jura strata
  - 1 oolitic lime (Portland), clay (Honfleur)
    marl, sand, sandstone.
  - ....2 oolitic lime (Coral-Rag)
    clay, marl (Oxford-Clay).
  - ....3 schistous lime, shell-marble (Forest-Marble)
    large oolite
    marl
    inferior oolite.
- Lias
  - 1 Marl and calcareous rock
  - .... 2 calcareous earth
    conchoidal and christalline
  - 3 calcareous sand,
    arkose, steaschist.

Plutonian or igneous formation. ......
- diorite, pyroxenous..........................
- porphyry, syenite, serpentine..........................
- trap, trachytes, basalt..........................
- lava, ashes, scoriæ, pummicestone..........................

Mixed or metamorphic formation. ......
- Indurated clay and sandstone, gypsum, anthraxiferous jayet.
- marble-chalk, saccharoidal lime, modified marl, &c..........
- Coal..........................
- dolomite, talkite, talk-gneiss, &c..........................

may rest on divers parts of the primary rocks and primitive surface of the Earth.

Trias
1 Keuper, gypsum, salt.
.... 2 red sandstone (Muskelkalk).
.... 3 variegated sandstone,
Vosges sandstone.
— (Grauwacke).

Coal sandstone
1 marl
psammite (Grauwacke).
.... 2 calcareous { fetid / grey (Zechstein).
.... 3 calcareous schists, &c.
.... 4 coal-beds { schists / psammites / sandstone / coal.

Primary Rocks
1 anthraxiferous [Devonian] { 1 mountain lime, old red sandstone / .... 2 carboniferous lime / .... 3 Grauwacke, schists, lime.
.... 2 slate [Silurian] { 1 schist / .... 2 quartzite, sandstone. / .... 3 Grauwacke or psammites.
.... 3 talk [Cambrian] = steaschists, quartz, marble-lime, micaschists, gneiss.

Intercalary volcanic or pyroidal rocks which have produced by their action.... { directly......... / indirectly......

Primitive Rocks = granit, &c., &c., primitive vallies and mountains.

Observations on foregoing Table.

This table presents a comprehensive view of all geognosy, by the vain endeavour to represent in a table. the true relations, the distribution and superimposition of rocks. — 1° The rocks and their groups are not represented in it as superimposed vertically, but in successive gradations; so that in setting forth from the first tertiary group, we successively pass on the other groups,—on the chalk, the Jura-formations, &c., until we reach the primitive surface as created. — 2° Each formation is divided into groups, which, for the same reasons, are also presented in gradations. — 3° Each group is divided into strata equally graduated: sometimes these strata overlie—the superior on the inferior—to indicate that the latter crops out from under the former; sometimes they do not overlie, to indicate that there is not, at least always, a superposition of one over the other. — 4° In each group parallel systems are written on the same line, and systems that are superimposed or dovetailed, are written on lines that overlie one another. — 5° The primitive surface takes in the whole extent of the table, to indicate that all rocks repose, somewhere or other, on it, as by the preceding arrangements we indicate that they all come to the surface, in a greater or lesser extent. — 6° In the transverse side series, which runs through all the Neptunian formations, we have combined all the plutonic or metamorphic formations, to shew that they are parallel to all the Neptunian formations, that they belong to all the rocks, and that they penetrate all.

[Extract from the work of Maupied: *Dieu, l'Homme et le Monde*, &c.]

[illegible]

SACRED COSMOGONY.

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PART. THE SECOND.

DEMONSTRATION OF THE PRIMITIVE REVELATION BY THE AGREEMENT OF GENESIS WITH SCIENCE.

CHAPTER IX.

Explanation of the first chapter of Genesis.

The work of the Six Days has been at all times admired by sages and philosophers both Jewish and Christian. David and Solomon speak of it with enthusiasm. It has been made the subject of commentary by the greatest geniuses and the most eloquent of all the Fathers, St. Basil, St. Ambrose, St. Augustin, St. John Chrysostom: it has been developed by Bossuet in his magnificent Discourse 'On Universal History.' Descartes, Newton, Leibnitz, Euler and Bacon revered it as Divine. The last named reduced all human science to the explanation of the Six Days, which he regarded as the principle of all his knowledge. Cuvier declared that of all Cosmogonies that of Moses was alone conformable to Nature. My design is to explain simply its real and literal meaning, and to confirm it by the passages which refer to it in the books of the most ancient writers of the same nation, who will always afford us its surest and most legitimate commentary. I shall not then attempt, like so many others, to discover in Moses a philosopher or naturalist, but a grave and well instructed historian, relating all he had learned regarding the origin of the World; making use of the documents transmitted by his ancestors; recounting only the principal circumstances of the facts recorded; and, doubtless, preferring to dwell on those the knowledge of which might remove the Hebrews from the errors of idolatry, and attach them to their Creator by gratitude and obedience. I shall shew everywhere the agreement between the revealed facts and the principles of science; but I shall do so briefly, reserving to myself to present afterwards separately the principal coincidences and to develop them as much as my limits will permit. I have collected in this chapter a large number of observations, which are found in various parts of the late work of Maupied. In concluding I shall contrast with our cosmogony those of the other peoples of antiquity, particularly that of the Book of Menou, which appears to be a close imitation of it. This comparison will shew clearly what distinguishes the faithful representative of the ancient tradition from the philosopher who seeks himself and rejoices in his own inventions.

First Day. — *State of the Earth after its immediate Creation.—Creation of light: its separation from darkness.—Nature of the Six Days*—"In the beginning, God created Heaven and Earth." In the commencement, God created, (that is drew from nothing,) the Heaven (all the stars) and the Earth (with all that it contains.) Like most historians, the Sacred Writer expresses at first in a few words the creation of all things, and gives a summary of what he is about to relate in detail. The whole work of Six Days is contained in these words: the creation of Heaven and Earth by the only God. After the last day, Moses will terminate as he began. "These are the generations of the Heaven and the Earth when the Lord created them,"—a recapitulation in perfect harmony with the preamble. Philology confirms this interpretation. The word *Beresith* "in the beginning," is in construction with the word *Bara* "He created," and may signify, in the beginning of creating—or when God began to create the Heaven and the Earth, &c.

We cannot find in this verse, with Buckland and Chalmers, a retrospect of the history of a former World, the ruins of which served as materials for the World of Genesis: nor, with the partizans of the cosmogonical ideas of Buffon, the creation of a primitive matter, of which all bodies were afterwards made. This general and abstract matter is found nowhere in the Bible. Taken in this sense, the word "matter" is neither

Hebrew nor Christian, but is derived from the philosophy of Greece. Hence Moses does not tell us that God created matter, but that He created such and such bodies. There is no creation of abstract beings in the cosmogony of Moses as in that of Menou.

Two things are asserted in this short preamble: that the World had a beginning; and that it is the work of a Supreme Intelligence and of one creative Will. In this sense it was understood by all the ancient writers, who used the language in which this history is written, and who are therefore the natural interpreters of its meaning. These unanimously repeat or interpret these simple and sublime words: "In the beginning, God created the Heaven and the Earth." (1) Was it in the school of the Egyptians that Moses learned this truth, the most comprehensive of all truths? Could the unassisted efforts of the human mind rise to this elevation?

Be that as it may, he recounts without astonishment the most astonishing of prodigies; he sets forth with precision the greatest of all dogmas, that of a God, Creator and Ordainer of all things. He brings us back, incessantly and without effort, to the primitive idea, which, although beyond the powers of our understanding to comprehend, is nevertheless its light, and is the foundation of all our knowledge.

"But the Earth was void and empty, and darkness was upon the face of the abyss, and the Spirit of God moved upon the waters."—Now the Earth was invisible (because of the waters that covered it), and void (of inhabitants); the darkness extended over the face of the abyss (of waters), and a strong wind passed over the waters. Nothing forbids us to give the name of chaos to this state of the Earth, at the first moment of its creation; but we must be careful not to imitate the poets and philosophers who altered its meaning, and perverted the tradition regarding it, and imagined a vague indeterminate, gaseous matter, the motion of which produced the

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(1) Job. XXXVIII. 4, etc.—Prov. VIII. 22, etc.—Ps. CI. 25.—VIII. 5.—Isaias, LV. 12.—11 Macchab. VII. 28.

sun, the Earth and all the splendours of the World. This is not the chaos of Moses. The Earth was not yet inhabited; but whatever it contained was complete. Water had been created, and covered the Earth, although afterwards it was gathered into one place; the soil was made, since God soon after took of it, in order to make the human body; the planetary mass (of the Earth) was made and was solid, because it sustained the waters. The World, then, did not pass through the chaotic state, which so many philosophers have imagined. "He founded the Earth on its bases," says David, interpreting this verse: "the abyss of waters enveloped it as a garment; the waters covered the mountains."(1) Thus, on the third day, when the Creator divided the waters between the atmosphere and the basin of the sea,—from that moment, the firm Earth appeared: "let the dry land appear." God, then, does not separate pre-existing and confused materials; but He creates and disposes them at the same time in an order conformable to the laws of matter. The solid nucleus, the Earth occupies the centre; the waters envelop this nucleus; vapours rise from the immense abyss; and motion is communicated to the waters and vapours, whence arises a strong wind, "the Spirit of God moved over the waters." What many interpreters understand of the Divine Spirit, the fecundating Principle, the creative energy, literally signifies "a strong wind." In Hebrew the word "God" is used in an amplificative sense. The mountains of God(2) is a term used to express "high mountains."

The Earth with its waters was suspended in space and equipoised by its own weight. It moved on its axis, but the causes of gravitation did not yet exist; there were no other masses than that of the Earth, and nothing could act on it. Then the waters and the substances contained in them underwent the law of vaporization, with so much the greater intensity as there was greater void about them. Vapours form slowly in the air, but instantaneously in a vacuum. Let a

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(1) Ps. CIII. 5. 6.
(2) Ps. XXXVI. v. 7.

drop of water, having been previously deprived of its air by distillation, be introduced into the vacuum of a barometer, and immediately this water, cooperating in part, presses on the column of mercury and causes it at once to descend. Hence, after the creation, a void existing all round the Earth, where as yet there was neither ether nor atmosphere, the water underwent the law of instantaneous vaporization. The expansive force of vapour, acting in every direction and without limit, like that of all gases, vapour must have been formed in great abundance, since it nowhere encountered an obstacle, and hence darkness enveloped the Earth—"and darkness was upon the face of the abyss." In this vast envelope of vapour currents set in; since it is a property of gases and also of liquids never to be in equilibrium, but always and by the least cause they may be put in motion. The enormous mass of waters that covered the Earth, finding, as did the vapours, a resistance in the solid mass of the Globe, must have perpetuated their motion by the force of their elasticity; and the Earth by its motion must have exercised an influence on the vapours and on the masses. Hence the strong wind that rose, by agitating these vapours, facilitated still more their disengagement, "and a strong wind moved over the waters." Job alluded to this first state of the Earth, and he understood the Sacred Text as we do.

In Genesis, man, the animals, and plants, appear at once in a state of complete development. The stars are created in a massive and stable state: the ether, the atmosphere—commence to operate from the moment of their creation. In a word, every part of the World is produced, so to speak, at one casting. The same holds in regard to the Earth; and this is established even by the insufficiency of the theories which, in order to give it another origin, bring it through a series of modifications before arriving at its normal condition. We can only imagine four hypotheses on the origin of our Earth, because we are not acquainted with more than four states or conditions of matter,—the solid, liquid, gaseous and mixed state, this last being the combination of solids, liquids and gases. We have seen that the astronomical chemical hypothesis, which supposes the Earth originally in the gaseous state, is entirely inadmissible. The plutonian theory of igneous fluidity is not more solidly established. It contradicts a great number of facts, and explains none in a satisfactory manner. The neptunian theory, that of aqueous fluidity, is now generally abandoned; it has no solid principle for its support, and is in contradiction with observed facts. No one has ever asserted that the Earth was created in the purely solid state. Such an hypothesis, besides being incomplete, would explain nothing. There remains, then, the fourth hypothesis, namely that the Earth was created in the three conditions of solid, liquid and gaseous, harmoniously combined. This theory excludes no element of things; it harmonizes physical science and moral truth; it explains facts; it is, then, eminently scientific. This is the theory of Moses, or rather the teaching of tradition.

Had the Earth been originally either in the gaseous state, or in that of igneous fusion or of aqueous liquefaction, it would be a perfect spheroid of revolution, without the least inequality—without mountains, without vallies, without water-courses, without variety of climates, and, therefore, without inhabitants.

The Earth was created in certain conditions in order to render it habitable; and its form is one of these conditions; for from this form result motions which are necessary to the support and continued life of all organized beings placed on it. This form, then, is not the effect of chance, or of blind causes, as are all physical causes. This form is, consequently, a primitive fact—an effect of the Divine Will.

Buffon, without intending it, arrived by calculation at this conclusion. The common direction of the movement of impulsion, which causes the planets to go from West to East, gave him for the six planets known in his time, the result of 64 to one, that they would not have this motion in the same direction if one and the same cause had not produced it. The number of planets having increased by the recent discoveries, the probability that their common motion cannot be ascribed to chance or any blind cause increases in the same proportion.

The inclination of the orbits of the six planets known to Buffon does not exceed 7° 30'. Now in comparing the spaces, he calculated that there was 24 to 1, that two planets should be in planes having a greater inclination to each other; and consequently 7,692,624 to 1, that it is not chance or any blind cause that has placed and included the whole six within the distance of 7° 30'. We must add, that the spheroidal figure of the planets, and the degree of flattening at their poles are in mathematic proportion with the velocity of their motions. There are then many millions to one that this form and this flattening are not ascribable to any other than an intelligent cause, which created these bodies with their forms for a determinate end. This cause had no need of laboratory, or furnace, or square and compass to effect this. These feeble instruments have been left to man, in order that he might observe what an Allpowerful Word had produced in an instant. —He said and they were made.

God said: "let there be light and there was light."—I translate from the Hebrew which is much more concise and energetic than the Vulgate. The text does not say, that *light shone*, but that *it was*. The lustre, the sensation of light, a modification of beings having an organ of sight, took place only on the fifth day, after the creation of such beings.

From Origen and St. Augustin to Euler, the creation of light placed before that of the sun, appeared always a difficulty. It is now an additional point of harmony between Genesis and Science, since this latter demonstrates the distinct and independent existence of the sun and of the luminous fluid. When he wrote, Moses could not know of himself that the light, which we call "day," was distinct and independent of the sun, at least as to its existence. Could he have answered the question put to Job, and find out the paths of light? (1) Did he know that it is the movement of this luminous fluid which produces the brightness we call day, and

(1) Job. C. XXXVIII. 17.

its repose which brings back darkness? Had he the telescope of Herschell to perceive that the sun is an opaque mass in the centre of an atmosphere in perpetual incandescence? And if Moses did not know all this, he then accepted with confidence, on the faith of tradition, a history he was not, humanly speaking, capable of appreciating, and which in many respects contradicted received opinions; for, to confine ourselves to the present example, if his contemporaries could have supposed that the days of Genesis were so named because of some analogy with our days,—an analogy not very apparent however for the times to which we refer,—it was not so of the creation of light, inasmuch as this was placed before that of the sun. This fact, known by tradition, must have appeared to be contrary to experience; and men might be supposed to say, as did the incredulous in the Gospel: "This is a hard saying, and who can hear it?"

Moses represents to us every creation as the effect of the Divine Word,—"God said." The other sacred writers accept and often reproduce the expression. "By the Word of the Lord," says David, "the heavens were created, and all their host by the breath of His mouth."(1) And the author of the Book of Wisdom, exclaims: "God of my fathers, Who hast made all things by Thy Word!"(2) That God should have spoken to nothing,—as the Word made Flesh was afterwards to speak to the dead in the depths of their tomb,—does not shock our reason. The circumstances of the creation of the World, as those of the resurrection of Lazarus, were so ordered for our sakes, who are not pure intelligences, and who judge of the greatness of things only by the impression they make on our senses and imagination. Other sacred writers, however, in citing Genesis, having also replaced the word "said" by the name of an attribute of the Divinity, it is doubtless permitted to think that the Word here represented the Will. Between the act of the Divine Will and its accomplishment there is no interval. In speaking of God, man is often

(1) Ps. XXXII. 6.
(2) Wisdom. IX. 1.

obliged to use expression borrowed from human actions. The doctrine is expressed in a language familiar to man.

"And God saw the light, that it was good,"—He saw (the Divine Will was accomplished) that the light was good, that is to say, suitable for its object, for the end intended. This end was manifold, and of the greatest importance, as we shall see further on.

God Himself declares that what He has made is good. This expression is often repeated in this chapter, and it is not without a motive. To inculcate the truth that the Creator has made nothing that is not good, is to celebrate His wisdom as well as His power; it is to condemn the immoral system of two principles, founded on the tradition of the fall of angels which some philosophers had disfigured. This system, ancient in the East, and renewed by Manes, who combined with it his own reveries, was extensively diffused, only because guilty man, on seeing evil in the world, believed that the world itself was evil, and the production of an evil principle. If Rousseau had said: "All was good, issuing from the hand of God," he would have spoken as Genesis, and would not have denied the fall of man, which has deranged the harmony of creation. The Jewish people did not fall into this error; their writers loved to repeat with Genesis: "God made every thing good in its time."(1) "All the works of the Lord are excellent."(2)

"And He divided the light from the darkness; and He called the light day and the darkness night."—He separated (by an interval of time) the succession of light and darkness; and He called the (time of) light 'day,' and the (time of) darkness 'night:' because these intervals of time were measured as our nights and days, by the diurnal motion of the Earth; and, secondly, because, after the creation of man, the sun and the other luminaries were to render them completely analogous to our days and our nights. Thus has the

(1) Ecclés. III. 11. (2) Ecclus. XXXIX. 21.

passage been translated by Bonald, in his book entitled: "Moses and the Geologists;" and St. Augustin—notwithstanding the erroneous ideas that prevailed in his time on light and the motions of the stars—perceived this so simple interpretation, when he said: "The space of the hours and of the time would have been called day independently of the succession of darkness and light." I shall return to what I have shewn at length elsewhere, that the days of Genesis had much more in common with ours than is generally imagined; and that their resemblances were much more important than their differences.(1)

"And it was evening and morning, one day." After each new period, these words, which, in the Hebrew, resemble an expression of enthusiasm, (2) are regularly repeated, as if it were the chorus of an ode.

It is with time as with space; the divisions which nations make of it are arbitrary. They do not all count their days in the same manner; some commence at mid-day; others, at mid-night; some at the rising, and others at the setting, of the sun. The Hebrews followed this last method: their day was from sunset to sunset. Hence their custom of designating an entire day by the words 'night and day,' and with still greater precision by the words, 'the evening and the morning;' so that Moses could not have used an expression the meaning of which was more rigorously determined by the custom of the Hebrews, to designate the duration of a day, than this formula: "it was evening, it was morning, one day."

The succession of day and night is not only the presence and the absence of the sun on our horizon; the phenomenon is much more complex; elsewhere I have developed its principal parts, we may also observe the periodicity of diurnal and nocturnal modifications. The state of the atmosphere is not

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(1) See the first note at the end of this volume, and the refutation of the system of Deluc on the transformation of the days of Genesis into indeterminate epochs.

(2) "It was evening: it was morning, one day."

the same by night as by day; its density is greater during the night; and hence sounds have then more intensity and extend farther. The state of the etherial fluid is not the same, as is proved by the diurnal variations of the electrometer, and those of the needle of declination. The state of the land and the waters is also different. Organized beings undergo these influences; the sleep of animals and plants depends upon it. Pathology establishes the same fact in regard to the sick, whose symptoms vary with the alternation of night and day. The night is much more favorable to repose, and the day to wakefulness. The elements of the Globe then experience a general modification which has its fixed periods and to which are probably owing a number of phenomena, the cause of which is not now well ascertained. The horary and diurnal variations of the barometer certainly depend on them.

The influence of the sun has doubtless a great part in these modifications, but is not their only cause. In total, or almost total, eclipses the sun is absent, and yet we never experience the effects of night; the absence of the sun is not exclusively their cause. It is because the action of the sun combines with the general order of these various modifications of day and night, that it influences them.

The Earth being created with its waters and vapours—the ether being diffused throughout space,—must there not have been causes productive of motion in these fluids, and resistances, causes of repulsion in the vapours, the waters and the land, where this periodicity commenced? This succession of states and of nocturnal and diurnal modifications, so important for the existence of beings, was to acquire a greater intensity and stability by the creation of the sun and the stars. This law of the diurnal and nocturnal modifications being once admitted,—and the conclusions of science tend to confirm it, —the measure of the three first days was, as at present, determined by it, as also, by the diurnal motion of the Earth.

SECOND DAY. — *Establishment of the atmosphere and firmament.—Separation of the waters.*

"And God said let there be a firmament made amidst the waters; and let it divide the waters from the waters. And God made a firmament, and divided the waters that were under the firmament, from those that were above the firmament, and it was so. And God called the firmament, heaven; and the evening and the morning were the second day."

The first day exhibited to us the Earth enveloped in vapours. These vapours—a combination of the elements contained in the waters and brought to the gaseous state—extended as far as the limits which God had ordained. The ether opposed to them a resistance, and kept them close to the Earth. The void being full, the water could no longer ascend as vapour. The ether took its definite place in space. The elements which compose the atmosphere properly so-called (azote and oxygen) spread out below: the lighter elements which compose the vapours of pure water (hydrogen and oxygen) occupied the higher regions; and the hydrogen when disengaged would ascend to the highest regions of the atmosphere, where meteorological observations shew that it maintains itself. In this way there was really an *extending*, (*an extension*), an atmosphere round the Earth between the waters and the waters—between the liquid waters and the waters in vapours and hydrogen—between the waters which were below the firmament (the atmosphere) and the waters that were above it. Did God raise some of these vaporized waters into regions remote from our atmosphere, where we cannot reach them by direct observation? This may be conjectured, but cannot be proved by any of the results of science in its present state. It is certain that hydrogen, the principal element of water, exists in the highest regions of the atmosphere, and extends to distances we are unable to estimate. Thus was created the firmament and the atmosphere. The ether took its definitive place in space, and the atmosphere of the Earth was placed between the waters and pure watery vapours, beyond which the hydrogen still reigns. Such is our exposition of the work of the Second Day. It remains now to prove it from a scientific and philological point of view.

Let us first examine the word 'firmament,' which seems to imply something solid, and to exhibit to us the heavens as an arched covering. Hence some have taken occasion to ridicule what they call the physics of the Scripture, as if Moses should have explained, as a naturalist, to the Hebrews, that the heavens are not solid but a plenary fluid,—an exposition which, of course, the people could not understand. Although Moses knew the nature of the heavens, was he not bound to lay science aside, in order to speak a customary and intelligible language to his people? If we consult antiquity, we shall find a considerable number of philosophers, especially among the Greeks, who regarded the heavens as a solid vault, to which many of them imagined the stars were attached. Should it astonish us if the Hebrews had the same ideas, and that Moses adapted his language to their thoughts. Such, however, is not the case, and the physics of Genesis admit none of these numerous errors which we meet at every step in the science of the ancients. As far as regards the present difficulty, the original text removes it most satisfactorily. Let there be an extension, an expansion, *rakiang*. The word *rakiang* comes from the verb *rakang*, which, in the absolute form, signifies to pound, to strengthen, to make solid; in the first causative form, 'to disjoin,'—'to extend;' in the second causative form, 'to extend,'—'to expand.' The word *rakiang* being derived from this second form, signifies, then, extent, expansion, but it also signifies whatever serves as support, as protection,—whatever serves as bond, and whatever strengthens in any way whatever. The Septuagint translated *rakiang* by *stereoma*, and the Vulgate by *firmamentum;* which have the same significations, although they principally express the idea of solidity.

Let us now collate those texts of Scripture which may teach us what idea the Sacred Writers attached to the nature of the heavens, and we shall find that it was perfectly just. The words 'heaven' and 'firmament' are often synonymous. The Psalmist says: the *heavens* announce the glory of God, and the *firmament* publishes the works of His hands. According to the rules of Hebrew parallelism, the two parts of this verse contain the same idea; and consequently, the 'heavens,' and the 'firmament' have the same meaning. This identity of signification is proved by a number of other texts, and especially by the history of the creation, in which, immediately after the verse we are explaining, it is said, that God called the firmament 'heaven.' Let us see, then, what the Scripture says of the heavens and the firmament. We read in Job: "Thou hast perhaps made the heavens with Him, which are most strong, as if they were of molten brass." (1) The heavens are here compared to a mirror of molten brass; like it, they appear solid and bright. Ezechiel uses almost the same comparison: "And over the heads of living creatures was the likeness of the firmament, as the appearance of crystal." (2) These comparisons, taken from the apparent nature of things, decide nothing as to the real constitution of the heavens. They correspond with the 'crystal skies' and 'mirror of the firmament,' used by poets, and nothing more. Pursuing our investigations, let us hear Isaias: "It is He that sitteth upon the Globe of the Earth, and the inhabitants thereof are as locusts: He that stretcheth out the heavens as nothing, and spreadeth them out as a tent to dwell in." (3) Again, "I am the Lord, that make all things, that alone stretch out the heavens, that establish the Earth." (4) And again: "My Hand stretched forth the heavens, and I have commanded all their host." (5) According to these texts, the 'firmament' or the 'heavens' are an *extension* contrasted with the Earth which it *founded.*

We read, however, elsewhere, that the heavens have been 'established.' It is, then, necessary to examine the meaning of this expression. The Psalmist says: "By the word of the Lord, the heavens were established, and all the power of them by the spirit of His mouth." (6) The power of heaven are the stars. The heavens and the stars have then been *established* by the word of the Lord. Here there is evidently question of the constant order of the heavens, of the regular motions of the celestial bodies. The expression 'establish,' does not

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(1) Job. XXXVII, 18.
(2) Ezech. I. 22.
(3) Is. XL. 22.
(4) Is. XLIV. 24.
(5) Jb. XLV. 12.
(6) Ps. XXXII. 6.

imply a material solidity in the Hebrew language no more than in the vernacular. The Psalmist again says: "Who established the Earth above the waters."(1) The meaning of the word 'establish' cannot be doubtful in this place. It expresses the equilibrium of the Earth amid the waters. Now the word 'equilibrium' implies the idea of stability, of resistance, of solidity: and this is the signification of the word 'establish' whenever there is question in Scripture of the stars, of the heavens, of the Earth, and of the waters. The Book of Proverbs will shew this to us in an evident manner. It is Wisdom that speaks: "When He prepared the heavens, I was present: when with a certain law and compass He established the depths: when He established the sky above and poised the fountains of waters: when He compassed the sea with its bounds, and set a law to the waters that they should not pass their limits: when He balanced the foundations of the Earth. I was with Him forming all things."(2) It is, then, the law of general equilibrium that is so admirably painted in this poetic imagery. Isaias will shew this again, in his own sublime language: "Who hath measured the waters in the hollow of His hand, and weighed the heavens with His palm? Who hath poised with three fingers the bulk of the Earth, and weighed the mountains in scales, and the hills in a balance?"(3)

These texts, to which others might be added, leave no doubt as to the meaning of these figurative expressions. The Sacred Writers wished to teach us that God established the equilibrium of the heavens, of the air, of the clouds, of the stars, of the waters, as well as of the Earth. From this comparison results also the sense we must give to the word 'firmament,'—whether, with the Hebrew text, we attach to it the idea of expansion; or with the Septuagint and Vulgate, we take it as signifying firmness,—what sustains and strengthens. In every case, this 'firmament' is nothing more than the admirable equilibrium which reigns in space, which regulates the motions of the stars and of the Earth. Now if science at the present day admits that the spaces of our solar system are

(1) Ps. CXXXV. 6. (2) Prov. VIII. 24-30. (3) Is. XL. 12.

filled with fluids, that these fluids are the impelling causes of motion; that they oppose a resistance to the solids; that in turn the solids oppose a resistance to them, from which result repulsion and the various motions; if we remember these facts, we shall find how just and exact is this expression 'firmament' to designate the celestial spaces; since the fluids expanded in these spaces are the bond of equilibrium, the cause of the stability of the motions of the stars and of the Earth. This interpretation is connected with all that precedes in the history of the Creation, and is its consequence. It is not an effort of imagination, as might be imagined by those who have not a clear and definite idea of the laws of motion, and of the causes in operation in our world; and who think that the air and the fluids, because of their subtility, cannot strengthen or consolidate anything. Such persons are unacquainted with the most ordinary facts of experience, and are not aware that it is the weight of the air which prevents the evaporation of the waters, which maintains and keeps them in the liquid state. The Sacred Text is more rational and more exact. It says: "let there be a firmament, made amidst the waters, and let it divide the waters from the waters." (1) What is it that divides between the liquid waters and the watery vapours? Is it not the atmosphere; composed of weightier gases than the watery vapours which consequently rise above them? But is it not also the atmosphere which weighs on the waters of the seas, and maintains and keeps them in their liquid state and in their limits? What name more appropriate to it than 'firmament,' which signifies an extension that sustains, and strengthens, literally as well as figuratively?

Thus the Earth is environed by liquid waters; the land and the waters are enveloped by the atmosphere which keeps the Earth in equilibrium and the waters in a liquid state. Beyond the atmosphere are found watery vapours and hydrogen, which, in turn, are compressed by the fluids that fill space and form the skies, in the midst of which all the sidereal bodies perform their motions. Thus the order is constant; all things are

(1) Gen. I. 6

established in equilibrium by the heavens or firmament, and the terms which narrate the work of the second day are perfectly conformable to the most general and most positive results of science.

THIRD DAY.—*Emersion of the land.—Formation of the sea.—Creation of vegetables.*

"And God also said: let the waters that are under the heaven be gathered together into one place: and let the dry land appear. And it was so done. And God called the dry land, earth; and the gathering together of the waters, He called, seas." (1)—Seas, in the plural, as we still say, the seas of Europe, and the seas of Asia; but this expression would not be rigorously exact, if applied to the seas, now that they are gathered together in one place; for independently of the great Ocean, we have the Caspian and the Mediterranean seas. Was there at the beginning but one sea-basin? We shall, further on, answer this question geologically.

The text above cited may serve as commentary to that of the second day, where "under the firmament" is opposed to "above the firmament." In this phrase, "let the waters that are under the firmament be gathered together into one place, and let the dry land appear,"—it is clear that the words, "under the firmament," must be understood of the waters that envelope the earth, since the emersion and apparition of the earth is to be the result of their flowing off into the basin of the sea. "Under the firmament," or "under the heaven," designates then the lowest part of the atmosphere, and "above the firmament," or "above the heaven," indicates its higher part—the region of clouds. Moreover, in Hebrew as in modern languages, the words, 'heaven' and 'firmament,' indifferently signify the atmosphere, or all the extent of the celestial spaces. Hence in narrating the creation of the stars, Moses will tell us that God placed them *in* the 'firmament.'

In the narrative of Moses, the creation of the Earth extends

(1) Gen. I. 9. 10

to the third day. The first day, the earth and the waters are created; then the light; the Earth receives its diurnal motion, and the measure of days, or the succession of day and night is established. On the second day, God created the firmament or the heaven, and the atmosphere of the Earth. On the third day, He separated the earth from the waters that covered it, and caused the dry, solid land to appear. These facts, contained in the six first verses, regard the Creation of the Earth. The Earth not having been at once brought to a perfect state, God did not say, "let there be Earths:"—for all the imperative forms of expression, that create the light, the atmosphere, that dry up the land and form the sea, have reference to the earth, since they tend to its perfection, and prepare it for its destination, which is, to be a suitable abode for organized beings, for the sake of man, the last term of all these creations which terminate in him.

The Hebrew writers have celebrated these first works of the third day, in language, the luminousness, magnificence and vivacity of which contrast with the calm, simple, sublime majesty of the narrative in Genesis, and prove its high antiquity. Job introduces the Lord asking among other things: "Who shut up the sea with doors, when it broke forth as issuing out of the womb: when I made a cloud the garment thereof, and wrapped it in a mist as in swaddling bands: I set my bounds around it, and made it bars and doors: and I said: hitherto thou shalt come and no further, and here thou shalt break thy swelling waves." (1) "The sea is his and He made it, and His hands formed the dry land."(2) "At thy rebuke, they (the waters) shall flee; at the voice of thy thunder they shall fear." (3) "Gathering together the waters of the sea, as in a vessel, laying up the depths in storehouses." (4) "By His wisdom, the depths have broken out." (5) "I have set the sand, a bound for the sea, an everlasting ordinance, which it shall not pass over; and the waves thereof

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(1) Job. XXXVIII, 8.
(2) Ps. XCIV. 5.
(3) Ps. CIII. 7.
(4) Ps. XXXII. 7.
(5) Prov. III. 20.

shall toss themselves, and shall not prevail; they shall swell and shall not pass over it." (1)

Before examining the Mosaic narrative of the creation of vegetables, we must ascertain what are the general media which are most suitable to species of this kingdom, in order to convince ourselves that Moses places their creation at the most appropriate time. Some paleontologists suppose that the surface of the Earth, at its origin, was impregnated with carbon, and that the atmosphere was composed almost exclusively of carbonic acid. They also admit a higher temperature at the beginning, which would have facilitated vegetation. Some attribute to the vegetables of the coal-beds a nature and conditions of existence different from those of our present vegetables; and taking for a period of many thousand ages, the day of the creation of plants, they hesitate not to maintain, that the plants could, during all that time, live and thrive without solar influence, and that they were in fact better without it.

We know, however, that plants like animals, when immersed in carbonic acid, die. If they are nourished by this gas, they cannot at least decompose it, and completely assimilate it, as when under the influence of the atmosphere and the sun. In darkness, or shade, they do not decompose it, but give it back in gas. They are almost tasteless, very tender, and in a state of debility that prevents them from flowering or bearing fruit; although their stems may be large. A surface impregnated with too much carbon, and an atmosphere of carbonic acid, would, consequently, have been causes of destruction to the vegetable kingdom at the time of its creation.

On the other hand, a temperature higher than is felt in our warmest climates, as that above 40° to 50° (Reaumur) drys up the germs of plants, far from favoring their development.

Consequently, either the primitive conditions of life did not essentially differ from those of the present, or the nature and structure of the vegetables were different from those of our living plants. But the examination of vegetable fossils at all

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(1) Jeremiah, V. 22.

epochs has obliged botanists to recognize in them the same nature, the same anatomical structure, and, consequently, the same physiological functions as in the existing vegetables. Were the height and dimensions of the vegetables of the coal-beds always what they are said to be, they would absolutely prove nothing as to the essential difference of the media of existence. They would at most lead to the conclusion that the present causes were originally more energetic and more active than now, without, however, being different.

Carbonic acid alone, oxigen alone, electricity alone, moisture alone, metallic oxides alone—would be so many principles of destruction for the vegetables; but the union of these elements are the conditions favorable to their development and their life. In following the simple narrative of Moses, we have seen the ethereal fluids—that is to say, electricity, heat, and light,—so necessary for plants, created to prepare by their action the earth, the waters and the atmosphere. The atmosphere is saturated with all these gases which principally supply the vegetable kingdom with its nutritive substance. The waters are gathered together into one place, leaving the dry land impregnated with many salts—a necessary result of the vaporization of the waters. The primitive soil is there, with its virgin-earth, its metallic oxides which characterize the granite: every thing then is prepared to receive the vegetable kingdom.

The sun does not yet exist; but in the ether there are heat and electricity, principles of vegetation. The sun does not indeed yet exist; but his presence at the moment of the creation of vegetables would have been hurtful rather than advantageous to them. During the day, under the influence of this luminary, vegetables absorb carbonic acid and give out oxigen: during the night, they absorb oxygen and give out carbonic acid. Now the action of light, heat and electricity having previously decomposed all the elements contained in the primitive atmosphere, it was necessary that the vegetables should appear first, and absorb a sufficient quantity of oxygen, so that when the sun appeared, they might under its influence act on the carbonic acid of the atmosphere, absorb it, exhale oxygen and thus prepare an abode for the animals of which this gas is the respiratory aliment. By this means, every thing was done in order; whereas had the vegetables begun by absorbing carbonic acid, which would have been the case had the sun been created before them, they would have been placed in unfavorable circumstances; not having oxygen in their tissues, the carbon would in all probability not have been assimilated, and their life would have begun by causes of destruction. The presence of the sun would also have prevented the vegetables from being, from the instant of their creation, in connexion with the electric fluid, which acts so large a part in vegetation. The sun, in effect, appears to favour the disengagement of the electricity of the plants; it was then suitable that these should be in electrical equilibrium, before undergoing the solar influence, which was to perpetuate the succession of all these relations. Created before the sun, before the animal and social classes, of which they are the foundation, the vegetables appear, like all that preceded their existence, in the order necessary for the harmony of the whole creation.

If we closely examine the original text of Genesis, we find: "Let the earth make grow all sorts of plants, the grass making seed, the tree forming its fruit according to its kind, containing seed, to be multiplied on the earth: it was so."

The Vulgate says, *germinet terra*, "let the earth produce"—an expression which seems to indicate the concourse of the earth in the production of the vegetable kingdom. Was the earth, then, endowed with special power to take part on this occasion otherwise than it does at present; and does Genesis favour the idea of Lucretius, who represents the earth as deprived of its primitive energy,—exhausted, and likened to a woman whom age has rendered sterile? This difficulty does not appear in the original text: "let the earth make grow:"—that is, the earth does not produce the vegetable; it is only applied to a function for which God had already prepared it; namely, that of furnishing to the vegetable a portion of its nutritive substance. "These are the generations of the heaven and the earth, when they were created, in the day that the Lord God made the heaven and the Earth. And every plant of the field before it sprung up in the Earth, (1) and every herb of the ground before it grew." And again: "And the Lord God brought forth out of the ground all manner of trees." (2) It is not possible to exclude more formally all participation of a blind cause, like the earth, in the production of the admirable phenomenon of vegetable life. The earth will indeed contribute to the development of the grain; it supposes the vegetable; it is its foundation; as it is the foundation of the earthly portion of the animal kingdom, as water is the foundation of aquatic life and air that of birds. "Let the earth make to grow:"—"Let the earth bring forth the living creature."—"Let the waters bring forth the creeping creature having life." (3)—Whatever may not be literally accurate in these expressions is corrected by other circumstances of the recital. To expect Moses to speak otherwise than he has spoken, is to imagine that he was a naturalist by profession, and those whom he addressed a people of naturalists.

When we look in Genesis only for what it contains, we see that all the plants appear at the same time and instantaneously; that the earth produced all sorts of vegetables. This is an additional proof that the plants are a creation properly so-called. Those who, in conformity with groundless theories, take the days of Creation for indeterminate periods, are not aware of the absurdity of supposing that the vegetable kingdom could have existed without the sun during thousands of ages. If they say that the creation of vegetables was accomplished at the end of one period, and the creation of the heavenly bodies at the commencement of the following period, and that thus the two creations were separated by a very short space of time,—they acknowledge implicitly the simultaneous creation of the vegetable kingdom, and abandon the principle of speculative geology, to which they leave only time without facts.

In the first part of this work we saw that the species was

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(1) Gen. II. 4-5. (2) Ibid. II. 9. (3) Ibid. I. II. 20-24.

denied or disputed by great naturalists, even down to our own days. Moses was better informed. According to him, the vegetables are not isolated individuals, but species, and species created by God.—" The green herb and such as yieldeth seed according to its kind, and the tree that beareth fruit having seed each one according to its kind." (1)—With the exception of that of Moses, all the ancient cosmogonies were pantheistic. He does not derive the species, one from the other, by successive transformations. He shews us that all were created from the beginning.

There is here also something deserving attention. The seed is the result of a law which governs each species : it supposes the existence of similar beings, who have produced it. Hence it is the vegetable that is created, and not the seed, which the vegetable is to produce. "Let the earth bring forth the green herb and such as may seed, and the fruit-tree yielding fruit after its kind which may have seed in itself upon the earth." (2)

It follows from these texts so precisely expressed, 1° that God created the vegetables by the power of His word, and that they have not been produced by the laws of matter and a generative principle inherent in the earth, as some maintained; 2° that they were not created in the state of germ or of seed, but in the adult state,—perfect, capable of producing seed, and of being propagated by generation in time and space; 3° that there were not only a certain number of types, —genera from which, by successive transformations, species were produced, but that the species themselves were all created. Without these grand and beautiful truths, Botany would be no science, since it would have no ground-principle. These theses shall be developed further on.

Fourth Day.—*Creation of heavenly bodies.*—Were the World created in the elementary or gaseous state there would be no aggregation of its parts, no mass could be formed: motion itself would not exist, because there would only be im-

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(1) Gen. I. 12. (2) Ibid. II.

pulsion without resistance, and, consequently, indefinite expansion. We are forced, then, to admit, with Genesis, a creation of fluids and a creation of solids.

The creation of a primitive mass in our solar system, before the existence of fluids, is open to no objection. The lever, represented by the resistance of the earth, is prepared to receive the application of the force of fluids. When they appear, the impulsive force will combine with resistance, and the appointed motions will be maintained by this combination.

But suppose the masses created all at once and before the fluids. The hypothesis of attraction, as a property of matter and without other cause, being a chimera, an absurdity—as Newton himself acknowledged,—the masses thus thrown into empty space without any bond which might balance and restrain them, would be exposed to mutual and destructive collisions. The harmony of the weight of each with the distances would be regulated by no law; and when the fluids appeared, it would be necessary to attribute to them a power which they have not—of putting all things in their place. On the contrary, when the masses are created, space is already filled with fluids, the bodies naturally balance each other; they are enveloped and held in by them; they are regulated in their respective motions by the impulsive action of these fluids, and by their own reaction of resistance. The creation of the heavenly bodies when the fluids filled space, is, then, conformable to the laws of motion; and, consequently, these masses appear at the fitting time. Moreover, the animals will not be slow in appearing; and that they may by their organ of sight be in communication with the light, this latter must be already in motion. The power of causing light to vibrate belongs to the heavenly bodies. The time of their creation is then come.

"God said: let there be luminaries in the expansion of the heaven to distinguish the day and the night; let them serve as signs to indicate the epochs, the years, the days, (the stars serve as signs, to direct the course of travelers through the desert, or of the mariner on the Ocean); let them be to cause light in the expansion of the heaven, to cause light on the

Earth. It was so. God made two great luminaries, the greater to rule during the day, the smaller to rule during the night, and the stars, (the word which we translate 'stars,' comprehends also the planets and the comets), God placed them in the expansion of the heaven to make light on the Earth, to rule the day and the night, and to separate the light from the darkness. There was evening, there was morning, the fourth day." (1)

I translate from the Hebrew. The Vulgate,—a masterpiece not sufficiently appreciated, written in a language which permits, even at the expense of grammar, a literal fidelity our living tongues do not allow,—does not always distinguish the shades of meaning in the original text, as it is easy to see by reference to the original.

According to the text, the heavenly bodies did not pass through several phases before arriving at their final state. They were created all at once and in an instant. "Let there be luminaries,—and it was so."—This is what all the Fathers who wrote on the Creation found in the text.

The sun and moon are not the two greatest of the heavenly bodies. Genesis, however, calls them two great luminaries, because it considers them in their relation to our Globe, on which they shed more light than all the others together. A candle which gives me light is for me a greater light than thousands of stars, when from the depths of the most distant heavens they emit a feeble and vacillating light.

Light is distinct from the sun, according to the teaching of science and that of Genesis. Science also tells us that the sun is merely the mover of the luminous fluid ; and this is what Moses says in equivalent terms. The expressions of Moses are : "let there be luminaries in the expanse of the heaven to make distinguish the day and the night ; let them serve as luminaries in the expanse of the heaven to make shine upon the Earth." In these texts there are two verbs,—'to make distinguish.' and 'to make shine': both are employed in the causative form. The absolute form for one is 'to divide,'

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(1) Gen. I. 14-19.

'distinguish'; and for the other 'to shine,' 'enlighten.' In the causative form the subject does not perform the action, he causes it to be done. Thus the sun and the moon do not shine; but they make shine, according to the force of the terms, with which the results of science perfectly correspond.

D'Alembert, Laplace, and all their school, by making light the very substance of the sun, furnished the contributors to the Encyclopedia the means of attacking the Christian teaching, and of accusing the narrative of the creation of a physical error, 'so absurd,' it was said, "that it was impossible to receive it as a divine record." Science, better informed, proves that matters ought to have occurred as Moses represents them.

What follows is not less admirable. From the first day Moses shews us the Creator separating by an interval of time the day and the night. This interval was measured by the rotation of the Earth, since there never was and never could be any other measure of day and night. It was necessary that a permanent law should render this measure sensible for man, when he should appear. It is established by the creation of the heavenly bodies, the relations of which with the ether must produce luminous phenomena. These of themselves do not furnish a measure of time; but they render it always sensible; or as the text so well says, they serve to distinguish the day from the night. They do not make the day; neither do they make the night; they are *luminaries*. So all the literature of our modern times, when it speaks of the phenomena of nature, abstracts from the results of science, and its language is almost always inexact. The narrative of the Creation in Genesis, written more than thirty ages ago, before the rise of the sciences of observation, at a time when so few natural objects were yet named, and in a language more susceptible of bold figures than our modern European tongues,—this narrative has an exactness and accuracy that ought to fill with astonishment every man who regards it as nothing more than an uninspired document.

Among all creatures the measure of time belongs exclusively to man,—a social being who is to live in his posterity to remember the past and record it; to mark with precision the date of his acts, in order to establish his respective rights and know his obligations and his duties. The measure of time is one of the bases of the social world; without it human memory would be impossible. Genesis expresses in a few words these essential relations of the heavenly bodies with the wants of man: "let them serve as signs to mark the epochs, the days and the years."

If from these observations we rise to more general considerations, we shall also find the Sacred narrative harmonizing with Science. The field of possible positive astronomy is limited to our solar system; beyond is the realm of conjecture. Our real knowledge of astronomy is naturally in direct relation with the importance for man which Moses attributes to the various celestial bodies. The Earth, the moon and the sun,—are the foundation of astronomical science properly so-called. After them come the planets of our system, which we know more or less in their geometrical and mechanical phenomena; and then the stars, whose relative distance we are scarcely able to know by observing their motion among themselves. Now such is the gradation followed by Moses. He recounts in detail the creation of the Earth; then, more briefly, that of the sun and moon, pointing out their utility for our Globe; and he has but one word for all the other heavenly bodies,—'and the stars,' as if he had wished to indicate the little we should ever be permitted to know about them. This fact is very remarkable.

To go further with positive astronomy. The plants, animals, man exist. They do not exist by force of astronomical or other laws: they are not a result of these laws: they were created by God, and in the establishment of the laws of this world, God prepared for them suitable media of existence. Such is the teaching of Genesis.

On its part, Science shews an intimate connexion between the astronomical phenomena and organized beings: it establishes the stability of our solar system relatively to all the stars, considered under essential relations. Amidst all the celestial changes, our stars present the almost rigorous invariability of the great axes of their elleptical orbits and of the duration of their sidereal revolutions. Their rotation shews us a still more perfect constancy in its duration, in its poles, and even, although in a lesser degree, in the inclination of its axis to the orbit in which it moves. Thus it is certain, that from the time of Hipparchus the duration of the day has not varied by the hundredth part of a second. Hence in the general stability of our world, we discover a special and more distinct stability in regard of the elements, the stability of which is all important for the perpetuity of living species. A constitution, also essential to the continued existence of organized beings, is the consequence,—according to the mechanical laws of the world,—of some circumstances characteristic of our solar system; such as the extreme smallness of the planetary masses in comparison with the central mass, the small excentricity of their orbits, and the small mutual inclination of their planes. Thus, all being arranged in our solar system, to present to organized beings, and especially to man, astronomical conditions necessary for his existence, we must necessarily admit, conformably to the teaching of Genesis, that these conditions were established for this end.

What matters it, then, that our planet is smaller than the sun, or that it is more reasonable to explain the celestial motions by the motion of the Earth round the sun than of the sun round the Earth? What has this to do with the destination of the solar system? We may even perceive in the motion of the Earth, and in its mass—so much smaller than that of the sun—a better condition of existence for living beings; for to these two causes we must attribute in part the tides of the atmosphere and of the Ocean, and, consequently their salubrity, so necessary for the animal and social world.

This is not all. Genesis tells us that all the sidereal masses of our system were created and arranged for our Globe, with a view to man, who was to live on it: and on the other hand, Science has almost demonstrated the fact, that of all the bodies of our system, the Earth is the only one which is habitable. The moon—which acts the principal part in the romance of Fontenelle—cannot be inhabited: it has no atmosphere.

In the occultation of stars by this body, there is no refraction observable on its limits: it follows that there is no refracting envelope, either of gas or of any vapour whatever, and, consequently, no air or water, two fundamental conditions of all organic existence.

As for the other planets they are either too near or too far from the sun to render life possible in them, in the supposition that they have an atmosphere—a fact that has not been ascertained.—"What organization could live in Mercury which has a higher temperature than that of molten lead? Is it more conceivable in Uranus, where, every thing else being equal, the mean temperature would be 300 degrees (of Reaumur) below the freezing point? Shall we people the comets with inhabitants? For example, in that of 1680, which, at its perihelion, according to Newton, experienced a heat two thousand times equal to that of red hot iron, and which at its aphelion does not receive an atom of solar heat? I insist less on the enormous cold, both because the natural solar heat may be modified even at immense distances by planetary atmospheres and circumstances of surface, which render it sensible, and because these globes may have causes of heat independent of that of the central body. Moreover, the calculation of temperatures, which diminish inversely with the square of the distances, becomes quite illusory if the solar action being annulled by a sufficient distance, the planet finds itself in relation with the sole temperature of space which may be any thing, and which is supposed to be 40° (of Reaumur) below zero. It is, nevertheless, true, that these organized beings would live in temperatures of which the opposite limits would comprehend an interval of from three to four hundred degrees; which it is not possible for human nature or any other being, animal or vegetable, to bear. The inhabitants of comets must be at least salamanders, although what Laplace calls cometary evaporation should diminish at the perihelion the frightful heat of the surface.—We must also acknowledge that the satellites of the planets are of too little use to them to be considered as foci of auxiliary light. Take for example those of Uranus. Seen at the distance of this planet from the sun, this latter appears under an angle of a minute and a half, that is to say as a half franc piece, and the light received is four hundred times less than that received by the Earth. Now if our moon gives us light which is 300,000 times less than that we receive from the sun, can the light reflected by the satellites of Uranus,—which receive four hundred times less than our moon,—be seriously considered as destined to supply the little light which the sun imparts at such distances? If, instead of six satellites, Uranus had six hundred, the supposed inhabitants of Uranus would not see a whit more clearly. It would be much more reasonable to suppose that the tens of thousands of stars which shine over our heads were made to give us light, for they act an infinitely more brilliant part in regard to our Earth than that of the satellites of Uranus." (1)

If the planets which we know are uninhabitable, on what ground shall we believe that those which may be imagined in the immensity of the stellar system, are inhabited? The unpeopling of the moon has been fatal to the hypothesis of a plurality of the worlds. This, however, is not saying that every thing has been made for the benefit of man; that he is the only object of universal Creation; and the only being called to celebrate the glory of the Creator.

The traditions of all ancient nations, in this agreeing with Catholic Faith, teach that there exist other intelligences more perfect than man, and created before him; who admire the works of God as he does; and who saw what he did not see—the universe issuing from nothing at the voice of its Creator. "Where wast thou when I laid the foundations of the Earth, —when the Angels of God praised me together and all the sons of God made a joyful melody." (2) In the narrative of Moses no other relation of the stellar system than what regards man was necessary to be mentioned. The history of the origin of the Earth was made for the inhabitants of the Earth, and the preference which this itself enjoys in the recital, above the rest of the Universe, is as reasonable as it is evident.

All the Sacred Writers have spoken of the work of the

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(1) Soirées de Montlhery. (2) Job. XXXVIII. 4-5.

fourth day in language of the same tenor as that of Genesis: all have seen in it a creation, properly so-called, and not, as the English geologists maintain, a new disposition given to pre-existing materials. It would be too long and unnecessary to cite them at length. I shall conclude by an observation on the indeterminate periods of the geologists so inappropriately called Biblical. They are entirely incompatible with our cosmogony. When this narrative exhibits the Creator placing the stars in the firmament to cause light upon the Earth, we expect to see creatures having the organ of vision; when the text adds, with reference to these same stars, that they may serve as signs to mark the seasons, the days and the years, the reader feels that man is about to appear. He is, then, no little astonished at seeing Deluc and those of his school separate the creation of stars from that of animals by a long period of time, and place another and still longer period between the creation of animals and man. The sun, created to cause light, would have given no light during thousands of ages; since there was nothing but vegetables on earth, and this luminary, established to shew man, the time, the days and the years, would, for thousands of ages, have shewn nothing of the sort, since the sole inhabitants of the Earth were animals. The Sacred Writers did not so understand the history of Creation. They saw indeed in it a progressive creation; but one the different parts of which were separated by intervals of time so short that it might be in some manner considered as simultaneous. Hence David said: "He spoke and all things were made: He commended and they were created." (1) —The writer of the book of Ecclesiasticus says: "He that liveth for ever created all things together." (2)

FIFTH DAY.—*Creation of aquatic animals and of birds.*

" And God said: let the waters swarm with the swimming animals, and let birds fly over the earth under heaven; and God created the great whales and every living and moving animal that the waters caused to abound, with their like,

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(1) Ps. XXXII. 9. (2) Ecclés. XVIII. 1.

(according to their species); also all birds, with their like, (according to their species). He blessed them and said: be fruitful, increase, fill the waters of the sea, and let the birds be multiplied on the earth." (1)

The birds are connected with the sea-animals, on which a great many of them live—with the worms and insects created with the birds,—with the vegetables of which a great part constitutes their food, but which they also protect against the ravages of a great number of small animals, so that by them the equilibrium between all those beings is maintained.

The *producant aquæ* (let the waters produce) of the Vulgate does not fully render the Hebrew expression, which signifies to swarm, to cause to creep in abundance. It is applied to what abounds and moves with great quickness,—to whatever has no feet, or very short feet, and appears to creep. It was very applicable to the swimming animals, such as the crustacea, fish, &c. The text says 'waters' and not 'seas,' because the river and lake species are included in the same creation with the sea-animals.

The interest the Creator takes in His work appears to increase as the work itself rises in the scale of perfection. He blessed them, and said: be fruitful and increase. Who does not know the prodigious fruitfulness of the aquatic species in general? These animals live on one another. They serve as food to terrestrial animals, to birds and to man: the eggs of many of them are abandoned by the parents immediately after their production. Amid so many causes of destruction they must needs have been created numerous and fruitful, in order to be perpetuated.

"Let the waters swarm with swimming animals."—It is always the same act of the Allpowerful Will which is immediately followed by its effect. There is no formation of womb in which the ovule might be developed, the animal itself is created. It is created in the adult state, and is capable of multiplying from the very first moment of its existence.

The animals are not created individually but specifically—

(1) Gen. I. 20.

"according to its kind," that is, God created permanent and determinate species founded on the faculty of reproduction. Whether we translate the word *lemineah* by *female*, after Glaire, or "according to its genus," or "according to its species," as does the Vulgate, it expresses, in the clearest and most precise manner, the creation of species. The establishment of immutable species is then as clearly taught by Genesis as it is rigorously demonstrated by zoology; and, consequently, the transformation of species is inadmissible.

The Sacred text distinguishes the organized beings by their true natural characters. The vegetable as well as the animal has an organization which performs certain functions. The animal is nourished; so also the vegetable: the animal breathes; so also the vegetable: the animal has blood which is red or white, hot or cold, &c.;—the vegetable has sap which is its blood, white or colored, and of a temperature more or less elevated: the animal secretes, and separates from its organization, certain products; so also the vegetable: the animal reproduces himself, as does also the vegetable, and that by analogous organs. In all these functions the animal is but a more complicated vegetable. But the vegetable has no perception; it does not more voluntarily. These two great properties are peculiar to the animal; and Moses expressed them when he defined the animal as a living and moving organization.

The examination of the different versions leaves no doubt on this point. The word *animal* comes from the Latin, *anima*, which itself is derived from a Greek word which signifies 'breath'—the wind produced by the entrance and issue of the air in the lungs. The name of animal is derived from the act of respiration, which is the least equivocal sign of life. The word *anima* signifies 'breath,' and by extension *life*. The Hebrew corresponding with the *anima vivens et motabilis* of the Vulgate is: *col nephesch hahhiah haromescheth*—an expression in which Moses comprizes all animals, even the lowest. The word *nephesch* signifies properly *breath;* then by extension, *life;* and it is the only word in the Hebrew which expresses what zoologists call sensibility;

it contains all its attributes in its various acceptations. The word *hahhiah* signifies life, and all that corresponds with our idea of animal. The expression *colnephesch hahhiah* means, every being having the breath of life, every sensible being, having appetites, &c. *Haromescheth* signifies 'that which moves of itself.' The sense of the whole phrase is, every living and self moving being. Animality is, then, indicated in the Sacred text by the same characters by which it is defined in zoology.

We may observe that these essential characters of the two kingdoms, so precisely stated in the Sacred narrative of Creation, owe their definite recognition as principles of science to Blainville. In establishing the reality, the stability, the creation of species, and the characters which distinguish the organic kingdoms, Genesis expressed by anticipation all the great principles of Science.

SIXTH DAY.—*Creation of land-animals.—Creation of Man.*

"God said let the earth bring forth the living creature in its kind, domestic animals, reptiles, and wild land-animals, according to their kind. It was so. God made the wild land-animals according to their kind; the cattle according to its kind; and the land-reptiles, according to their kind."

On the sixth day were created the animals more closely approximating to man by their physical organization; which, being placed in some manner under his hand, were to be developed collaterally with him.

The Hebrew word *behemah* signifies domestic animals: it contrasts with the terms *haiah haaretz*, wild animals who wander over the earth. The Septuagint and Vulgate have so translated it. Cahen has rendered *behemah* by 'cattle'. The Psalmist, speaking of the empire which God gave to man after his Creation, says:—"Thou hast put all things under his feet, all sheep and oxen, moreover also the beasts of the field." (1) Hence the literal interpretation of the text shews that some

(1) Ps. VIII. 6.

species were created domestic, and some wild.—Those who maintain that the original was the wild state deny it; but Science contradicts them, and speaks like Genesis. By domestic-animals we are to understand those which are specifically such, as the dog, the ox, the horse, the sheep, &c., and not those who may, more or less, become such, as the civets, which are tamed on account of the substance they produce, the elephants and many others. We must distinguish between species naturally domestic, and those of which some individuals may be tamed; since all animals, even the most ferocious, may be trained to a kind of domesticity.

Had the creation of land-animals been separated from that of man by thousands of ages, wherefore should there have been domestic-animals, who would not be contemporary with man, and who would become extinct long before man's appearance on earth, as the advocates of Deluc's system suppose?

We have already seen that vegetables and animals were created specifically. Another point remains to be determined. Was each species so created, a multiple, or a single couple? Were they created on one or more points of the Globe?

"Let the earth cause to vegetate,"—says the Sacred text: "Let the waters swarm with swimming animals; let the birds fly on the land, under the heaven; let the earth produce living creatures."—In these expressions, the earth, the waters, the heaven—are taken in their general and widest signification. We are not then to confine these creations to a special locality. It is in the waters, under the heaven, on the earth in general, and not at a particular point, that they appear at the command of God. When Genesis says: "In the beginning, God created the heaven and the Earth,—the Earth was invisible,—let the firmament divide the waters from the waters,"—the words 'heaven,' 'Earth,' 'waters,' 'firmament'—are taken in their most general signification. Moses does not express himself otherwise in speaking of the vegetable and animal creation. It is, then, evident from the text, that the species were established by the Creator on all the points where they could live; and that we should not admit any exception to the general fact, unless such exception be intimated or implied in the words of Genesis itself. The Sacred narrative appears to except the class of birds and quadrupeds; for it is said in the following chapter that the Lord, "brought all the beasts of the earth and fowls of the air to Adam to see what name he would call them."(1)—All the species of these two classes had, then, the same centre of creation as man. It may be replied that these same species might have been created at the same time in other countries. But, first, it does not appear why the domestic species, created for man, and all of which belong to these two classes, should have been placed at points of the Globe, where man would not be found until long after; and then, is it not remarkable that of so many classes of plants and animals, those of the birds and of the mammals, should be precisely the only ones which are not found in the lowest formations, in Europe or America, which have been examined? These two classes appear, then, to have been limited in their creation to the elevated plateaus of central Asia, and probably also to those of Africa.

We now come to the second question. Was each species created multiple? The terms used in Genesis to express animals and plants, are employed in an absolute and indeterminate signification, and we have no motive for saying that the species were created in single couples. The fact of the creation of plants and animals, as expressed in Genesis in a general manner, as well for the number of individuals of each species as for the places, is in perfect harmony with the facts derived from natural history. The inferior animals, such as the spongiæ, thetiæ, polypes, madrepores, corals, in a word all the radiata-class that live in water, and the immense majority of those that live in the sea, where they are more or less attached, almost as vegetables, to the bottom-surface,—would have soon disappeared, had they been created in single couples and only on one point. The same must be said of the mollusks, the articulata, the aquatic reptiles,—animals which seldom change place, rarely travel far, and are limited to certain regions; some on the shores, others at the mouths of rivers,

(1) Gen. II. 9.

others in the bogs, others in the open sea, and at great depths. Moreover, these species, and those of the class of fishes, live on one another. We must, then, admit that they were created in great numbers, and on all points where they could develope and be multiplied. Among the birds and the mammals, some are herbivorous, granivorous or frugivorous, and others carnivorous. The carnivorous animals destroy the herbivorous, and feed on them. Were the herbivorous animals represented only by a small number of each species, they would have been completely destroyed by the carnivorous birds; which would afterwards have devoured one another, as that happens sometimes now, and the perpetuity of creation would have been impossible. Among the birds and the carnivorous mammals, some live on fish, on mollusks; others, on insects; others, on reptiles; others, on animals of their own class. The law of harmony which maintains the equilibrium among all beings, required, then, that the species of all the different classes should be created multiples in individuals.

It is said, Gen. I. 30, that God gave the plants and all vegetables as food to the animals of the Earth, to the birds of the heaven, and to all that moves and is endowed with the breath of life.—Hence, there were herbivorous or frugivorous animals on all the groups of the animal series: and this natural history teaches us. In the mammals, in the birds, in the reptiles, in the fishes, in the insects and crustacea, in the mollusks and in the radiata,—everywhere there exists a great number of species that feed on vegetables. Vegetables must, then, have been created at the same time on all the points of the dry land, and on all those of seas, and land-water courses, where they could be developed, since they were intended to support the aquatic as well as the land-animals. The general facts combine, then, well with those of observation, to tell us that the species in general were created in great numbers and on many points of the Globe.

Man alone was created single in his single species, on one sole point of the Earth. Zoology, philosophy, history and the tradition of the peoples, unite in confirming this triple statement of the author of Genesis: throughout there is accord between Science and Religion.

It yet remains for me to speak of the order followed in the creation of organized beings. We will institute a preliminary discussion on a word which has much changed in signification with the progress of zoology. The word *reptile* of the Vulgate, in Hebrew *haromescheth*, signifies every animal who moves quickly and who appears to creep. With the Greeks and Romans, and even with the naturalists of the middle ages down to our own modern times, all the small insectivorous animals, the small species of castor, as the beaver, &c., the rodentia, as the rats, are also comprized under the general name of reptiles. This word had not the same signification for the ancients as it has for us. In their language, it often designates the small animals in general, and sometimes all the animals. We have in the narrative of the Creation examples of this signification of the word. In the creation of aquatic animals, it is employed to designate all these same animals, with the single exception of the cetacea. God created the great whales and every living and moving creature which the waters brought forth. Further on the word is applied to all terrestrial animals. This appeared so evident to St. Jerome and M. Cahen, that both laid aside the use of the word 'reptile,' and translated the word by 'animal.'—"Rule, over all the animals that move upon the Earth."

Much later when the progress of science permitted the introduction of a complete and rigorous nomenclature, the zoologists comprized exclusively under the name of reptile, the serpents and all the animals that resemble them and that really creep. In Genesis as in all the ancient languages, a reptile designates, 1° the real reptiles, 2° all the small mammals that appear to creep, 3° all the lower animals, 4° sometimes all terrestrial animals. The context, then, has to be consulted on the meaning Genesis attributes to this word in the creations of the fifth and sixth days. As for the animals created on the fifth day, which are all aquatic, and are in many respects so similar, "it appears to me," says Maupied, "that *reptile* or *moving*, which certainly designates all the lower animals, the fishes, the amphibians, the aquatic reptiles, &c., should also comprize the terrestrial reptiles, such as we understand them now-a-day."—Whereas in the creations of the sixth day, in which there is question of the terrestrial animals, the word signifies the small mammals which appear to creep in contradistinction to the larger animals, designated by *cattle* and *beasts;* in the same manner, as on the fifth day, the small aquatic animals, whether the lower, or fish, or reptiles properly so-called, are styled reptiles in opposition to the great sea-animals—great whales. This two fold contrast is here of great weight, especially when taken in conjunction with the custom of ancient languages and the history of nomenclature."

According to this interpretation of the word, God at first gave existence to all the inferior classes, up to the marine mammals, and afterwards to the terrestrial mammals which comprize the most perfect species of the animal kingdom. However that may be, we must not look in the narrative of Moses for successive creations of classes, but successive creations of great groups, produced each one simultaneously. He shews us all the vegetables receiving existence at once; then all the sea-animals, and the winged-animals, created at the same time: then the terrestrial mammals; and then man. If the partizans of long periods of time could have laid aside their geological ideas, while studying the Sacred text, they would have clearly seen, either that there are no distinctions of classes, as is the case in the narrative of the creation of vegetables; or that the order in which classes are indicated is not the order of gradation; as in the creation of aquatic-animals, where the marine mammals, the great whales, are mentioned with the other lower animals of this class: or that the order of nomination varies, as in the creation of terrestrial animals, in which the wild quadrupeds are expressed sometimes before, sometimes after, what the text designates by the word 'reptile,'—a new and convincing proof of the simultaneousness of all these animal and vegetable creations.

The order of consecutive gradation or of our conceptions, could not be the order of creation. The species of the various classes of the two kingdoms are connected one with the other by mutual relations of support and of conservation, which would have been continually violated in a creation by successive classes. Moreover, the gradations extending to the species, it would have been necessary to proceed—not by classes, not by genera, but by successive species; and even thus it would not have been possible to observe the order of serial gradation, by reason of the numerous parasitical species of the two kingdoms which could not, unless this order were reversed, be separated from the species of classes different from their own, with which their existence has essential relations. Where, for example, would the Creator have placed the louse of the whale, if, according to the order of zoological gradation, this insect had been created before the sea-mammal on which it was to receive its development?

A successive creation by species or classes, following the serial order, was then impossible. A simultaneous creation, by exhibiting all beings created at once, might have appeared the result of a predetermined cause, acting under a necessary impulse. A creation the different portions of which would have been separated by long periods, would have been regarded as the effect of the laws of Nature. The order of Genesis, which preserves all the natural relations of beings, as also their mutual relations in the serial scale, is the most reasonable and the most suitable one that the human mind can imagine possible. It shews forth with greater lustre and in greater number than any other the divine attributes of the Author of the Universe.

With one sole act of His Will He created entire kingdoms: all the stars, all the plants: hence He is Allpowerful. He creates them successively, at unequal intervals, and according to an order which He varies; hence He is supremely free. He interposes but a few hours between His different creations; hence He acts without the concurrence of mechanical laws, whose action is always slow. Moreover, either the laws which now perpetuate the created order are merely the result of the properties of things and of their mutual relations; and in this supposition they could only have existed in these relations and with all these qualities, after the creation of beings, and their

Author is He who created these beings; or they are the direct effect of the immutable Will of the Creator; and in this case it is very evident that they have no influence on Him. Hence He is supremely independent. In fine, by creating the kingdoms, He connects them with each other by relations of conservation and perpetuity: hence He is sovereignly intelligent, and the only Creator, the only Disposer of the Universe. And now, He is about to form a being who shall be charged to bind the world to its Author—*nexus Dei et mundi*—"the link of God and the world,"—and offer to Him the homage of universal Creation. He will destine this being, the reflexion of the Divinity, to this sublime end, by creating him at once physical, intelligent, moral and religious; by subjecting him to moral laws, and by making his voluntary submission to these laws the condition of his perfection and his happiness. The world has, then, an object, the only one worthy of God, His own glory; and hence the Creator of the world is sovereignly wise.

"God said: let us make man to our own image and to our own likeness; let him rule over the animals of the sea, and the birds of the air, over the cattle, over all the earth and over all that moves on its surface, and God created man to His image; to the image of God He created him; male and female He created him." (1) This is the master-piece of Creation; the style of the historian rises with the subject. Man is not an animal in Genesis; the narrative of creation distinguishes him from animals in a more marked manner than animals from plants. It does not, then, place him in the animal creation; it does not say, for example: God created the terrestrial animals and man; but when the most perfect animals were created, God suspends His action; He appears to hold counsel with Himself: "Let us make man." Before, He had done all with a command, "let the light be," "let the earth bring forth, &c;" when there is question of man, it is no longer the language of command, but of counsel. There is, however, something still more grave and significant.

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(1) Gen. I.

"Let us make man to our own image and likeness," says the Creator!—"and God created man *in His image*."—We expected this repetition which here, as in the preceding works, shews us the accomplishment of the Creator's Will; but that was not sufficient for Moses: and comparing again such a creature with such a Creator, he exclaims, as if overwhelmed with admiration; "in the image of God He created him." Neither Moses, nor any other Sacred writer, nor the Jewish people ever believed that God was corporeal. They always protested against the corporeal Deities of other nations. It is not, then, by his body that man is like to God." 'God,' says the Book of Wisdom, "created man incorruptible, and in the image of His own likeness He made him." (1) Plato found in philosophy the confirmation of this truth; and taught that man was the image of God. Cicero said that man bore a likeness to God—*est homini cum Deo similitudo.* (2) And yet the latest Jewish translator of the Bible, after having faihtfully translated the text, expresses in a note his rationalistic view: "Let us make man according to our ideal, and let us make him like to our ideal."—Every being that acts intelligently acts conformably to his ideal. Did not God make all things according to His ideal? If this is all that Cahen has seen in the creation of man, what does he think of the motive of the prohibition renewed to the children of Noe after the deluge? "Whosoever shall shed man's blood, his blood shall be shed; for man was made in the image of God." (3) Translate this, as Cahen does the former text, "because God made man according to His ideal,"—and the descendants of Noe would have the same motive to respect the life of a plant or of an animal as of man.

The Hebrew text reads: "Let us make the Adam (man) in our image."—"Let them rule over the animals,—and God created Adam.—He created *them* male and female." Here the word Adam is not a proper name, limited solely to the first father of the human race: it is a collective noun, common to both sexes, and in Hebrew,—like the word *homo* in Latin,

(1) Wisdom. II. 23. (2) Lib. I. c. VII. (3) Gen. IX. 6.

and *man* in English,—comprehends both man and woman. The sense is, not that God created man an hermaphrodite, as was the opinion of some ancient Indian philosophers, but that He created the two first individuals of the human species; and that He created them in two sexes. Hence in the following verse they are spoken of in the plural number. "God blessed them and said: increase and multiply."—Here the species is created; but this time in one only genus, and one only couple, from whom have descended all the people of the Earth.

There are many other differences between the creation of man and that of the organic kingdoms. The whole kingdom of plants is created simultaneously and instantaneously: it is so with the aquatic animals, and so with the terrestrial animals: each of these groups was brought to existence by one sole act of the Divine Power. Man forms a remarkable exception; he is produced at three intervals, by three successive acts: 1° God takes from matter the physical nature of man: He forms a body of the slime of the earth; but this body is without life; whereas the animals lived as soon as they were produced; 2_0 God creates afterwards the spiritual being, by breathing into the face of this material body the *spiraculum vitæ*—the breath of life, as the Vulgate translate it;—and man becomes living by the breath of God Himself. But the original text clearly distinguishes the principle of life given to man from that given to animals. In speaking of these latter he always employs the expression *nephesch haiah*, respiration, life; in speaking of man, he says that God breathed upon him the soul of lives—*nischemat haiim*. Man participates in his body of the vegetable and animal lives; but the soul rules and governs these two lives; since, according to Genesis, by it man becomes an animated being,—*factus est in animam viventem*,—"and man became a living soul"; 3° in fine, by the formation of woman, taken from man, the social being is created. Hitherto God was pleased in the external realization of each of the wonders of His thought: God saw that it was good. But His last creation is incomplete; it calls for another. "It is not good, says He, that man should be alone; let us make him a helper like to himself." And yet it was suitable that man should previously know the excellence of his own nature, and the impassable abyss that separated him from the animals. God brings them before him. Adam observes and compares them; gives them names, and passes in review all this animal creation, among which he does not find a being like to himself, none worthy to enter into society with him. Hence this expression of admiration, when the Eternal presented to him the companion taken from him, while he slept. "This time, it is bone of my bone, flesh of my flesh; let her be called woman—*isha*—because she has been taken from man. Wherefore shall a man quit father and mother and attach himself to his wife, and they shall be two in one flesh." (1) "This origin of woman, and this word of Adam," says Lacordaire, " contained the whole constitution of the family; the reciprocal dignity of man and woman; the indissolubility of their union, and this union in two persons only." First, the dignity; since woman was taken from man, and can never be reproached with having been formed of an inferior clay; the indissolubility, since their union was in one sole flesh; their unity, since this flesh belonged to two alone. (2) Man was then created by three successive acts; first the physical man; then the intelligent man; and finally the social man: this is the culminating point of the work of God.

Let us now see how He established human society in this world, created for it. " He blessed them and said: increase and multiply; and fill the Earth, and subdue it; and rule over the fishes of the sea, and the fowls of the air, and the beasts and the whole Earth and every creeping creature that moveth upon the earth."

Thousands of animal and vegetable species, both terrestrial and aquatic, are already extinct; those that remain have their limited localities, out of which they perish; but man is everywhere: the benediction of His Creator remains with him; he fills the Earth; its space is not too vast to contain him. The history of his relations with the rest of Creation exhibits him

(1) Gen. II.

(2) Trentième Conférence.

to us as the being who establishes among all other living beings order, subordination, harmony; who cultivates, fashions, extends, improves, and embellishes nature, although it is not permitted him to transgress the laws appointed by the Creator. Whom do we call barbarians but the tribes who have let slip from their hands the sceptre of the animal and vegetable kingdoms, and who make no effort to resume it? And what is a civilized people, but one that subdues the earth, who enjoys it as a master, disposes of it as an owner, and who rules over the animals of the sea, the birds of the air, and over all that moves on the surface of the Earth? Man is, then, both by fact and right, the master of the earth and of its resources.

The Scripture recalls in a multiplicity of passages this glorious investiture of the Viceroy of the world, which the Creator Himself bestowed. "Thou hast made him (man) a little less than the angels; Thou hast crowned him with glory and honour; and Thou hast set him over the works of Thy hands. Thou hast subjected all things under his feet; all sheep and oxen, moreover the beasts also of the fields; the birds of the air, and the fishes of the sea, that pass through the paths of the sea." (1)—"God of my fathers and Lord of mercy, Who hast made all things by Thy word. And by Thy wisdom hast appointed man, that he should have dominion over the creature that was made by Thee. That he should order the world according to equity and justice. (2)

Such is man according to Genesis, and such is man according to experience and science,—the agreement of which with this Sacred record does not fail in a single instance. The free activity of human intelligence makes man a moral and perfectible being; his intelligence and his morality make him social and religious, that is, a being who cannot attain his physical, intellectual, and moral development, unless in the society of his fellow creatures, and by the influence of the moral and religious law. Herein man differs from all other organized beings infinitely more than by the species.

In his physical nature, man resemble the most perfect of

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(1) Ps. VIII. 67-89. (2) Wisdom. IX. 1, 2, 3.

the animals; in his intellectual capacities, while he somewhat represents them, he enjoys an infinite superiority over the most gifted of them: as a moral being, he has no point of contact with whatever exists among them; and as endowed with religion, he approaches the Creator by the thought of the future and by immortality, which makes him foresee death, and, consequently, recognize the authority of God and of Religion, which is the knowledge of God.

These different qualities can only be developed in the social state, which, consequently, is natural and necessary to man. Man could not have invented it, no more than he could have invented oxygen, which is the aliment of respiration. Man was then created in this state.

The social state in its turn cannot exist without articulate language, which is its basis and that of all human knowledge. Man could not then have invented articulate language.

A moral law conformable to the nature of man is also a condition without which society could not exist. Man is a religious being, who necessarily implies the existence of a moral or religious law, which developes and perfects this character—the most sublime of all these of his nature. Man has then received this law from God.

Man was created in a state of perfect development, as well intellectually as corporeally. He did not, then, begin by the savage state, which is a degradation of the civilized state; still less by an imaginary state of nature, from which he never could have emerged, and which would have made of him—the most perfect of created beings—a contradictory being, capable by nature of perfection without being able to attain it; having different qualities, but not having the conditions necessary for their development.

Now all these logical deductions, which will be found more developed in the course of this book, are confirmed by corresponding facts. 1° We have seen the first human couple commencing in the state of perfect development, both moral and physical; and Adam expressing the constitutive principles of the family, before the family as yet was complete; it became so by the birth of his children. Engaged in pastoral and agricultural pursuits and the practice of the arts connected with them, they formed at first but a single family. The murder of Cain divides them; and hence proceed two peoples, who dwell together, and eventually become confounded with each other long time before the deluge. The social state in Genesis is then the original and primitive state of man.

2° On issuing from the hands of God, Adam gave names to the animals; he named his companion, he conversed with the Great Creator. Articulate language is not, then, a human invention but a divine gift.

3° God exercised the moral liberty of the first men, both by commanding them to study the other beings, to name them, to subject and govern them; and by subjecting themselves to a law of probation, calculated to make them feel that they depend on His eternal and sovereign justice. After their fall, He reproached them with their disobedience, and punished them; He punished the fratricide of Cain, &c. It is, then, from the Creator that Genesis shews us that the moral law was derived. The state of nature is, then, as incompatible with this Sacred record as it is with human science. They were not in the state of nature, nor in the savage state; they had been created with capacity to speak, they conversed with God, and received from Him the moral law. They were in their creation endowed with a fully developed intelligence, and had not to await its slow development from the influence of their equals and that of the physical world: two conditions necessary for the successive physical, intellectual and moral development of their descendants.

The Scripture abounds with passages relative to the creation of man. It is not possible to quote them all; but everywhere the Sacred Authors will be found to have translated the words of Moses, as I have done, literally. (1)

God saw all His works, and they were perfect: it was evening, it was morning, the sixth day.—Creation then ceased, and the world is maintained by the laws which its Author has established.

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(1) Job. XXXIII. 4.—Wisdom. X. 1.—XV. 8-10.—1 Cor. XI. 8.—Ecclés. XVII. 1-11.

Seventh Day.—After having created man on the sixth day, God gives him dominion over the terrestrial animals which were created the same day as himself, but before him; and over the aquatic animals and the birds, created on the fifth day. He gives as the foundation of the nourishment of man, the birds and other animals and the vegetables created on the third day. All these beings were then contemporary; the third, the fifth and the sixth days were not indefinite periods.

Thus, adds Moses, "were created the heaven and the earth and all the furniture of them."—"God blessed the seventh day and sanctified it," in memory of the work He had accomplished. This day also made part of the days of Genesis since Moses calls it the seventh day. No one will say that God blessed and sanctified an indefinite period. It was then an ordinary day, and, consequently, the other days of the same series were ordinary days.

Let us hear Moses once more: for who else can make known to us the nature of the days of the first week of the world? "Six days shalt thou labour and do thy work; and the seventh, the day of the Lord thy God, thou shalt do no work; for in six days the Lord made the heaven and the earth, and all that is in them; and He rested in the seventh day, and He blessed and sanctified it." (1) Thus the days which God spent in creating the world are those in which man is commanded to labour: the day in which God rested,—that is, ceased to produce new creatures—is the day in which man should rest. The days of our week and those of the week of Creation are then perfectly similar.

There is an intimate connexion between the nature of the time mentioned in the first Chapter of Genesis and that of the creations it records, in this sense, that if the creations are simultaneous, the transformation of these times into periods of immense extent has no reason in a philological point of view; and if the days of Genesis are indeed ordinary days of twenty four hours, the Creations it records were necessarily simultaneous. As the falsity of the system of indeterminate

(1) Exod. XX. 9-11.

periods is seen with the greatest clearness in every part of this recital; and as the times mentioned must be analogous to our days, it follows, that the Creations of which Moses gives the history were simultaneous. This is otherwise established by the strength and precision of his language, by all the circumstances of the text, and by the unanimous interpretation of all the ancient writers.

I will add a single observation on the sources of the narrative of the Creation. All interpreters agree that Moses, in composing the history of the Creation, made use of written documents preserved in the ancient patriarchal families. The difference that is found between the history of the Creation and the history of Man, which commences in the second Chapter, is evidence of the fact. An attentive reading of the first Chapter shews us, that each leading thought is contained in about the same number of words; that the expression: "God saw that it was good, and, it was so done," repeated six or seven times, recurs with little variation in the expressions themselves or the order of their repetition. These characters which appear to indicate a hymn, an ode, are not found in the following Chapter. Another difference not less striking is, that in the former document God is only designated by the word *Elohim*, whereas in the second this word *Elohim* is always joined with *Jehova*, the Sacred name expressive of the past the present and the future. It is thought that Moses preferred to retain the characters of these documents of so high an antiquity than to render them in an uniform style.

Plan of the Creation.—The world being intelligible, it is evident that it has been made by an Intelligence, and for intelligences. There are relations of cause and effect between man and the laws of this world, for he has been organized in conformity with them; he can appreciate them, apply them, and, in certain circumstances, modify them. He is capable of perceiving their harmony, and of deriving intellectual pleasure from their contemplation. Guided by the evidence of Infinite Intelligence displayed in the work of Creation, man can rise from this world—the exterior throne of the Creator—

to the interior throne of Him, whose omnipotence is displayed in such a vast and harmonious combination. Man is, then, the end or object of this world. A glance at the plan of Creation as exhibited to us by Moses, and demonstrated by science, will place in still clearer light the evidence of this truth.

All the natural kingdoms are necessary to one another. On this principle depends their general harmony. In a successive Creation they ought to have been produced in the order of their general necessity. The most necessary to all others should have appeared first; and the being for whom all the rest were created, and to whom all are more or less necessary, and who represents them all, should appear last in the order of Creation. This principle is the logical law of sequence in a successive Creation, and is demonstrated by facts; and this is the very order followed in the successive Creations recorded in Genesis.

The earth which is to serve for the dwelling of all beings is created first. It is created before the heavenly bodies, because these have relations with the earth which they fertilize, with its waters, its atmosphere, its plants, its animals, and with man. The questions of relative greatness, of material dimensions, of position, &c., have here a very secondary value, as they are results of the destination of these bodies; and these bodies themselves are made for the earth on which man is to dwell; and on which will take place all that it is of importance to us to know; all which conducts our intelligence to the Divine Intelligence. It is from it, as from a point of observation, that we are to contemplate the Universe.

Light is created on the first day; because it is necessary to all beings, and the link of harmony between the various parts of Creation. By light we do not mean so much the phenomena of light as the ether—the subtile fluid which all results of science teach us to regard as the cause and seat of the phenomena of light, of heat, of electricity, and of magnetism. It establishes order on the earth and in the atmosphere; it is necessary for the life of all organized beings and for the development of the intelligence of man in this world. The part it plays in the Universe is immense; and perhaps we should assign to it as a cause the invariability of the motions of the heavenly bodies, and the great phenomena which are displayed in the centre and at the surface of the Earth.

The atmosphere and firmament, which next present themselves, are a consequence of this subtile fluid; they prepare the completion of the creation of the Earth, which is effected by the flowing off of the waters and their limitation to the basin of the seas.

Every thing necessary for the life of plants has been made; there is light, and heat, electricity and humidity, atmosphere and dry land. On the third day the vegetables were created and prepared for the animals and for man—a physical no less than an intelligent being. They nourish his body, they occupy his mind; by means of them he will subdue the Earth, and make all its elements tributary to his necessities. After the first action of the already existing bodies on each other, the sun, now become necessary in order to continue the phenomena, is created, as also the stars. But the vegetables having been produced in a state of complete development, and being thus able to discharge their functions without the sun, and, in these first instants of their existence, exercising on the atmosphere an action the energy of which would have been diminished by the sun, ought to have appeared before it; and such was the fact.

The heavenly bodies are called into existence on the fourth day. Their presence will place the ether in relation with the organs of sight in man and animals: it will cause in them the sensation of light, which will enable them to distinguish objects, and serve them to guide their steps by day and by night. The heavenly bodies are, then, necessary to the plants, to the animals, and to man, whether considered as a physical or social being, by their motions and revolutions, which exercise so great an influence on the laws of life on our Globe. With the co-existence of the Earth and the heavenly bodies, begin the seasons.

On the fifth and sixth days the animals are created. Then, all being ready for him who was to rule over this world, man appears.

There is, then, an order in the production of beings: each one is created before those for which it was created; and in this order man comes last. Man is, thus, the end or object, the last term of material creation. The Earth was made, it is true, for the dwelling of plants and of animals; but these were made for man, and have place on the earth because of man. They are a dependence on, and a complement of, the residence of him who combines all the ends for which animals and plants were created, who is nourished by them physically, intellectually and morally, and makes them the instruments of his rule over the Earth.

There is, then, a plan in the Creation of the world. Every plan supposes an Intelligence, by which it was conceived before it was executed. In this plan all the beings have one object, one end; they all appear and successively terminate in man,—a physical, intellectual, moral, and religious being. The end of man himself cannot be in creatures; if not in creatures, then in the Creator; if not in this world, then beyond this world. The world, then, was made for man and man for God.

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CHAPTER X.

Agreement of Genesis and Science on the Non-eternity of Visible Beings.

We have seen that in Genesis there are as many coincidences with the results of science as there are facts recorded. We have established and developed these facts; but, in the preceding Chapter, this harmony with scientific results is generally rather indicated than developed. We have now to accomplish this portion of our task, by pointing out and developing the scientific facts which correspond with those related in the first Chapter of Genesis.

For materialistic pantheism every thing is God, that is to say, necessary being, and, therefore, every thing is eternal:

there was no beginning and there will be no end. Every day, says the advocate of this error, men are born, to replace those who every day die ; but man always remains, enriched by what his predecessors have bequeathed to him, and endowed with the acquisitions of all ages. So also is it with animals and plants ; the individuals die ; the species perish, or are transformed into other species. There is no reason why it was ever otherwise ; none, that this state of things will ever change. Hence, he concludes, it is evident, that the species have always existed, and that the world is eternal.

The falsehood of such a pretension is demonstrated by all the sciences : but geology, which had not yet been interrogated, supplies us with an unlooked for and unanswerable argument for its refutation, as far as regards the organized beings, the surface of our Earth and its waters.

Geology is able to assign the point when life began to appear on our Globe and to deposit its products. This point is the epoch in which were formed the sedimentary primary, or transition-strata. Then life emanated from Creative Omnipotence, and from that moment the history of vegetable and animal productions is associated with that of mineral phenomena.

If we descend through the series of rocks, in setting out from the uppermost strata, we find traces of life everywhere in the tertiary, secondary, and primary formations. We find that the lowest strata of the primary system becomes gradually bare of organic remains. The slate bearing on it impressions of terrestrial plants, and alternating with limestone, which contains some marine-fossils, degenerates into micaceous-schist ; this, into gneiss, and this last into granite. Arrived at this point we no longer find clay-schist, or sand, or sandstone ; no more lime, nor carbonic substances ; in fine, no more deposits formed by the water, nor organized beings ; but masses of granite enveloping the whole Globe are everywhere found below the sedimentary rocks, in the hollows of which these rocks were deposited.

There was, then, a time when this immense granite-basin was empty ; when the waters,—this first condition of life—did not exist on the surface of the Globe—void and uninhabited. It was, then, this great basin that received at the beginning the vegetable species and the sea-animals. It was on a surface in relation with the immense inequalities of the granite that were produced the fluviatile and terrestrial species. There was their and our first cradle.

Among the fossils found in the most ancient primary strata, was there none whose existence preceded the laws established to govern and perpetuate the living generations, and which were part of the great work of the Creation? Perhaps the plants we find existed before the sun, bore flowers that spring time did not open, and the development of which was instantaneous and not the slow and progressive work of years! It is not, certainly, in our European strata that can be found the debris of the first flowers of the earth, unless indeed, other oceanic currents—analogous to those which bear to our shores the seeds and plants of the West Indies,—may have transported to our as yet nameless climates some remains of this primitive and sacred flora.

Thus all things have had a beginning. The proof of this great fact, the announcement of which opens with such sublimity the history of the World by Moses, has been found by geology in the entrails of the earth. From the bottom of abyss, whither the hand of God had brought and accumulated their remains, the dead have come and deposed to the truth of the Sacred record of Genesis.

Geology goes still farther: after conducting us as it were to the cradle of life, it makes us assist at its last moments: it shews us the tomb of thousands of animal and vegetable species; and confirms, in its own way, the revelation that teaches us, that all that has begun will have an end.

Of the species found in the formations, the number of which Alcide d'Orbigny estimates at 24,000, the greater part have perished. There were, doubtless, many errors in the determination of these species, and, consequently, much exaggeration in their enumeration; but, making allowance for these errors and exaggerations, it is, nevertheless, certain that a vast number of the fossil species are not now living. They are not found on the surface of our soil. Were there only question of the disappearance of some specific forms, we might retain the hope of finding them one day in some yet unexplored corners of the Earth; but numerous genera, entire orders and sub-classes, have entirely disappeared, without leaving any vestige that can be discovered. The numerous families of the ammonites and belemnites have never been found above our secondary formation or in our seas. The last species of the order of trilobites appear to vanish with the clay-beds. The class of the ichthyosaurians is nowhere found above the tuffa-chalk, and that of the pterodactyls disappears with the upper oolite.

Will it be said, that the absence of these species does not prove their extinction, as we are not acquainted with their habits; that it is not certain that we look for them where we would be likely to find them; and that their abode at great depths under the waters, is perhaps the only obstacle that prevents their discovery?—In the first instance, this cannot be supposed of a great a number of extinct species; and in the next place, the 638 species of fossil-fish, determined by Agassiz, do not appear to have had habits different from those of their congeners which dwell in our seas. Whence then does it come that we do not find them living? Moreover, all the species regarded as lost were not marine; there were many, as certain kinds of reptiles, which dwell in rivers; others lived on the dry land, not to say any thing of the vegetables and land animals.

Among these vegetables are counted more than 250 species of fossil ferns, many of which attained a height of 50 to 60 feet; and all have disappeared from the Earth's surface. The genus lepidodendron, of the family of the lycopodiaceæ, contains more than forty fossil species, the largest of which, we are assured, were 60 feet long, and had a foot and a half of diameter. In the coal strata are found equisetacea ten feet high, lycopodiaceæ from 60 to 70 feet; conifers of an equal height, for example, the *pinites brandlingi*. Were these species extant, they would not be concealed from our sight by the smallness of their dimensions.

Among the river-animals, in the class of the scutiferæ, the order of the émidosaurians or crocodiles, has found six new subgenera in the formations. The subgenus of the gavials is indebted to the fossil-flora for nine or ten new species: they were of gigantic dimensions. The order of the plesiosaurians has entirely disappeared. The megalosaurus, discovered at Stonefield, between the oolite and the lias, and also in the Wealden sands, was from 30 to 40 feet long.

The great fossil land-mammals complete the evidence of the fact, that species have become extinct. From the time that geological investigation became common, after so many and so minute observations in almost every part of the world, not a single one of these numerous extinct animals has been found living. The supposition, that they may exist in some undiscovered country, while it might have its weight for a few species, loses all appearance of probability when there is question of so great a number of the larger animals.

The family of the Didelphi has lost. . . .	18 ? species. (1)
That of the cetacea, (whales, dolphins) .	12 ?
That of the Edentes	27 ?
That of the Ruminantia	30 ?
That of the Pachydermata.	50 ?
That of the Rodentia.	57 ?
That of the Carnivora.	43 ?
That of the Primates, (apes)	10 ?
Mammals not reduced to classes	7 ?
Total. . . .	254 species extincts

The class of mammals has then lost about 254 species; we may with certainty say at least 200. There are not more than 600 living species; this class then is diminished by one fourth its original number. Those orders the species of which are the largest have suffered most,—the edentia, the ruminantia, the carnivorous animals, and the pachydermata.

A great number of the animal and vegetable creation have

(1) The point ? shews that these numbers are proposed by the paleontologists: how accurately zoologists will decide.

thus perished. Those which remain daily disappear from the surface of the Globe, the more rapidly in proportion to the multiplication of the human race. Every thing yields to man; all retire before him; he seems destined to cause the extinction of the creatures which were made for him and for the maintenance of equilibrium in all parts of his empire.

The earth, his place of sojourn, tends to become void and empty, as at the beginning; and we can foresee a time when it will cease to be habitable for him, and when he will exist in the realms of eternity.

Nothing, then, is eternal in the Universe and on the Earth. Every thing in the bowels of our Globe, as well as on its exterior surface, attests a commencement and indicates an end. The end, no less than the commencement, affords proof of its having been created. The waters have not always existed: we can ascend to their first deposits. The sedimentary surface is composed of strata superimposed, produced by a cause which acted in a downward direction, so that the lowest are necessarily the most ancient. The superimposition of these strata gives us the certainty of their relative antiquity. The primary rocks, if covered by all the other formations, were certainly produced before them. This admits of no denial.

The question may be asked; were not the primary sediments, often and for a long time, carried hither and thither by the waters before being deposited in the form in which we now find them? Geologists admit that the superior rocks were partly derived from the debris of the primary formation. What prevents us from supposing that the primary rocks themselves were produced by the disintegration of more ancient rocks which no longer exist? Who can say, that other sedimentary rocks, and other organic remains are not covered by these granite masses, which are regarded as the primitive surface of the Globe, and the theatre on which the vegetable and animal kingdoms were first produced? In this supposition, the primary rocks would not indicate, as is generally supposed, the first action of the waters, and the commencement of organic life.—We reply, in the first place, there are facts which contradict these suppositions. 1° The seat of the igneous cause is often placed below the entire thickness of the inner surface of our Globe; and yet in its eruptions it never casts up sedimentary rocks different from those with which we are acquainted. 2° It is true that, the superior rocks were formed in part by the debris of the emerged portion of the inferior strata; but as the waters could not destroy and, at the same time and in the same place, reconstruct, we ask where was the basin which they coated with rocks, anterior to the primary formations, when these latter, the thickest and most extended of any, are almost everywhere found, even in the islands and recently emerged points of our present seas? 3° If the primary rocks had been composed of the *debris* of rocks, taken up by a new action of the waters, and taken from more ancient sedimentary strata; if they were the last result of a series of renewed operations and of various combinations, they would not present the great simplicity of composition which distinguishes them from subsequent formations, and shew that the waters had at their disposal materials which were but little varied, and which were taken, for the most part, from the granitic rocks and marine-animal remains. The primary rocks are not only, then, the most ancient sedimentary rocks with which we are acquainted; they are also the first which were deposited by the waters. Were it even necessary to deny that, under the earliest transition strata, we find the primitive surface of the Earth, and the cradle of organic creations, the reality of such a surface and of such a commencement would not be less incontestable. We should be obliged merely to look for it lower down. The aqueous deposits cannot extend to an indefinite depth: they must have had some foundation, a basin to receive the waters and the organisms they carried; and this primitive basin must have some other origin than any which the waters could produce. We shall thus arrive at a period, when this basin, anterior to aqueous sediments, contained none, and when this primitive surface of the Earth was void and empty. Hence it is proved that the Earth, the waters and the beings which inhabit them, have not always had existence; that they had a commencement, and that they will have an end.

CHAPTER XI.

Specific difference of Light and the Sun.

On the first day of Creation, God ordered the light to be, and it was: "Let there be light and light was." The sun and the other heavenly bodies did not yet exist; they were not created before the fourth day. We know the ridicule with which this statement of Moses was received by the philosophers of paganism; and still more recently by the infidel authors of the last century. Newton was thought to have demonstrated that the light was an emanation from the sun, which repairs its daily loss by occasionally absorbing a comet that might come too near the great luminary. Such, however, is not now the generally received theory of light. In all our academies and colleges, it is publicly taught, that light is distinct from, and independent of, the sun, which is nothing more than the cause of vibration in the luminous fluid. Light has, then, an independent existence; consequently, it may have been created before the sun. It is visible without the sun, and the sun would not be visible without it: it must then have been created before the sun. Not only is the sun without the power of producing light, but this latter acquires more importance than ever by its various influences on the development of all the species of the two kingdoms; for it is also caloric, electricity, and the universal fluid diffused throughout all space. Such is the great thesis which naturalists are at present engaged in establishing, and which is in part already established. One thing, however, is undeniable,—the specific difference of light and of the sun. What, then, are we think of this Hebrew Legislator who, addressing a rude people, more than 3300 years ago, told them that the light was created, when the sun and stars were not yet created? And do not imagine that Genesis admits two primitive sources of light—the ether and the sun. When it records the creation of this body it teaches that it was placed in the firmament "to distinguish night from day," and "to cause to shine on the Earth." Thus in Genesis, as well as in the teachings of science, the sun is not the measure of the day; but renders that measure sensible to us; it does not produce the light, but puts it in motion.

Let us glance at the arguments by which the Newtonian theory of emanation has been rejected, and the independent existence of light demonstrated.

The hypotheses of emanation and of undulation were but confusedly known to the ancients. Descartes was the first among the moderns who maintained the theory of undulation. He supposed that the Universe was filled with a subtile substance, composed of infinitely small globules, and receiving from the sun an agitation which they communicated to the whole Universe.

Huyghens was more successful in his enunciation of the theory. He supposed that all space was filled with a subtile, invisible, imponderable, and very elastic fluid,—penetrating the interior of all bodies, and filling the interstices of their various particles. He named this fluid an ethereal substance. The bodies which appear to us luminous are those whose particles, being agitated by a very rapid vibratory motion, agitate the ethereal substance, and produce in it undulations, similar to those which sonorous bodies produce in the air; with this sole difference, that their propagation is more rapid in consequence of the greater elasticity of the medium. By means of the undulations of the ethereal substance he explains all the phenomena of the transmission, reflection and refraction of light.

Father Grimaldi, a Jesuit, was the first to draw attention to the positive facts which were to lead to the discovery of the true nature of the luminous fluid; and Robert Hooke explained many phenomena by the new theory, and especially that of colored rings, and of very thin plates.

Things were in this state when Newton appeared. He maintained that light was a body, which might form enormous masses like the sun and the other luminous bodies. From these bodies escape, in all directions, particles of light, which produce the various luminous phenomena. This is the system of emanation. It is very remarkable, although not sufficiently noticed, that when Newton formed a general theory of the world, he abandoned in great part, the hypothesis of emanation, and partially adopted that of the undulation of the ethereal fluid. Newton's theory afterwards found an adversary worthy of him in the great Euler, who combated the theory of emanation, and deserves to be regarded as the author of the theory of undulations, because he shed on it the highest degree of evidence. "If the sun, he remarked, continually emits floods of luminous matter, it ought to be soon exhausted, or at least we should perceive some alteration in its appearance: and space, instead of being absolutely void, as the Newtonian philosophy supposed, would be filled by luminous molecules of the sun and of the other luminous bodies, which would impinge on each other, and be deranged in their motion and direction. —The propagation of light in the ether is effected in the same way that sound is propagated in the air; and as the motion caused in the particles of air produces sound, so the movement of the particles of ether produces light, or luminous rays: so that light is nothing more than the agitation or vibration of the particles of ether, which exists everywhere by reason of its extreme subtility, by which it penetrates all bodies." (1) This theory explains all the phenomena, which are not satisfactorily explained in the theory that regards the luminous rays as an emission of the luminous matter of the heavenly bodies.

Gilbert, Borelli, Bacon, Kepler, Descartes, Huyghens, Grimaldi, Hooke, Newton and Euler admitted the existence of the ether, or of an analogous substance, to explain all the luminous phenomena, universal gravitation, and the gravity of terrestrial bodies; and many of them, also, to explain the electric and magnetic phenomena. This great principle did not prevent them from investigating and occasionally demonstrating, by mathematical verification, the constancy, regularity and intensity of the facts connected with light. They, indeed, clearly perceived that mathematical calculation could only serve to verify and generalize facts, but could not indicate their cause. Hence they inquired after this cause, and sought

(1) Letters to a Princess of Germany. Vol. I. Letter 20.

it in a created principle.—"Notwithstanding," says Maupied, "this agreement of all the great naturalists of the 17th and 18th centuries to regard ether as a general principle, the cause of light and gravitation, other ideas, those of the exclusive mathematicians, prevailed for a time. Newton, influenced by his fondness for mathematical science, neglected the investigation of causes. This tendency was followed, and carried to extreme exaggeration; and thus the principles and discoveries of this great man were perverted and travestied. His followers raised for him a throne which he would have rejected with indignation, but on which they placed themselves. They devoted time to the study of the laws of the propagation of light, of its reflexion and refraction. It was easy for them to demonstrate geometrical truths the existence of which is independent of all theory;—as also to verify the exactness and mathematical constancy of the phenomena, because the order of the world is admirable: but they disdained to look for the cause of the motions whose regularity they demonstrated. Hence they considered light as geometrical lines moving in space; they made them issue from the sun and the other luminous bodies, which were invested with the faculty of projecting these particles in right lines. They did not stop to enquire if these lines,—veritable abstract entities—could harmonize with the phenomena of more matter, or with those of organized bodies. Universal gravitation, which generalized the facts, was not in favor with them; it implied the idea of cause; they changed its name to that of attraction; intending, no doubt, by this means to confuse the ideas of the multitude. This attraction became a property of matter and of all bodies; and thus,—instead of a general principle, which permitted a regular concatenation of facts, by leading us, to a first cause, —they created entities eternal as matter itself, and inherent in it. They easily demonstrated, because it is true, the mathematical exactness of the motions of the heavenly bodies, as also of all bodies placed on the surface of the Earth; but they regarded this exactness as a cause, whereas it is obviously an effect. They succeeded, however, not only in changing the ideas of men, but also in partitioning all the phenomena of the Universe; making of them, so to speak, as many independent departments as there were classes of phenomena; and from that time it was a matter of doubt, whether there was plan or unity in the Universe. We had the mathematical system of light radiating in straight lines, and that of mathematical attraction inherent in all bodies. To give more authority to this system it was said to have been derived from Newton, a man who was an enemy to systems; who, when he was led away to form one, admitted the ether as the general cause of the phenomena, and rejected attraction as an absurdity." (1)

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(1) *Dieu, l'Homme et le Monde,* t. I. p. 180.—Far from recognizing attraction as a cause, as the school of Laplace has falsely affirmed, Newton protested against it. "I cannot understand," wrote he to Bentley, "how brute and inanimate matter, without the intervention of something which is not matter, can act on and influence other matter, except by mutual contact; but this would be the case if the quality of gravitation was, as Epicurus pretends, essential to and inherent in matter. For this reason I beg you not to attribute to me the idea that gravitation is inherent in matter. To admit that it is innate, inherent and essential to matter, so that one body can act on another, through the void and distance that separate them, without the concurrence of an agent by which the action and the force could be transmitted from one to the other, is, in my mind, the greatest imaginable absurdity; and no one, I think, can fall into it, who is ever so little familiar with reasoning in things of philosophy." According to Newton, attraction, as understood by Laplace, is an absurdity. The mathematicians are obliged to suppose two forces, attraction and repulsion, both inherent in bodies; and to attribute to these forces the capability of increase and diminution, of equilibrium, and of mutual attraction and repulsion in different degrees. Attraction is not a cause, but merely a fact. Newton never uses the word 'attraction,' and he rejects it as a cause of motion. D'Alembert and Laplace, but not Newton, have given authority to the theory of attraction as more convenient, more adapted to geometrical calculation; but this theory is based on an untenable and inconceivable hypothesis. Laplace presents a geometrical figure by which he demonstrates that, admitting that the constituent molecules of a mass have the power of acting at all distances on other molecules, this mass, acting on an exterior body within the sphere of its particular action, would draw this body to its centre. The demonstration is complete, if the hypothesis is admissible. To perceive the tendency of this hypothesis, we must change its terms, without altering the value of the proposition. This is, that a grain of sand placed at the surface of the Earth can move a grain of sand placed at the surface of the sun, and even at the confines of the Universe, although these grains be separated by vacuum. Is it allowable to a mathematician, who knows that the Earth is enveloped by a zone of fluids, the pressure of which preserves the level of the waters,—who should know that this zone

Observation was, however, on the point of producing new facts, which were inexplicable in the theory of emanation, and very intelligible in the opposite theory of undulation. The mathematicians had to yield;—a new proof that the World and Creatures do not deceive, and that they reveal their author to whosoever seeks for him in good faith. The theory of undulation is demonstrated by the fact of interference. It explains the phenomenon of scattered light, another rock of scandal for the advocates of the theory of emanation; for we cannot conceive, why, when we interrupt the luminous rays by a screen, there is immediate darkness in the place where the experiment is made; the extremity, separated from the ray, ought still be seen in the place which it occupies; whereas in the theory of undulations, we can understand that the impulsion communicated to the fluid is arrested by this experiment. The phosphorescence of the sulphate of barytes, of the diamond, of the hydrochlorate of lime, &c., can only be explained in the theory of undulations, by the vibrations of a substance placed in their vacant interstices.

We shall add some facts still more general. The same body exposed to the rays of the sun receives a greater brilliancy than when it is in the shade, or illumined by a candle. There must, then, be a greater agitation of its molecules in the first than in the second case; and yet, if it merely reflects the light how does that occur.—If the sun were the source of light, we should have no luminous phenomena in its absence; whereas we can reproduce the same phenomena, although with less intensity, by means of artificial illumination. Light is produced in all the phenomena of combustion; as also in all electric phenomena, although there is no consumption of matter. In the greater part of the chemical phenomena of composition and decomposition, there is also production of light as well as of electricity. Light consequently exists independently of the bodies called luminous. Light is everywhere, in the most

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contains active agents, substances sufficiently subtile to penetrate the densest bodies, and to communicate to them elasticity, is it allowable, I ask, to such a one to seek so inconceivable a cause for the general motion?

fluid as also in the most solid bodies; it springs from water and the atmosphere as from the flint; it is in the candle that burns, as well as in the wood that ignites by turning in the hand of the Indian. So also is it with heat; so with electricity. This latter and light are so closely united that in certain circumstances they produce each other.

Physiological facts go still farther. When in certain pathological affections it is necessary to cut the optic nerve, at the moment of the operation the patient experiences a luminous dazzling, as if he were plunged into an ocean of light. A blow on the eye produces a similar effect. In certain cases of hallucination the sick imagine that they are environed with flames,—overwhelmed by waves of fire. This results from extraordinary pressure on the optic nerve.

All these facts leave no doubt, 1° on the existence and production of light, independently of luminous bodies; 2° on the existence of a luminous fluid which penetrates all bodies, even organized beings as well as space, and produces everywhere similar phenomena; 3° on the necessity of motion in this fluid for the production of the sensation of light.

Shall I add that the susceptible structure of the eye, joined with the composition of the daguerréotype,—which is only a mechanical copy of the eye,—demonstrates the same thesis? If the luminous rays were molecules, emanating from the sun and other luminaries, how could they traverse the organ of sight, where they were not before? How could they carry these images of bodies? All this is inexplicable in the theory of emanation. On the contrary, in admitting that the molecules of all bodies cause vibration, in a different manner according to their nature, among the molecules of ether which penetrates all bodies, it is easy to comprehend how these vibrations are impressed on our organ, and how their differences impress on such susceptible substances different images, according to the nature and arrangement of the molecules of bodies. It is the same explanation for the eye as for the daguerréotype.

Hence the distinction of light and the heavenly bodies is an ascertained fact: and Moses, who consecrated this distinction by placing the creation of light before that of those bodies, and by calling the light 'day,' is in perfect harmony with science: a remarkable fact in an historian who had no other source of information,—abstracting from revelation—but his own good sense.

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CHAPTER XII.

Existence of a single great primitive basin.

Moses teaches us that, on the third day, God gathered together the waters into one place, which He called seas. (1) This unity of place for the gathering of the waters of the first epoch is the more remarkable in Genesis, as Moses had no means of verifying it. We have, at the present day, a great number of interior lakes, as those of America, and the Caspian; and a great number of Mediterranean seas, as the Adriatic, the Baltic, the Mediterranean, the Red sea, the Chinese sea, that of Japan, the Gulf of Mexico, &c.; which, indeed, communicate with the Ocean, but still form different basins, placed often at different levels, so that it cannot now be said that the waters are gathered in one single basin, in one place alone.

If from the present epoch we re-ascend to the tertiary, we find there also a number of small marine basins, more or less independent, and the deposits of which, by reason of this circumstance, geologists are much puzzled in connecting.

The secondary epoch presents the same phenomenon; nevertheless its basins are much more extensive and less numerous. But those of the primary epoch, which received the carboniferous and Silurian strata, possess this character of unity which Moses mentions; and appear to have formed but a single large basin. The deposits contained in this large basin, notwithstanding their immense extent, are everywhere the same; and we can see that the local circumstances in which they were

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(1) Gen. I. 10.

formed were uniform, and identical at great distances. We find carboniferous limestone and Silurian limestone in England, in Germany, in Sweden, in Norway, in Russia, at Spitzbergen, in European Turkey, in Asiatic Russia; at Zanesville in North America. It forms the table-lands of the Republic of Bolivia in South America. It is found in New Holland and in Van Diemen's land. It occurs at the Southern extremity of Africa, at the Cape of Good Hope; and in all the continents it is remarkable for the uniformity of its mineralogical characters, still more than for similarity of fossils; whereas the most important of the secondary formations, that of white chalk, differs on points comparatively near each other. Thus the chalk of Meudon is very unlike that of the environs of Perigueux.

These mineralogical differences between portions of the same formations, secondary or tertiary, arise in part from the basins, at these two epochs, being more numerous and less extensive. They were more numerous—the local circumstances common to all being rarer; they were less extensive, the litoral deposits were nearer to the pelagian deposits, and river-deposits to those of the sea-coast. It results from these circumstances, that the deposits of these epochs are less similar among themselves at small distances, than the primary deposits at large intervals. These latter are similar and often homogeneous not only on the same continent, but also in different continents, in Europe, Africa, Asia and America. The statement in Genesis, regarding the unity of the primitive basin, is confirmed by these observations.

It is true that if the transition-rocks had been deposited in a great number of primitive basins, they would more resemble each other than the members of any formation of the higher series, because in each continent the first strata, formed by the water, were composed of almost the same substances, solely derived from the organic kingdoms, and the disintegration of the primitive mountains. It is not, however, the simple composition of the ancient strata alone that leads us to recognize one single primitive basin. When the deposits of a geological system are uniform at great distances on all the continents, we must conclude that they were made in very large seas, and not in many basins of comparatively small extent, where the formations of different origin, being nearer to each other, would, by combining and commingling, have rendered uniformity of the parts of the same formation, on a great scale, impossible.

The outline of the sea-bed has, then, often changed since the primary epoch. The emerged surface has been augmented by the lowering of the level of the sea. The sea, in retiring, has left, in the depressions of its ancient bed, enclosed lakes, and seas which no longer communicated with their principal basin. New islands have appeared in the sea; the great primary basin has been changed into a large number of secondary basins, in consequence of partial fillings-up, and submarine depressions of the surface.

We arrive in a still more precise manner at these conclusions, when we follow, on the geological charts, the division of the granitic chains and primary rocks, and that of the secondary and tertiary formations.

The North of Africa, a part of Spain, France, England, Belgium, Germany, Holland, Austria, Italy, Prussia, Russia, Turkestan,—originally formed one or two arms of the sea, having for shores, on the North-East, the Ural mountains, which, by their connection with the Algydims, join the Altai chain. These latter trend towards the South throughout all central Asia. From central Asia the Northern mountains of Kabul and of Persia have a South-West direction towards the Southern Caucasus. They unite with the Taurus-chain and the mountains of Asia-Minor; whence, in a Westward direction, they pass through European Turkey and unite with the Carpathians, and afterwards with the Alps. By looking over a geological chart, it will be seen that all this line of direction forms one long sinuous chain, almost everywhere of granite or crystallized schist. This immense shore may have been cut, here and there, by straits; but the chains present table-lands more or less vast. Moreover, the Atlas mountains formed in Africa an island: the centre of Spain formed another. Perhaps these islands were connected with the vast island Atlantis, which, according to Greek and Egyptian traditions, disappeared in the waters during the memory of man. The most probable conjectures concur in placing this island in the Atlantic sea, to the West of Northern Africa and of Spain. In the supposition of Buffon and other geologists, that the Canary islands and the Azores indicate the line which united Atlantis with America, we should arrive by these islands on the continent of North America, which, on the Western shore communicated with Asiatic Russia, and through it with central Asia.

The centre of France,—comprizing Limousin, Auvergne, Lyonnais, a part of Provence,—was another island, perhaps even a peninsula, united by the Alps with the great chain of the Carpathian mountains, with the mountains of European and Asiatic Turkey, as also with the plateaus of central Asia.

The granitic Vosges, the crystalline Ardennes, Southern Germany, also crystalline or transition,—may have formed one or more islands, which soon were united, as their surface and their extinct volcanoes would seem to indicate. The great island then comprized the Vosges, Ardennes, all Southern Germany, and from the Black-Forest to the Harz mountains. They may have then extended towards the East, and, somewhat later, have been united with the primitive rocks, which would join these regions to the Carpathian mountains, and make of all this extent one great peninsula.

Upper Poitou and Bretagne with lower Normandy were another island. The South and West of England had, probably, some crystalline or granitic islands. In going towards the North we find granitic rocks in Norway, Sweden, Finland and Laponia, which formed a primitive island. This soon became a peninsula by the transition rocks of Russia, which united it with the Ural mountains, and through them with the mountains of central Asia.

The Asiatic continent in its turn was for the most part a primitive surface; for Asia presents to us her immense granitic chains and their vast table-lands, from Mount Altai to Mantchouria, and, returning from Mantchouria, by the South, to the Himmalaya mountains. In the centre of this immense plateau of granite or crystalline schist, the great desert of Gobi is formed of tertiary deposits. Southern Arabia and Southern Africa were also a primitive continent. Western North America presents, according to the geological map of Boué, an immense granitic and crystalline surface.

Central Asia was, then, inhabited from the beginning. By its mountains, it opened vast issues to the West, the North, and the East, which the animals first might pass, as also, subsequently, man, and thus all central Asia, Northern Asia, North America would be peopled. From this latter, North America, Atlantis and its dependencies, mounts Atlas, Spain, Britain, and, perhaps, the South-West of England with the sea-bed, that is now partly covered by the English channel. Departing once more from central Asia, by Asiatic and European Turkey, the Carpathians and the Alps,—animals might have reached the central table-land of France; thence, somewhat later, the plateaus of Southern Germany, the Vosges and Ardennes; and, almost at the same time, migrations from the Ural mountains might have arrived in Lapland, Sweden and Norway.

Meanwhile the secondary rocks were formed; they filled up the seas; by this and other causes the primitive islands and continents were augmented in extent; new ones were produced; the great primary sea was divided into many gulfs.

The predominance of primary and secondary rocks in Russia,—the absence of the higher secondary and the tertiary strata,—the chain of secondary mountains of moderate elevation which traverse it from East to West,—the extinct volcanoes of the Southern portion of the Ural mountains, these volcanoes being placed at the limit of the granitic and primary rocks,—these facts, to which may be added the general movement of the waters of the Northern Pole towards the Equator, render it very probable that the emersion of all Northern Russia took place at a very early period. The primitive sea might, at that time, have extended from the South of Russia, from the Baltic to the sea of Aral, and beyond it. But the Southern part of this primitive sea was soon divided into many basins by a granitic chain, which we may follow from the mountains of Persia to the Carpathians, and thence, on one side to the Alps, and on the other to the Vosges and the Ardennes. In all this chain, where we find besides vestiges of ancient volcanoes, the secondary rocks are much less numerous and less complicated than in the West of Europe.

It was, perhaps, at this epoch that the volcanoes of Auvergne were in active operation. Then also the primitive sea was divided anew into the Hyrcanian sea,—of which the Black Sea, the Caspian and that of Aral are the remains,—and then into the Celto-Germanic Ocean. The Eastern Alps were already free from water, as were also a great part of the Western Alps. The dislocations of Jura, of the Swiss-Alps, of the Alps of Dauphiny and of Savoy, &c., changed these secondary seas into tertiary seas; and then there was the Anglo-Belgic basin, the basin of Paris, that of the Garonne, of the South of France, and that of the Adriatic.

Somewhat later may be supposed to have taken place the formation of the rock of Gibraltar, and the destruction of the Atlantis, as also the formation of the Western Mediterranean sea, and later, the definitive separation of the Caspian from the Black sea, the discharge of the waters of this last through the Propontis to the Agean sea or Grecian Archipelago. Since that time, the North sea separated England from the Continent, by excavating the Pas-de-Calais and the English channel, and, perhaps, also the geological basin of Paris. Western and Southern Europe appear to present the countries where the geological rocks are the most numerous and most complicated, a circumstance which, independently of every other consideration, would lead us to regard them as having been longest under the water, and as having latest emerged.

If there be occasionally error in assigning the relative epochs of the gradual diminution of the primitive sea, and its change of limits, there is none, certainly, in regard to the limits themselves. It is also certain that this series of phenomena were successively accomplished; that the continental parts already emerged, which present only primary or lower secondary deposits, have been a shorter time under the water than those which exhibit all the orders of the strata with the greatest part of their large formations; whence it follows, that the rocks cannot be of the same age in the different basins.

In proportion as the waters were confined within more restricted limits, they left on the surface of the land they abandoned, sand, mud, rounded flints, &c. The flowing off of numerous lakes, formed in cavities by the retirement of the Ocean, increased the number of these terminal strata. The dislocations of different surfaces gave occasion to caverns, which river water-courses filled with the organic and mineral substances they took up in their progress. Hence it follows, that all these beds of diluvium cannot be of the same epoch, because they were deposited in each country in proportion as the seas of these countries retired, and they became the seat of rivers, plants, and animals. Primary or tertiary rocks, already emerged in some continents, continued to be formed in others. Asiatic, African, or other alluvions became contemporary with our secondary rocks; for example, the alluvions of Siberia, the tertiary rocks of many parts of Asia,—may have been deposited before the conclusion of the European secondary period. The fresh water limestone of Auvergne,—which is more ancient than the first basaltic wave that flowed over the surface of that country, may be anterior to the last formations of the secondary series of the rest of France. I could not pass over in silence these inferences, which naturally follow from the exposition of parts; although we may abstract from them for a moment, to give our undivided attention to a single subject,—the agreement of Science with Genesis as to the fact of one sole primitive sea-basin.

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CHAPTER XIII.

Harmony of Revelation and Science:

1° On the primitive and general division of the Earth: on the simultaneous or, at short intervals, successive appearance of the great groups of the vegetable and animal kingdoms; and the primitive and general distribution of beings: 2° On the continuity of life on the surface of the Earth from the beginning of time; and 3° On the continuance of the same relations between our Globe, the atmosphere, the air, the light and the heavenly bodies.

I.

On the second day of Creation God gathered the waters into the basin of the sea, and then appeared the Continents, with their rivers,—some of which are named, as the Tigris and Euphrates,—and consequently with their vallies, their plateaus and their mountains. In the history of the Deluge the Sacred historian mentions the mountains of the submerged countries, and particularly those of Armenia. These are the first elements of physical geography which we find in Genesis, when we re-ascend to the origin of the world,—a sea, rivers, dry land and mountains.

The general creation of organized beings is successive in the Cosmogony of Moses; but all the parts of each great division are brought simultaneously to existence, first the whole vegetable kingdom; then the animal kingdom, the aquatic animals and the birds; then the land animals, and lastly man. All these groups appear in the space of four days.

In narrating the creation of each group, Moses refers it to its principal medium of existence; the plants to the land and the water; the animals to the land, to the water, and to the air. He thus makes known to us the primitive and general distribution of organized beings on the surface of the Earth.

What extraordinary opinions,—contradictory of these facts,—have been maintained by hypothetic geologists! Has it not been said, that in the first ages of the world, the Earth was without mountains, vallies or rivers? Has it not been asserted, that the different creations were separated by thousands of ages?—That the sea had received its inhabitants long before the earth and air, and that the Days of Genesis could be nothing less than periods of indefinite length.

We appeal from geology to geology itself, when better informed and judging impartially, as befits real science.

In all the continents the primary geological series consists of marine, and fluvio-marine deposits; both perfectly characterized by their inorganic materials and respective fossils. The necessary consequence of this general fact is, that from the beginning there were seas and rivers; and, consequently, dry land and mountains, as Moses taught more than three thousands years ago.

These same primary strata contain fossils of land, sea, and fresh-water origin, as also insects. Hence the same general and primitive distribution of beings as in Genesis.

In fine, we verify in these primary strata the presence of all the great types of vegetable life, and of the most of those of animal existence. Hence we may conclude, that all these groups appeared simultaneously, or that their appearance was only separated by short intervals as Moses teaches us. On its part, zoology demonstrates that the species of one class having intimate dependence on the species of another class, the classes could not long exist independently of each other.

We simply point out these facts, many of which have been already developed, as the remainder will be established in a subsequent portion of this work.

II.

Since life begun on Earth it has been maintained thereon without any interruption.

The history of the Creation presents us with no trace of those revolutions that destroyed all creatures, which we meet with in every geological theory. On the contrary, the narrative of Moses implies that such never took place. He shews us the Creator approving of all His works. On the mineral kingdom He establishes the vegetable, and finds it conformable to His design.—"He saw that it was good." On the vegetable kingdom He establishes the animal kingdom; He blesses its species, and says:—"Increase and multiply, and fill the waters of the sea, and let the birds be multiplied on the earth, —"He creates man on the sixth day, and commits to his command the land animals created on the same day, the vegetables created on the third day, and the aquatic animals created the fifth day. Now, it would be absurd to suppose that from one day to the following day these kingdoms disappeared,—the victims of some general catastrophe, and that the Creator destroyed in the evening the work He had made in the morning. Wherefore call these beings into existence, if He drew them from nothing only for one day, to plunge them once more into nothing the same day, or two days afterwards? In such a supposition He would not have ordered the plants to produce seed according to their kind; He would not have blessed animals, and bid them increase and multiply. In a word, He would not have given to man dominion over beings who were destroyed before man appeared.

Once arrived at man, Moses sketches his history which he brings down to the Deluge. Then he shews us Noe and his family saved from destruction, and saving with themselves the species of the class of birds and of that of mammals. Noe comes out of the Ark. He offers an agreeable sacrifice to the Eternal, who expresses on this occasion His will, no more to destroy whatever lives.—"I will establish my covenant with you, and all flesh shall be no more destroyed with the waters of a flood, neither shall there be from henceforth a flood to waste the Earth." (1)

In the primitive history of the Earth, the only revolution mentioned is the deluge, and we know that the deluge did not destroy the succession of life on the Earth. It destroyed a great number of individuals; but even in the supposition of the local universality of this divine punishment, its action was less destructive than is commonly thought, and it is probable that it did not annihilate a great number of species. The language of Moses obscurely intimates the destruction of the individuals of the classes of birds and mammals who were not in the ark, with the exception of reptiles properly so-called.

(1) Gen. IX. 11.

Had Moses intended to speak of the class of reptiles properly so-called, the species of this class would have been preserved in the ark with all those of mammals and of birds, because Noe gathered therein all that the text designates by "creeping things." But, if, as is more probable, the creeping animals spoken of by Moses are the smaller mammals,—which move near the earth and appear to creep,—we will shew that the reptiles may have survived the deluge, with the species of the other groups which were not represented in the ark. "The type of the spongiaria," says Maupied, "and that of the radiata, living exclusively in the water, could not have suffered much. The type of the mollusks is still almost entirely aquatic, with the exception of certain genera, as the helyx and the limax; but all the non-aquatic helices, either have a shell in which they can retire and live a long time, or can find an asylum in the cavities of rocks, or in trees, or in the earth. Moreover their eggs and those of the limax may have been preserved in a thousand different ways. The type of the articulata comprizes ten classes, of which eight are aquatic;—the two others, spiders and insects, are partly aquatic, partly land animals; but it is well known that these animals conceal themselves at great depths either in the earth, or in the rocks, or in the timber, or under the bark of trees. Besides a great number live for a long time in the state of larva or worms, which are often aquatic, although the adults may be terrestrial or aerial; and these larva are deposited in plants, in fruits and in the earth. In fine, all these animals are oviparous and lay their eggs, which are very small, beyond the reach of all causes of destruction. If from the great tribes of the vertebrata we take the birds and mammals, the species of which were preserved in the Ark, we have only the fish, the amphibians and the reptiles. The amphibians are almost all aquatic, with the exception of some frogs; in regard to which it is not established that the tadpoles or even the adults cannot live in water, but which certainly live in holes sufficiently deep below the surface, or in the cavities of rocks. Among the reptiles many orders, as the crocodiles, a great number of tortoises, are also aquatic; the others may either live in water, or bury themselves in the earth, or adhere to floating wood. The reptiles may, then, have survived the deluge, especially as the ova may have been preserved from accident by a multitude of circumstances. There were then only the birds and the land mammals, two classes least numerous in species, for which the deluge would have been annihilation. We have seen that Moses, in all likelihood, only spoke of these two classes in the narrative of the Deluge; for the Hebrew word which is generally rendered by 'reptile' designates also the small mammals with short feet, who appear rather to creep than to walk." (1)

Moses was not a naturalist; there is no likelihood that he had studied insects in their various scales of ova, larva, chrysalis and butterfly. How did it happen, that the two classes, the species of which he says were preserved in the ark, are precisely those which the deluge would have destroyed? This appears, at first sight, to be a decisive argument in favour of the submersion of all the primitive continents; for if the deluge had not been universal, where was the necessity of bringing into the ark any other but the domestic animals, and those which were to be sacrificed to God after the catastrophe? Still the order given to the second father of the human family, to preserve with himself all the species of the two classes, is very intelligible in the supposition of a single centre of creation for the birds and the mammals. In this supposition, which, as we have seen, the text of Genesis admits and favours, the continent inhabited by man and the two highest and most necessary classes of animals, would have been entirely closed at the epoch of the deluge, and separated from the other continents and islands by a sea, too wide even for the most part of the birds to commence their migrations, and spread abroad over the primitive surface, or those which subsequently emerged.

The loss of species sustained by the vegetable world was, doubtless, less than that of the animal creation. The waters rested on the mountains for not more than five or six months,

(1) Art. *Déluge*, de l'*Encyclopédie Catholique*, par M. Maupied.

and in the vallies for about ten months. It would be unreasonable to attribute to an immersion of such short duration the destruction of a great number of vegetable species. The annual submersions of lower Egypt commence in the summer, and are over about the middle of autumn. During all this time nothing is seen in the Delta but the tops of trees. An earthquake which occured at Ahmenabah, at the mouth of the Indus, in 1819 submerged Fort Sindré, and all the surrounding country to the extent of thirty six miles in length, and twenty one in breadth. In 1828, nine years after the event, Captain Burnes, visited the submerged district in a yawl, and saw the fish swimming among the trees, which were still standing.

The diluvian currents must have left much sediment on the low lands; but on the mountains and their declivities, vegetation must have been developed the more quickly as the soil had been fertilized by the waters, and their retreat coincided with the spring. It would be useless to dwell on so many means of preservation which the vegetables possessed in their seeds, their roots, their stems. They are so tenacious of life, that the ebb and flow of the tide, which twice every day deposits on many shores sand and marl, does not after ages destroy vegetation. On issuing then from the ark the animals were not exposed to perish by hunger; the herbivorous found the vegetable world, and the carnivorous numberless carcasses of all classes abandoned by the waters on the surface of the earth. The deluge must have modified the geographical distribution of the species of the two kingdoms, by scattering the seeds, the ova contained in floating timber, the larva, the chrysalis in its coccoon, and the individuals of the aquatic species: but it did not destroy families, still less did it annihilate classes and groups.

We think we have rigorously shewn that, according to the narrative of Moses, no revolution has interrupted the succession of organized beings, or arrested the general development of animal and vegetable life on the surface of the Globe. We have now to prove the same conclusion by scientific facts.

Preoccupied with this erroneous idea, that general revolutions alone could explain the annihilation of so many lost species,—some geologists have made great efforts to conceive what these revolutions could have been. Buffon, in his "Epochs of Nature," attributed the extinction of species to a general change of the primitive temperature of the Globe. He thought that none but the ancient rocks contained lost species. Deluc imagined the falling-in of the habitable surface on the cavities over which it was suspended by weak pillars and similar inadequate supports. Cuvier brought the Ocean on the land as often as be found marine-deposits in the Paris basin. Ampère supposed deluges of fire, &c. These hypotheses of general revolutions, which repeatedly destroyed the anterior creations, and prepared the earth for new ones, are untenable. This we have sufficiently established in the first Part of the present work. Still as they are to be met with in the writings of many distinguished naturalists, and are maintained more indeed in reverence for the names of those who proposed them than from other reasons, they may still exercise an influence on the minds of those who have not followed the direction given for some time back to science by more numerous and better appreciated facts. This is our motive for insisting on these facts, and for shewing, that whatever may have been the revolutions to which it has pleased these geologists unnecessarily to subject our Globe, they did not destroy all that lived at these epochs, and that the torch of life, once lit on the earth, has never been extinguished.

The clays, the sands, or sand-stones, are, in general, the product of rivers, and the limestone, the product of the seas. From the lowest sedimentary strata—those which have been changed into crystalline schist,—up to the alluvial soil, which is even now in state of formation, all orders of rocks, even in their minutest divisions, exhibit clay, sand and limestone deposits. There have, then, always been seas and rivers, and, consequently, dry land for the land animals and plants. But all these marine, or fluvio-marine strata contain fossils in greater or lesser number; and the presence of land plants has been ascertained in the most exclusively marine formation—the white chalk: hence, at all times, the sea, the earth, and the rivers had inhabitants. Moreover, there are fossil, vegetable, and animal species—passing identically from one layer to another, and forming by their reunion a continued chain, which extends from the Silurian system to that of the present day. Such are the facts we have to develop, by following in all their divisions the European strata, which are the best known to us, which appear to be the most complete, and to correspond to all past epochs. They furnish us with unmistakable traces of the continuance of life, not only under some form, but under all the principal forms we behold at this day. We must not, however, lose sight of the principle, that the presence of a single land vegetable, of a single animal in a stratum of the surface, implies the existence of a multitude of others, by reason of the harmony of the laws of existence in the different classes, which do not allow one class to exist without the other, when considered in great groups. Thus carnivorous animals cannot exist without other animals, either carnivorous or herbivorous; and herbivorous animals imply the existence of plants, which, in their turn, imply the existence of other plants.

PRIMARY ROCKS.—The Silurian system of England is of marine origin; we are not then to look in it for land animals or plants. It is purely local, as are all the other strata of the interior of our surface; the sea was not then universally diffused; and hence there are found in other countries, in France and Germany for example, fluvio-marine strata which correspond with it: they abound with terrestrial plants and also contain insects.

The Silurian system consists of thick strata, intimately united with each other. At all stages of it are found bivalve and univalve mollusks, polypi, and crustacea. The middle and higher strata have moreover yielded annulata, fish, crinoideans, and sea-plants (*fucus*). In a word, the Silurian, like every other marine limestone formation, is composed, for the most part, of the remains of marine-animals. A certain number of polypi, of shells and of fish are common to this first system and to the succeeding systems, as is acknowledged by English and French paleontologists. Among the fish the *onchus murchisoni* (Ag.) passes from the higher Silurian strata into the ancient red sandstone of England; and among the mollusks, the *Pentamerus lævis* (Sow.), and the *terebratula gryphus*, ascend,—the former from the lower Silurian strata (rocks of Orderley and the hills of Mey) into the carboniferous limestone of Nowgorod; and the latter, from the upper Silurian strata (rocks of Ludlow) to the carboniferous limestone of Herefordshire. The period of the old red sandstone is comprized between these two epochs. Hence although the old red sandstone were not fossiliferous, we would, nevertheless, have the proof that there were organized beings during all the time that corresponded with its formation.

The old red sandstone is, however, fossiliferous at all its stages. It contains land plants, crinoideans,—some of which are common to it and to the carboniferous limestone; bivalves, univalves, polypi, crustacea, fish. One of these last mentioned, the *gyrolepis maximus* (Ag.) passes from the old red sandstone into the muschelkalk of Lorraine near Luneville. It consequently traverses all the carboniferous limestone.

The want of natural classification in geology obliges us to accept here the erroneous hypothesis of the geometrical superimposition of strata: but it must be understood, that if the different systems of strata, instead of being entirely superimposed, have many parallel parts, the facts we mention acquire still more importance.

The carboniferous limestone consists in its lowest portion, of fresh water deposits, which contain,—at Burdie House near Edinburgh, and in some other parts of Great Britain,—saurians, pterodactyles, &c. The middle and upper portion is marine or fluvio-marine; in it are everywhere found polypi, crinoideans, echinoderms, bivalve and univalve shells, &c. A crinoidean, the *cyathocrinites planus* (d'Orb.) passes from this rock into the magnesian limestone of Durham. The lower portion of Burdie-House shews among other species of fish, the *gyrocanthus formosus* (Ag.), which abounds in the coal bed of Dudley and elsewhere. We have, however, no need of these transitions to arrive at the secondary rocks, because the mountain limestone often alternates, on its higher levels, with the coal-sandstone, and consequently is connected with the coal, the land plants of which it shews.

SECONDARY ROCKS.—The coal-strata are throughout fossiliferous. They contain crustacea (cypris, trilobites) sea mollusks, as also land, and fresh water; the fishes, annulata, insects, &c.; and more than three hundred species of plants, belonging to all the types of the vegetable kingdom. Many are found to the upper rocks. The *sigillaria reniformis* (Brong.)—of the English coal-beds and of those of Mons and Essen,—passes into the sandstone of the keuper of Gotha. In the family of the lycopodiacea, the *lepidodendron phlegmarioides* (Brong.) of the coal basin of New Castle and of Silesia is also found in the keuper of the environs of Cobourg. We have also the *girolepis maximus*, which is found up to the muschelkalk. With these passages we might omit many intermediate rocks; but we shall briefly consider them, and everywhere find the products of life.

The sandstone of the Vosges or *loth-liegendes* of the Germans, which comes after the coal formation, shews more vestiges of land than of sea organizations. It appears to have experienced in a high degree plutonian influence.

We enter on the Alpine limestone, badly named by the earlier geologists, for it has nothing in common with the limestone of the Alps. It is the zechstein or copper-schist of the Germans, and the Dolomitic conglomerate, or magnesian limestone of the English. It contains polypi, crinoideans, mollusks, fishes, reptiles, &c.

To these rocks succeed the variegated sandstone, the muschelkalk and the keuper. The variegated sandstone,—*bunter-sandstein* of the Germans,—is a fluvio-marine production, as are also the preceding strata. It yields land-mollusks and land-vegetables in large number. In the family of the equisetacea or ferns, the *equisetum mougeotii* is a fossil of the variegated sandstone and of the keuper of Marmoutier (Lower Rhine); the *equisetum arenaceum* of the variegated sandstone of Wasselonne and Marmoutier, reappears, according to Berger, in the Cobourg keuper and also in that of Bale, as Merian relates. Among the ferns, the *clathropteris meniscioides* passes from the variegated sandstone of Ruaux and of St. Etienne near La Marche (Vosges), into the keuper and into the sandstone of the lias of Hör in Scania. These three plants existed then at the epoch of the muschelkalk, which is intermediate with the strata in which it is found.

The muschelkalk is also a fluvio-marine formation. It presents crinoides, mollusks of the two great divisions of that class, land plants, plesiosauri, ichthyosauri, and other kinds of reptiles.

The keuper or rainbow-marl and saliferous sandstone of the English—a fluvio-marine formation—contains a large number of shells and of land plants. The keuper and the variegated sandstone contain the same fossil-plants; and the same species of fish are common not only to these two formations but also to the muschelkalk. The *horned ammonite*, and, among the bivalves, the *possidonia keuperina* (Voltz) are very numerous in the keuper and muschelkalk. The last or uppermost layers of the keuper unite with the first of the lias which follow.

The lias present a collection of sand and clay strata, and still more frequently marl and lime, with numerous alternations. The lignite, the coal, the anthracite are found in them subordinated. By these characters, we easily recognize a fluvio-marine formation, all the parts of which interlie each other, as the clay, the limestone, the lignite in the tertiary basin of Paris. The belemnites and the ammonites abound in them. The lias of Lyme, in England, have yielded belemnites, the ink-bags of which preserved their primitive form, and contained a dry ink, which was but slightly impregnated with carbonate of lime. The lias also contain bivalves, fish in great quantity; among others the *lepidotus gigas*, which is found in the lias of France, England and Germany: as also ichthyosauri, 24 feet long, plesiosauri, saurians, echinoderms, crinoideans, sea-stars, and land and water plants. Many fossils are common to them and the oolite, as, for example, the *avicula inæquivalvis*, the *orbicula reflexa*, and the *am-*

monites striatula. In more than one place, we find, interposed between the lias and the oolite, deposits which share the mineralogical qualities of the higher lias, and the lower oolite strata.

The oolite group is fluvio-marine, as are the preceding ones. It consists of frequently repeated alternations of clay, sandstone and limestone, succeeding each other in the same order as in the lias group. Thus, after the sands of the lower oolite, which cover the clay strata of the lias, comes the shell and coralline limestone (oolite of Bath) and the coral limestone of Caen (cornbrash and forest-marble of the English); after the clay of Oxford or of Dives comes the coral-rag; after the kimmeridge or Honfleur clay comes the sand of Weymouth and the Portland limestone. The lower oolite of Yorkshire and of Scotland may be called a coal-formation.

The *ostrea marschii* is common to the lower oolite and to the cornbrash; the *trigonia gibbosa* passes from the lower oolite to the Portland limestone. The Kimmeridge clay, in the neighborhood of Oxford, contains the *gryphæa virgula*, which is so frequently found in the upper oolite of certain parts of France that this deposit has received its name from the circumstance. Near Clermont, in Argonne, at some leagues from St. Ménéhould, indurated marl crops out from beneath the gault; then, in decomposing, they cover all the cultivated fields with oysters, which might appear to have been designedly planted there.

The oolite is rich in fossils; it contains polypi, crinoideans, echinides, star-fish, annulata, crustacea, large quantities of insects, fish, mollusks, crocodiles, ichthyosauri, plesiosauri pterodactyles, tortoises, land-vegetables of various classes, &c. At Stonesfield, the cornbrash and forest-marble strata,—between the inferior and middle oolite,—contain the two celebrated jaw-bones which most French and English geologists refer to land mammals.

The *megalosaurus Bucklandii* is common to the oolite and Wealden group; the teeth and the bones of this great saurian are also found in the limestone of Stonesfield, and in the Wealden sands of Hastings. The *terebratula plicata* would embrace a still wider range, if it be true that it passes indentically from the middle and upper oolite to the green sandstone and chalk-marl.

The Wealden group has numerous affinities, by its rocks and fossils, on the one part with the oolite series, and on the other with the cretacea. It also is a fluvio-marine formation, composed of alternate beds of limestone and marl, sand and clay. The Purbeck limestone constitutes the lower part, the Hastings-sands, the middle, and the Wealden-clay the upper strata. All these rocks contain organic remains; and the species of the middle and upper strata are for the most part the same. This group gives polypi, crocodiles, and other reptiles. The *iguanodon mantelli* is common to it and the green sandstone, which forms part of the following group.

The chalk-formation consists; 1° of the lower green sandstone (iron-sand); 2° of the gault or clay mixed with marl; 3° of the green upper sandstone or chloride of chalk (marl chalk or tufa); 4° of the white chalk, or chalk properly so-called; 5° of the Mæstricht-chalk or pisolite limestone. All these deposits,—with the exception, perhaps, of the pisolite limestone, the relations between which and the other members of the series are less perfectly known,—are mineralogically united and pass into each other by almost imperceptible shades. This phenomenon is the more remarkable, as we have a pelagian formation—the white chalk, which rests, at least in part, on formations deposited at much shorter distances from the continents. The chloride of chalk disengages itself more and more from the silicate of iron to pass into rough chalk, which is confounded—first with the lower, which is sandy, and then with the white chalk, which is purer, so that the chloride of chalk had not ceased entirely when the white chalk began to be deposited. Between Presagny and Vernon (Eure) the lower white chalk and the chloride of chalk are found in parallel layers, presenting at the same time lateral transitions from one to the other. The current which deposited the white chalk appears to have sometimes alternated with the current that deposited the sandy-chalk.

As might be expected, the fossils become more and more pelagian in passing from the chloride of chalk to the chalk properly so-called. The ammonites and the scaphites, so abundant in the lower portions of the chalk series, become very rare in the chalk, and, for a long time, it was believed that they were not to be found in it. Charpentier found ammonites and scaphites in the white chalk of Andely. I myself have picked up the mould of a very easily recognizable ammonite from the white chalk of Tilly, near Vernon.

This group is fossiliferous in each of its parts, as are all the other formations we have referred to. The green sandstone or chloride of chalk, contains many polypi and echinides, sponges, crinoideans, star-fish, bivalve and univalve mollusks, crustacea, annulata, reptiles, &c. The land-plants abound in the chalky sandstone of Schona, in Saxony, of Tetschen in Bohemia, &c. We have then here also fluvio-marine formations. The white chalk contains animals of the same classes. We find also in it symmetrical infusoria in immense quantity. The pelagian deposit of the chalk of the plains contains but a small quantity of floated timber; but that of the Alps abounds with remains of land-plants, and yields some lignites. Thus even in the most pelagian parts of the interior of our surface, we find fluviatile or fluvio-marine deposits. The pisolite limestone has given polypi, bivalve and univalve mollusks, fish, echinides, star-fish, crustacea, &c.

Many fossils connect with each other the different parts of this group. Many species are common to the lower and upper green sandstone. The *pecten quinque costatus* is found in all the members of the series. The *terebratula carnea*, the *theicidea radians*, &c., pass from the chlorite of chalk of Présagny into the white chalk of Vernonnet. The *belemnites mucronatus*, and the *baculites faujasii* are common to the white chalk and to the pisolite limestone of Faxoë, in Sweden. In the white chalk of England have been found some vertebræ of the mosasaurian, or fossil monitor of the coarse chalk of Maestricht. These two formations contain also the *conoclypus leskei* (Ag.) and the *hemiaster prunella* (Desor.). The *var. lata* of the *microster cor-anguinum* (Ag.) is found in the tufa-chalk of Perigueux and at Maestricht; the *salenia* *geometrica* in the white chalk of Civière, near Vernon, and in the tufa-chalk of Mans.

Tertiary Rocks.—The lower and middle tertiary rocks are composed in France of alternations of clay, sand, lignites and marine-limestone. This fluvio-marine formation, the members of which are connected in the Paris basin, is followed by a fresh water formation,—the middle siliceous limestone: then comes the gypsum or plaster of Paris, surmounted by green marls, sands, or upper marine sandstone, covered in part by the upper lacustrine limestone, with its millstone or cavernous silex.

The upper tertiaries form a group, the scattered and unconnected fragments of which are only connected by their fossils. Under the name Sub-Appenine strata, they comprize the downs or tufa of Cotentin, the calcareous moellon of Hérault, the downs of Touraine, the fluvio-marine sands of Montabuzard and of Montpelier, &c.; the coralline crag and the red crag of Suffolk, in England; then follows the crag of Norfolk, and a multitude of deposits recently formed or which are still in course of formation.

We pass from the secondary to the tertiary strata by mineralogical and paleontological transitions. Scipio Gras describes a tertiary formation in the Department of Drôme, composed of two strata, one of which visibly buries itself under the chalky-marls of the mountain of Veaux, and the other of which dissolves into the chalk, while it is not possible to distinguish a well marked line of demarcation between them. This rock is everywhere intimately connected with the chalk; an evident proof of a continuous formation. (1)

In the South of Italy, "the limestones pass from one to the other by almost imperceptible shades, from the chalk inclusively to the sediments which are still deposited and consolidated; and if, in one locality we find characters and superpositions that appear to announce well defined periods, in another we find graduated transitions. Thus from Syracuse

(1) *Statistique minéralogique du département de la Drôme.*

to Pachino, by Noto, we find the most modern tertiary rocks pass gradually into the chalk; a transition which we again find on mount Saint Calogero and at the foot of Mount Erix of Trepani. This double connection of secondary and tertiary formations, observes J. Hoffmann, is one of the most curious facts in the geology of Sicily; the more so as there is a mixture of fossils, at the limit of the two formations, and the shells of tertiary rocks present characters of a recent deposit." (1)

Infusoria form the paleontological transition from the chalk to the tertiary deposits, and even to the actual epoch. Dujardin has given us a classification of these animals in reference to their organization. (2) In the class of infusoria he places only the symmetrical and unsymmetrical animals, and rejects many others of a higher organization than Ehrenberg of Berlin comprizes therein. It is to be remarked that animals of this class, thus limited to the simplest organisms, do not appear to have been met with any where in the fossil state. All the genera assigned to this state by Ehrenberg are of the number of those which Dujardin refuses to admit among the veritable infusoria, as not being asymmetric. Now, according to Ehrenberg, who has devoted himself to these delicate observations, the chalk is composed, for 19/20 of its mass, of small coral-form animals (bryzoaires) and infusoria. Among the numerous fossil infusoria, twenty one genera and forty species are common to the chalk series of the present day. I shall merely mention the *grammatophora africana*, a chalk-fossil, which is found on the coast of Sweden. Many other chalk-species pass into the tertiary rocks, as the *rotalia globulosa*, of the white chalk of the South of Europe, and of the tertiary rocks of Massachusetts in America. "It is a very remarkable fact," observes Humboldt, in a letter to Arago, (3) "to find among the marine-animals of the present day, beings distributed in Europe and Africa in a chalk-formation, anterior to

(1) Bulletin de la Soc. géol. de France.
(2) Journal de l'Institut. Section des Sciences naturelles, Vol. II.
(3) Bulletin de la Soc. géol. de France.

the tertiary series, in which it was supposed were to be found the aurora, the first traces of actual life, the types of the organic forms which either survived the revolutions of the Globe or have been born since." When Humboldt wrote these words, Beaumont had not yet found our genera of tertiary mollusks in the chalk of the Alps.

The strata of the tertiary epoch, much thinner than the others, contain, in proportion, much more paleontological remains. The clays abound with insects and arachnidans in Prussia, Pomerania and Sicily. In France and England they contain marine, terrestrial and fluviatile mollusks, terrestrial plants, yellow amber or vegetable resin, fish, birds, fresh water tortoises, crocodiles, mammals of the genus *canis*, palæotherium, cheropotamus, rhinoceros, mastodon, lamentin, &c.

The coarse limestone contains polypi, echiniderms, radiata, marine and river plants, a prodigious quantity of shells, bones of the lophiodon, of the hyracotherium, teeth of fishes, of crocodiles, of didelphs, of cheiropteræ, of apes, &c.

The lower lake limestone contains grains of characeæ, mollusks, lophiodons, &c.

The plaster of Paris contains floated timber, fresh water mollusks, insects and spiders of all kinds, batrachyians, crocodiles, land and fresh water tortoises, birds, edentals, ruminantia, pachyderms, carnivori, rodentia, apes, &c.

The green marl contains sea and fresh water shells, insects, &c.

The marine sandstone, and the strata which correspond with it, contain fresh water mollusks, bones of the lamentin, of the dinotherium, of moles, of the hedge-hog, of the *mus araneus*.

The upper lacustrine silex of Paris contains fresh water mollusks, aquatic plants, &c.; and the parallel strata contain the gigantic tapir, with remains of rhinoceros, mastodons, &c.

The sub-appenine strata, as the sands of Montabuzard and Montpelier, present the combination of genera formerly considered as characteristic of this division, with those belonging to the tertiary strata, that is to say, to gypsum, middle mollasse and the lacustrine basins. Thus the cetacea, the reptiles, the palæotheria, the lophiodons, the rhinoceros, the mastodons, the horses, the ruminants, are found united with sea, river, and land shells.

Species of every class form passages from the most ancient tertiary deposits to our epoch. Two vegetables, the identity of which has been established by Brongniart, the *equisetum bruchyodon*, and the *chara helicteres* traverse the totality of the lower and middle groups. The first existed in France before the coarse limestone by which it is covered at Montrouge near Paris; and it was not destroyed by this formation, since it reappears above in the gypsum of Armissan near Narbonne. The second was its contemporary in the same country, but it is of higher antiquity. It is found in the lower, middle, and upper lacustrine silex. These vegetables fill almost entirely and on the same points the interval where Cuvier, Deshayes and Beaumont placed their periods of disorder and general destruction. Such is the power of facts; two small plants refute three systems.

Deshayes has recognized the identity of the following marine species, which we meet with as low down as the first tertiary beds, and which are found in the seas of Europe and other continents: *Dentalium entalis*, *eburneum*, *strangulatum*, *novemcostatum*, *elephantinum*, *dentalis; auricula ringens*, *cytherea nitidula*, *phasianella pullus*, *fissurella græca*, *bulla lignaria*, *lucina divaricata*, *trochus agglutinans*, *turbo minutus*, *natica glaucina*, *natica millepunctata*, *solen strigillatus*, *venus decussata*. Thus past existences are connected with actual beings by links which no general destruction has broken.

We arrive at the same result by the fresh water mollusks. The *lymnaeus arenularius* passes from the lower marine sandstone of Beauchamps into the upper marine sandstone of Valmondois, where it appears to cease: but before reaching this stage, it meets, in the lower marls of the gypsum of Villette, the *planorbis corneus* which extends as far as the higher lacustrine silex of Palaiseau; while a third species, the *planorbis rotundatus*, found in the lower lacustrine silex of Fontainebleau, is associated with the *planorbis corneus* in the marls which are under the gypsum of the environs of Paris; is again seen in the upper marine sandstone of Valmondois, then in the upper lacustrine silex, and is found living in the isle of Scio, under the name of the *planorbis orientalis*. Other species, taken separately, embrace all the tertiary period and form part of the present world. The *melanopsis lateralis* of the lignites of the clay of Soissons is an inhabitant of the river Orontes in the environs of Aleppo; and the *lymnaeus palustris*, which characterizes the lower marine sandstone of Pierre-Laye, is absolutely the same as our *lymnaeus palustris*.

The land mollusks form a similar chain. The *mummy cyclostoma* in five varieties is seen in the lower marine sandstone of Beauchamp, in the coarse limestone of all the environs of Paris, in the gypsum of Montmartre, and in the upper marine sandstone of Senlis; while the *cyclostoma elegans* is found in the upper marine sandstone of Fontainebleau, and is an inhabitant of Europe. All these conclusions have been announced by Deshayes.

The other classes would furnish us with equally conclusive examples, but for brevity and sake, I shall confine myself to that of the mammifers. The animals of this class do not appear in great number in our European strata, before the epoch of the middle tertiary. Many species connect the middle and upper tertiary with the present order. Thus, the reindeer, which lives still in the North, and our bovine species, are fossils of the plasters of Val d'Arno in Italy. Our *vespertilio serotinus*, bat, is found in the gypsum of Montmartre, and our *vespertilio murinus* in the fresh water schist of Oeningen, parallel to our plaster-stone. The *desman of the Pyrenees*, (*mus araneus*, or mouse-spider), and the *talpa Europea*, the ordinary mole, have been found in a deposit of Sansans near d'Auch, parallel to the gypsum. These observations have been made by Blainville. (1)

In fine, every geologist knows that the most recent rocks, such as certain shell-beds of sand and clay, the bone-caverns,

(1) Osteographie.

the breccia, and the deposits which are still in course of formation,—abound in marine, fresh water, and land-animals. In these are found a great number of the same species as in the tertiary strata, and a still greater number of living species.

To resume: the study of the sedimentary envelope of the Earth proves that it is composed of a continued series of marine and river formations: the seas, the rivers, and consequently the dry land have then always co-existed from the most ancient epochs to our days. But these marine or fluvio-marine deposits are not only all fossiliferous; they, moreover, constantly present to us all the principal marine and land organic types of the two great divisions of natural history. Hence these two kingdoms have always co-existed with all these forms. Still more, we have remarked a good number of species of various classes, of which some, setting out from the most ancient strata, are associated in subsequently formed strata with others which are found still higher up, and thus on; so that the chain formed by these fossils embraces all the geological epochs, and, by its latest links, is connected with our present epoch:—a new and evident proof that the natural kingdoms never ceased to exist a single moment since they were established on earth.

Thus, as far as the facts of science perfectly harmonize with Genesis, so far are they incompatible with the ideas of many geologists, who speak of entire destructions of successive creations by general revolutions of the Globe, whether in the atmosphere, or in the position of the seas, or by profound and always new modifications, which the general organization of the Globe passed through previous to the appearance of man upon the earth.

Independently of what we have just seen we have the proof that great changes may occur on the surface of the Globe without producing effects which were thought to be inexplicable, except in the hypothesis of revolutions of the Globe. Thus, the powerful cause which gave to our continents their present aspect, which has divided our tertiary formations, broken our table-lands, furrowed our fresh water-basins, &c., has not extinguished the contemporary species, since in the last marine tertiary strata, formed subsequently to the action of this cause in Sicily and France, and all the circuit of the sea-basins, the fossil marine mollusks are mixed in great number with the living mollusks, as the living mammals are associated in the bone-caverns, in the alluvions, and even in the bogs with species of extinct mammals. Man himself is accompanied by extinct species in the bone-caverns of Brasil, as in those of France, England, and Belgium. His bones, or the products of his arts, have been observed in marine deposits in Sweden, Italy, and on various points of North America, at Guadaloupe, at St. Domingo, in the isle of St. Lorenzo. In the territory of Liege, his remains are mixed with the remains of fishes, and the caverns that contain them are placed 80 feet above the water-courses of the vallies. Since the formation of the rocks in which he is found imbedded, the earth has consequently undergone considerable changes; the vallies have been more deeply hollowed; basins have been emptied; and man existed in Europe and America before these two continents and their islands received their last form,—before their entire emersion from the waters.

III.

Continuance of the same relations between our Globe, the atmosphere, light, air, and the heavenly bodies, from the epoch of the first sedimentary strata to the present epoch.

This conclusion is a consequence of the facts developed in the preceding article; but it affords occasion to place in still clearer light the extreme absurdity of the geological systems.

The atmosphere contains the respiratory aliment of the vegetable and animal kingdom: it is oxygen, azote and carbon combined in certain proportions.

Now Genesis states and geology proves that vegetables and animals directly inspiring air have never ceased to live on the earth. We must hence conclude that the combinations of atmospheric air have never essentially varied in any important degree.

Our plants are constituted with fixed relations to air and light: taken from this medium they soon fall away. Our animals have eyes capable of receiving impressions of the luminous fluid. The deposits of all epochs contain plants and animals analogous to ours: the trilobites of the Silurian strata, the ichthyosauri of the secondary rocks, the crocodiles, the fish of all ages—had eyes of the same structure as those of the crocodiles, the fish, and the crustacea of our time: they were then in the same relation to the air and the luminous fluid; and the air and the luminous fluid were then in the same relation with the stars considered as instruments to cause vibration in the luminous fluid. The relations of the sun, of light and of the air with the two natural kingdoms have never ceased to be what they are to-day, since at all depths of the interior of our surface we find vegetables and animals.

The waters of the different basins of the Globe, taken up in vapour by the action of the sun and of caloric, are received into the atmosphere, where they are condensed into clouds, which the winds drive in the direction of the mountain-chains. There they descend in rain and snow; there they produce and nourish the rivulets, the union of which forms rivers, and these the great water-courses which restore the waters to the sea and the great lakes. Such are the actual relations of the sun, of caloric, of the atmosphere, of the air with the general system of waters. Now, if these relations had ever ceased, life would have ceased upon the earth, whereas the contrary has been demonstrated. Moreover, had the rivers ceased to flow, they would no more have deposited sediment in the basin of the seas, would no longer have transported thither organic remains; whereas we find, at all epochs of the world, fossiliferous deposits formed by the water-courses.

The combined action of the sun and moon determines the marine and atmospheric tides, and, by these motions, contributes to maintain the air and the waters in a state of purity and salubrity suitable for the inhabitants of the Earth. To the influence of these bodies we must also refer the annual alternations of rise and fall in the waters of our rivers. This phenomenon,—combining with the motion of the waters of the sea, with its rising and falling tides that correspond with the phases of the moon,—is the cause that sometimes the rivers encroach on a greater extent of the bed of the sea, which they coat with their sediments, and that sometimes the sea encroaches on the bed of the rivers, the sediments of which it covers with its own deposits. These alternations of sea and river formations, of which the variations in thickness, extent of layers, and nature of their organic and inorganic materials, are in constant proportion with the difference of tides on the one hand, and on the other, with that of the level of the continental streams,—these alternations belong to all the geological epochs without exception, since they constitute all the divisions of the rocks, and at all epochs they appear as at the present epoch. Consequently, at all these epochs the seas and the rivers have borne the same relations to the heavenly bodies. It is thus well established by geology, that our planet has always been governed by the same laws, and that its relations to the atmosphere, light, caloric, air, sun and moon have not changed.

Moses also supposes that this order of things has always continued from the epoch of creation down to his time. He goes further. After the brief and miraculous occurrence of the deluge, he exhibits to us the Creator giving to the terrified world the assurance that during all future time no interruption should ever be experienced in the succession of sowing and reaping, of cold and heat, of summer and winter, of day and night.

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CHAPTER XIV.

Reality of Species. — Creation of Species in the state of complete development.

God said: "let the earth bring forth the green herb, and such as may seed, and the fruit-tree yielding fruit after its kind, which may have seed in itself upon the earth."—"And God created the great whales, and every living and moving creature, which the waters brought forth, according to its kind."—And God said: "let the earth bring forth the living creature in its kind, cattle and creeping things, and beasts of the earth according to their kinds." (1)

Nothing is more clearly or more frequently expressed in these texts than the creation, and, consequently, the reality of species. Genesis affirms it, as well for the small as for the large plants,—for the small as well as for the large aquatic animals,—for the birds, the wild land animals, the domestic animals, in a word, for all that lives and moves on the earth. The Hebrew word *min* which is rendered by the word 'species' or 'kind,' signifies also 'appearance,' 'resemblance;' hence some interpreters translate the passage thus: "God created every flying thing with its like,—the wild animals with their like, &c." It is, however, the same signification, but the notion of species is more fully developed in this latter translation.

An act of the Omnipotent Will precedes the creation of each group of species, limits it, defines, and brings it immediately to life, without making it pass through the stages of successive development to which its products will be subjected. The Creator does not sow the seed of the vegetable; He creates the vegetable itself, which He commands to produce seed 'to its own likeness,' or 'according to its kind.' When He comes to the other natural kingdoms, He does not create a womb, in which an ovula will be developed: He creates the animal itself,

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(1) Gen. I. II. 21-24.

who must perpetuate himself by producing beings that resemble him.

The production of all the species is accomplished in four days. On the second day, the Earth is yet enveloped with water, and void: on the sixth, it has already received all its inhabitants; and God says to them: 'increase and multiply.' On the sixth day, the land-animals and the birds are brought before man, that he may consider them and give them names. They were, consequently, created in the state of perfect development; and this must necessarily have been the case, because they were to provide for their subsistence from the first instant of life. But if the vegetable species, created on the third day, had not been also produced in this adult or perfect state, the herbivorous animal species—and there are such in all groups of land or aquatic animals—could not have been able to find nourishment. Plants were then necessary for animals, as were insects for birds, and the herbivorous for the carnivorous species. We must, then, acknowledge that, according to Genesis, the laws which now regulate species were not observed in their creation, and that their entrance into life was an immediate result of the Creative Will.

We have now to verify the harmony of Science with Genesis on these three points: the reality of the species, the creation of the species, and this, in the adult or perfect state. The zoological portion of this chapter will frequently be an analysis, or textual reproduction of a thesis, defended by Maupied, in 1841, and composed under the direction of his illustrious teacher, Blainville.

I.

Reality of species in the vegetable and animal kingdoms.

All animals commence by an egg, or a germ. The concurrence of two individuals is most frequently necessary for the transmission of life. Hence, species has been defined in natural history, 'two like beings who perpetuate themselves in time and space by producing individuals like to themselves.' Hermaphroditism forms no objection to this definition, since, when it is insufficient, as in the helices and limaces, the concurrence of two individuals becomes necessary: the animals which are of but one sex constitute a more mysterious but adequate hermaphroditism. They form, as the vegetable, an aggregation of individuals. Thus the green hydrus may become an aggregation of individuals; and although this aggregation should not be evident, it nevertheless exists, since all its parts may form separate individuals. The production by gemmation being only the continuation of the being who possesses in itself both generative powers, must, doubtless, be referred to the same law. Be that as it may, and to confine ourselves to plainly demonstrated facts, the transmission of life,—this mysterious and necessary function of organized beings, without which all life would cease,—has not been left to a pure chance of molecular impaction. On the contrary, great precautions have been taken by the Creator to assure the perpetuity of His work and the accomplishment of the command: 'increase and multiply.' By means of it, all species, entering as it were into a participation of the creative power, of which they reveal to us the image, are charged with perpetuating themselves independently of others: they form, each one, an association apart, perfectly defined, the individuals of which resemble, and can mutually recognize, each other.

The mixture of species would have destroyed the harmony of the Creative scale. Its author has provided for it by the various modes of reproduction, by the conformation of the reproducing organs, differing according the species, and in fine by rendering unfruitful individuals born of the unlawful connexion of two similar neighboring species; among which alone these violations of established order can occur, and then only under the influence of domesticity and constraint. Is any thing more necessary to establish the reality of species? Species is not, and cannot be, an abstraction, as *the* animal, for example, is. *The* animal in fact does not exist: there are animals whom we combine and represent under the abstract idea of animal: but the species is as real as the individual; for it will not be denied that, at least in the present state, an individual cannot exist alone and by himself. He must have had a father and mother, who have given him birth. Here then are three individuals, who have with each other relations so intimate, so real, so indispensable, that one of these three being wanting to the other two, these would soon disappear and leave a void in the chain of beings. It is this triad, this union of similar beings,—on the relations and existence of which are founded the perpetuity of creation and the very existence of the individual,—that constitutes the reality which is called species. Without individuals there is no species, as without species there are no individuals. Species is the source of individuals; and these are in some manner the drops of water that replenish the source. The individual is maintained by nutrition; the species by generation, which may be defined 'the nutrition of the species.'

Were there only individuals and no species, all these relations would be a mere fiction. The connexions of the same species with one another would not be a law, since the reality of species, on which alone this law is founded, would not exist. A law cannot regulate an abstraction: but if this law did not exist any individuals, the calf and the horse for example, could produce between them: but such is not the case; and consequently the law exists, and the reality of the species is demonstrated. If there are only individuals and no species, why do those who make this assertion, consider the products of two different species as anomalies,—monsters which they qualify by the name of 'hybrids,' as if to indicate the injury done to Nature in their production? Is it not, because, while denying 'species,' they feel themselves forced to admit them; seeing not only that the facts which pass every day before our eyes,—too common, no doubt, to arrest the attention of those who disregard common things,—as well as facts which are rare and unusual, prove the reality and the existence of species? It is a fact that the products of two species are ordinarily unable to reproduce; it is a fact, that the products, when they are fruitful, are so only for a short time; and that they soon disappear in one of the original types; and it is also a fact, that these connexions take place only between neighboring species, in the state of domesticity and under the influence of constraint. Never has it been proved that new species were the result of such unions. The few facts which are brought forward to establish the contrary, prove nothing more than that what were regarded as two distinct species belonged really to the same species, and hence were capable of producing fruitful issue.

Albert the Great defined 'species,'—the union of individuals which proceed from each other. Linnaeus, 'the perpetual succession of individuals which are born in continuous generation.' Kant also occupied himself with this question of species, with the view of determining whether there were or were not many human species; and, according to him, species can only be that which is transmitted by generation. These profound views are confirmed by the most positive and most general facts. The reproductive organs are conformable to each other in each species. There is an intimate relation between them, in their structure, their position, their disposition. They differ in different species, so that connexions are not possible except between species of the same or neighboring kinds. The product of generation varies also according to the species; for example, the egg is greater or smaller, and consequently requires oviducts more or less large for its passage. The time of its development is longer or shorter, according to the species, not only in different genera, but also in the same genera. Thus in the genus, *canis*, the time of gestation for the fox and the wolf is five months; it is only two and one quarter months for the dog. The time of fecondation is also different for each species; and except in this time, the organs are as it were benumbed and do not produce. The products ought then to be matured at the same time, and require, consequently, in the two individuals the same or very near the same organization, manners and habits. There are, in fine, two facts not less decisive, 1° that the products of one species are alone capable of perpetuating it with all its qualities and properties; and 2° in the free state animals of different species never connect with each other, however near they may be. In animals which have sufficient hermaphroditism, or the two parts essential to perpetuation,—to the stability of the animal in one same individual, the species is constituted by one sole individual: but in most of animals, the sexes of which are in two individuals, the species consists in the two individuals, which cannot perpetuate themselves without mutual concurrence.

Those who deny the fixity and reality of species, endeavour to ground the differential characters of animals on qualities such as size, colour, dimensions of parts, &c.; so that when these qualities—which according to them constitute the species—disappear, the species is changed and modified; Hence they conclude that the species not being fixed, there are in reality nothing more than individuals, who are not connected by any indissoluble bond: consequently there are no permanent laws nor principles by the aid of which we may constitute the science of organization; for the denial of the species involves that of science.

But the negation of species rests on insufficient grounds, or what comes to the same thing, the characters assigned to species are not its real characters. Size or dimension is not a specific character; it depends on circumstances more or less favorable to the development of the individual. Every one acknowledges that the house-dog forms one single species, and yet it contains all varieties of size from the lap-dog to the Newfoundland-dog. The species of the horse also presents all these varieties of size; they are met with in all the degrees of the animal series. The dimensions of parts depending on size, prove nothing more than size itself. It is otherwise with the proportion of certain parts, one with another; but the number of parts is not a character of species. We find, sometimes, an additional vertebra in some skeletons of white men which we do not find in skeletons of other men of the same colour and of the same nation. This fact and other analogous facts are observed in animals which every body recognizes as belonging to the same species. Colour is not a character of species; from the chimpanzee to the genus *fetis*, it is sufficiently fixed; but to set out from the genus *canis*, especially in domestic animals, it presents every variety. And yet the system of coloration, that is the fixed disposition of various colours in the individuals of the same species, forms a character of species!

Size, dimensions, number of parts, and colour—may serve to characterize the varieties of the species, and not the species itself. These varieties prove the elasticity of species, and the elasticity of species contributes much to their perpetuity. But the *laxum* of this development more or less great of the properties,—of the qualities of the species, has its *maxima,* and its *minima,* its extreme limits determined by nourishment, or climate, or habitation, or domesticity, or habits of labour and rest. These limits cannot be passed without the destruction of the animal, that is, if you change *too much* or *too abruptly* the media and circumstances, in place of obtaining a new variety or a transformation of the species, you destroy the animal. It is also remarked that the *laxum* of variations is much less extensive for the free and wild, than for the domestic animals. Thus the facts which are often referred to as objections to the reality and fixity of the species, contribute to its demonstration.

REALITY OF THE VEGETABLE SPECIES.—The essential character of the vegetable and its highest function is that of reproduction. The greatest part of the vegetables, the polycotyledons and the monocotyledons, reproduce not only by bourgeons, buds which rise on the branches, trunks or roots, but also by seeds and special organs, which are visible and two in number, the female organ or the pistil and the male organ or the stamen. In the ferns, the lycopodiaceæ, the mosses, &c., the floral organs are not visible; but their product or their seed is observable, and proves that the power of reproduction exists in them. In these families, however, the reproducing organs, or sporules, may be, and have been considered as real bulbs, and consequently as a prolongation of the adult vegetable. In fine, the inferior vegetables are merely an utricular tissue, and in them the product of generation is nothing more than the continuation of the adult. There is, then, in all plants a real power of reproduction. Whether this function be the result of visible organs or not, it nevertheless implies modifications of tissues, and various organs, more or less limited, according to the different species, and the complication of their organization.

In whatever way reproduction takes place, the being produced is always like the reproducing being in all its essential parts.

It happens, however, accidentally, that the fertilizing subtance of a vegetable, being placed in contact with the female organ of another vegetable of a different species, there results a third individual which is not entirely like either of the reproducing individuals, but which can neither perpetuate them nor itself, except by artificial means, and which, consequently, is a real anomaly, that, instead of weakening, confirms the law. It returns to its species, when the seed is employed to multiply it; and this fact is general. The few exceptions which might be mentioned are neither sufficiently clear nor sufficiently certain to be accepted by science. We must, then, conclude that the vegetable species is a constant reality.

The plants which reproduce themselves without interruption, no matter in what way, are what we call a 'species.' To comprehend all the facts and all the modes, the species may be defined in botany, a series of individuals reproducing one the other without essential alteration by successive generation, either by continuation of tissues, or by peculiar organs. This being established, species is evidently a reality in nature, invariable as to its essential characters, but variable in its accessory qualities. Thus a plant covered with hair on an arid mountain, if transported to a cultivated soil, will soon lose its hair, and become softer and fuller; but it will preserve the same tissue, the same fundamental properties it originally had; it is a variety, not a new species. Varieties are obtained by change of climate, by culture, by grafting, &c. They are infinitely more numerous in the domestic than in the wild plants.

It has been asserted that the species change in course of time into others different from the first: but, in the first place, this opinion is hasarded without sufficient grounds: and, in the next place, we have only to agree on the force of terms. If varieties obtained by artificial means depart so much from the original plants as to cause the identity of species to be at first sight unperceived, it is nevertheless evident that a fern will never produce a lily: nor a lily, an oak, &c.; in a word, that species separated from each other can never approach so as to unite by a series of varieties derived from both and tending to unite them. The common plants are of all the most elastic; they have been the object of a multitude of experiments, to which neither time nor human skill was wanting; and they never have given a result which resembled a transformation of species. The variations of species in this department of Nature, as well as in the animal kingdom, are circumscribed by limits which they cannot pass. Botanical Science combines then with Genesis to say, that plants form distinct species, which are fixed, and capable of perpetuating themselves in space and time by reproduction.

II.

Creation of Animal and Vegetable species,

Vegetables possess the organs necessary for their perpetuation: they find in the media which surround them the substances adapted to their wants, they elaborate and assimilate them, and by this means they develop and grow. If they had merely organs of nutrition, they would soon have disappeared, for when fully developed they languish and die. It was then necessary that they should have been created with organs by which they might be continued by reproduction, and such is the order that exists. To suppose, however, with Lamarck and his school, and all the materialistic pantheists, that this order is the result of the laws of matter, which originally established it, is contradicted by reason and experience, and is destructive of science. To dissipate these halucinations, it would be sufficient to recall the false notions which the pantheists form to themselves of nature and of matter. (1) I shall, however, observed that all the vegetable species, as also the animal species, being fixed, determined, and organized in intimate relation with the circumstances and media in which they live, could not have been produced by a blind and mechanical cause. We shall, however, find in the comparative study of the laws of matter and of those of vegetable life, a still more direct refutation of the pantheistic hypothesis.

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(1) See Chapter VIII.

The laws of matter are properties which are inherent in it. Matter could no more exist without these laws than these laws could exist without it; and as long as matter exists, it possesses its properties. The earth no longer produces spontaneous vegetation: all the plants—from the highest to the most simple—are born of other plants; such is now the law. We must then conclude that the earth never could produce vegetation, or that it has ceased to possess this quality. This would be capriciously to make and unmake the laws of matter. When we wish to find them immutable and mathematical, we insist that they are so. On the contrary, when we find variable and temporary laws more convenient, we will have them so. Science would thus become impossible. To say that brute matter can produce organized beings, is to say that it can surpass itself; that it can give what it does not possess. It is composed of various elements; but to no purpose are these elements combined and mixed; their products are simply masses more or less confused, or disposed in a certain order, without these elements ever differing from themselves; neither life nor organ results from such combinations. Organized substances, once deprived of life, are soon decomposed, and re-enter the class of inorganic matter; for the laws of affinity, to which matter is subject, incessantly tend to unite and crystallize molecules, so that animal and vegetable debris, such as the shells of mollusks, the cuticles of radiata, the woody substances of vegetables, as soon as they are reduced to brute matter, crystallize and assume a form most opposite to that of organization. All geological phenomena attest this great fact. Matter is ever subject to its general laws; and all observations prove, that as soon as matter is abandoned to itself, it crystallizes. Organized bodies are formed of matter withdrawn by the principle of life from the laws of brute matter, so that the vital motion, the continual afflux and reflux of molecules in organized tissues, are an obstacle to the law of crystallization; and life is in reality a perpetual struggle with the general laws of matter. When the equilibrium is disturbed, when the organic tissues yield to brute matter, the general law resumes its empire, disorganization and death

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take place. This is proved by the abundance of calcareous substances in the bones of old men, and of aged mammals; the cellular tissue is filled; nutrition can no longer be effected; and fractures are almost always incurable. This is still more remarkable in the lower animals, as in the shell of the echinus or sea-urchin. The older the animal is, the less does its shell contain animal substances, and in its extreme old age, it is entirely calcareous. In all the fossil sea-urchins, the shell is constantly composed of spathic crystals, which is also found to be the case in the living sea-urchin. Vegetables follow the same law. The obstruction of the vessels by inorganic matter brings on old age and disorganization. The fossil vegetables are crystallized; and in the most of them there is not a particle of woody substance. Far from producing vegetables, the general laws of matter tend constantly to their destruction. And assuredly if this general property existed in matter it would exert all its energy on molecules already organized, in order to compose thereof other organized bodies; whereas, on the contrary, as soon as life has ceased, all the elements are disorganized and are subject to the laws of brute matter, which are an obstacle to organization. The hypothesis of Buffon regarding organized molecules circulating in the Universe is refuted by this single fact.

Not only matter cannot create organized bodies, but the simple elements which are found in the vegetable appear to be its product, and vegetable substances are formed entirely in their tissues. Skilful experimenters have sown grains of cresses in various powders; such as the flower of sulphur, of silica, of the oxide of lead, &c.,—bodies the composition of which is well known. They vegetated; after having reduced to cinders a large quantity of them, in order to submit them to analysis, there were found the same alkalis, the same salts which are found in the plants that vegetate on the open soil. They contained alumen, phosphate and carbonate of lime, carbonate of magnesia, sulfate and carbonate of potash, oxyde of iron. Now these substances, not existing in the air or in the powders which served as soil to these plants, nor in the carefully distilled water with which they were watered, we must admit that they were produced by vegetation itself. Whatever be the fact, it is at least certain that the vegetable substances as the lignin, the essential oils, the sap, the gums, &c., are formed entirely in the vegetable tissues; they are not then supplied by brute matter; which, on the contrary, is itself transformed and animated by the laws, and under the influence, of life and of life alone; and consequently it is necessary to have organized bodies already living in order to produce organization and organic substances. Since even the vegetable substances, which are not a vegetable, cannot otherwise exist but by the action of vegetation; *a fortiore* the vegetable, which is the combination of all these substances, cannot be spontaneously produced by matter and its laws.

Once we have the first vegetables, all these difficulties disappear, and the phenomena follow their ordinary course. But in supposing the spontaneous generation of the first vegetables, an impossibility is required; for the production of the vegetable is precisely the most complicated phenomenon—the highest and most vital function of vegetation. Vegetables are reproduced by seed, by germs, by shoots, and by the prolongation of their tissue, which is another name for branching. The manner is immaterial, it is always essentially the same function. The bud, the slip, the graft, are nothing more than the separation from its parent of a vegetable already formed, which is thus made to have an independent existence. The sporules of the ferns, the reproductive organs of the mosses, of the mushroom, and of the lowest elements of vegetation—are real seeds, or rather bulbs: and to produce seed or bulbs, there are required organs more or less complicated, according to the character of the vegetable itself. The seed is only produced when the vegetable is mature; it is the most complicated result of vegetation. To have seed we must have vegetables. Seed, then, cannot be produced by the general laws of matter.

Instead of extracting, with Lucretius, from the bosom of the earth the cedars of Libanus, and aged oaks by the sole force of matter, the hypothesis of modern materialists, to be consistent, should take in all facts, and begin *ab ovo*. They should admit a first rudiment of organization, to be gradually developed under the influence of the laws of matter. This is what has been done. They have supposed that an original organic molecule was developed in a globule of liquid; that this molecule engendered another, and thus on up the production of the entire vegetable. This hypothesis is, however, as untenable as that which supposes the production of an adult plant. For in what organ would be developed—I will not say this seed—but this ovula, the first utricle, the sap even which must form it? Although this sap, this utricle, this ovula existed, how could they be developed, and how nourished? There is no protecting envelope to defend this tender ovula, this slight utricle, this liquid sap—from the exterior agents which would dry it up: there is no placenta to nourish this poor little ovula, abandoned in the Universe to the laws of matter, which are an insuperable impediment to its development. This is not all. When this first ovula has become a seed or an inferior vegetable, a mould or a moss, as may be supposed, how can it escape all destructive circumstances,—how can be made to issue from it, by successive transformations, all species, so different from one another, and of which there are now counted forty thousand for all climates, temperatures and soils, on land and sea? The vegetable cannot, like the animal, change the place of its dwelling; it is the slave of the circumstances of soil, of climate, &c.: it cannot choose. If the circumstances and the media are not suitable for it, it perishes: and how great soever may be supposed the laxum in this want of suitable media, never will sea-weed produce a land-plant, or even a fresh water vegetable.

From all these facts we may conclude that neither the germ, nor the ovula, nor the seed, nor the adult plant, nor any vegetable substance is the result of the laws of matter, with which laws, as we have shewn, organization and life have continually to struggle. Consequently vegetables were necessarily required to produce vegetables and vegetable substances. Vegetables, however, have not always existed on earth, as geology establishes. As all die so all were born,—individuals and species, and the first individuals, now no longer existing, had a beginning as they have had an end, like the rest. We must then admit an Intelligent Power, Who, having created matter and fixed its general laws, created also vegetables, and withdrew them from the laws of matter to subject them to those of life, which keep up in His work the equilibrium with the laws of matter. The vegetable species have not been produced, one from another, by successive transformations; they have then been created.

Creation of Animal species.—We have seen that the general laws of matter, far from being capable of organizing vegetables, tend to destroy all organization, in order to bring back matter to its more general and predominating state of inorganization. This is still more evident in the animals, which having a more complex organization, and being formed from matter much more removed from its native state, they have to contend with more numerous and more energetic causes of destruction. There is nothing in nature which can produce an organized substance but an organism. Every animal substance, from the limestone-coral to the nervous system of the highest animal, necessarily supposes a preceding organism in which it was formed and developed. Every animal substance is the product of organization, and it is only from an organized product that a new organization arises. Thus the egg, the germ, the fecundating liquid—are animal products, real secretions of organs capable of producing them, and without which they could not be. Nay more; it is not sufficient that the egg, the germ, the fecundating fluid—have been produced; if they are to give birth to an organized being, capable of living, they must have acquired a certain degree of development or of maturity, before separation from the parent beings. Organization proceeds solely from organization; and, consequently, the first living organized beings must have been necessarily created in a perfect state of development, otherwise they could not have existed, or continued to exist.

Let us suppose, however,—contrary to all facts and to all the laws of organization,—that a first organized germ could be spontaneously produced in a liquid globule. What would have become of it? There was no organ to receive and protect this organized molecule; this molecule had not itself any organ of support or development: it was consequently born to die. Let us, however, suppose—contrary to all the laws of matter and to those of organization,—that this molecule, this primitive germ, is developed: it must needs be the lowest conceivable animal, an infusorium, it has been said. But, in the first place, the infusoria, which may be certainly regarded as organized, are certainly produced by generation; and, consequently, instead of favoring the hypothesis of spontaneous generation, they contradict it. Besides, from this infusorium to the animal kingdom there is a great difference. Will the infusorium produce a sponge, for example, which is always born of another sponge? The sponge, in its turn, will never give birth to a sea-urchin, nor to any other radiary; at least such facts have not presented themselves to observation from the earliest times. We must, then, admit the spontaneous production of as many germs as there are species or, at least, genera of animals. Wherefore carry to greater lengths these absurd suppositions, when the facts already are more than sufficient for our purpose? Neither the mollusks, nor the articulata, nor the fish, nor the amphibians, nor the reptiles, nor the birds, nor the mammals are seen to rise from the slime of the earth warmed by the sun's rays.

We might, then, stop here, but the pantheistic thesis has auxiliaries, and it is the more necessary to destroy it radically, as between it and that of Genesis there is no possible accord. Now the hypothesis of the transformation of species is refuted by zoology; and geology itself will supply us with a confutation of it which may have the merit of being new and unexpected.

Zoological Proofs.—Modern pantheism has at its disposal the progress of physical and chemical sciences which were unknown to Indian and to Greece. Hence it has improved its arguments, and, instead of making every thing proceed from man, with the philosopher Kapila, or from the earth, with Epicurus and Lucretius, it derives from a monad, produced by motion in a liquid globule, the primitive type of each great group of animals. There is a type for the inferior animals, or zoophytes; a type for the mollusks, a type for the articulata; a type for the vertebrata. This primitive type has inclinations and wants to satisfy; but for this it needs organs. It acts in this direction, and at length, the use of the rudiments of organs which it already possesses, develope in it perfect organs: but the inclinations and wants always increasing, necessitate the development of new organs, and thus it is that the lowest of the headless mollusks becomes by a successive improvement, a poulp: the last of articulated worms, a coleoptera; the last of fishes the most perfect mammal, and finally, man. Such was the system of Lamarck. The author has not decided whether Nature began the vegetable series with two or three types. He could not avoid admitting a God, who is, however, admitted as Creator, and then laid aside. And yet without an Intelligence, at once Creative and Ordaining, there is no finality. The animal and the vegetable no longer can be a collection of limited organs, determined under a definite form: consequently, species are no longer possible; there are only individuals, or, to speak more accurately, a single individual, developing successively in himself, according to his wants and wishes, all the organs contained in germ in the original type, —a thesis which commends itself in science by unity of plan and composition, at least for each great type. German pantheism,—withdrawn from idealism by Kant and Fichte, and modified by Schelling, Goethe and Oken,—admits but one sole being, containing every thing in himself. Taking the first of mammals, for example, we ought to find in it all that is in the lower mammals; and in every individual animal each of the parts represents the whole. 'All is in all' is the abridged expression of this philosophy. Goethe undertook to introduce it into the natural sciences. Oken educed its necessary consequences. "Nature," says he, "should be regarded as one sole living being, of which all the parts are organs. A higher animal must contain all that is found in inferior animals. The animal kingdom has been completed solely by the successive development of the organs which the animal type presented at its initial point." This is also the doctrine of Lamarck; but for the Germans this development is effected alone by the surrounding media, whereas Lamarck joined with these latter, tendencies and wants as causes of development.

It results from this review that all the forms of pantheism are substantially the same: they are all resumed, in a scientific point of view, in this single proposition: "There is unity of plan and of composition in the animal kingdom. In each animal, each of the parts represents the whole; and each animal is the representative of the whole animal kingdom, since in each animal we can find all the same parts as are in the others. Consequently, there are no species, but merely individuals; all derived from one sole primitive type,—the unique plan of all animals and of the whole animal series. All animals being merely one by their plan and composition, they must be considered as parts or organs of the One Being, the Universe."

To understand well this unity of composition, we must remember that simple bodies combined with each other produce compound organic bodies, which are called 'immediate principles': these 'immediate principles' form tissues; the tissues, uniting in a determinate manner, form organs, the organs, united together to execute some functions constitute preparatives, and the union of a certain number of preparatives affecting a determinate form, capable of sustaining itself by the functions of the organs, and of perpetuating itself, is what is called a living organized beings, such or such an animal. So that if we are able to shew that the number of elementary principles and that of their combinations, or 'immediate principles' is the same in all animals; that the structure and number of the tissues, organs, functions, preparatives—are everywhere the same; and that it is also the case with the general form and the plan; then we shall be obliged to admit that unity of plan and composition exists in the animal kingdom. If the contrary is the case in all these points, it will be rigorously demonstrated that this unity of form and composition does not exist; that, consequently, beings have not proceeded from each other by successive transformations; but that they all have been specifically created.

UNITY OF COMPOSITION DOES NOT EXIST.—1° *In the number of the elementary bodies.*

Organic chemistry proves that the number of simple bodies is not the same in all animals. To quote but one example; iode exists in the sponges, but is not found outside this group. Moreover, if it were necessary to admit unity of composition for all beings in which are found the same elements, it would exist for certain animals and vegetables, while it would not exist for others: for there are elementary bodies which are common to some animals and plants, and which are wanting in other animals and plants. Unity of composition is, then, untenable for the elementary bodies.

— 2° *Or in the number of 'immediate principles.'* The consideration of 'immediate principles' is much more important: it is by them that new bodies, having particular forms and properties, are formed. But a great number of 'immediate principles' are peculiar to certain species; and sometimes vary from one neighboring species to another in the same class, and much more in classes of the same type. The fibrine, the immediate principle of muscles, exists in all animals that have muscles: but in those which have not, and which are reduced to the cellular tissue, it would be impossible to find it. The peculiar oil which is secreted by the glands of the croupion in birds belongs solely to this class of animals. The milk with which mammals nourish their little ones does not belong to the other classes. The means which protects the skin of amphibians is not an analogous product with the scutella of reptiles which effect the same end. The virus of venimous reptiles is not common to all reptiles. The musk and the civet are only found in a small number of mammals, &c. Wherefore so many 'immediate principles' in the higher animals, the germs of which do not exist in the lower animals? If the successive transformation of species be admitted, we would still be obliged to account for the presence of these 'principles' without antecedent elements; and this can never be done on the supposition of unity of composition. If we recognize an order and an end in Creation, the finality of each species, and in each species, the finality of its organs and of their structure, gives us the reason for the existence of these products.

—3° *Or in the intimate structure and number of tissues.*

The anatomical structure is not more favorable to the unity of composition. The tissues have different structure and composition in different organs. Many tissues are wanting in a number of animals: neither the nervous tissue nor even the muscular tissue can be discovered in the hydrus, nor in most of the polypi, and especially in the sponges. The osseous tissue is found only in the vertebrata. The muscular tissue, even in the animals that have it, is sufficient to refute the thesis we oppose. A great many of its parts are wanting in many animals.

—4° *Or in the number of the organs of the sensorial apparatus.*

Do we find in the animals the same number of organs differing only as to the degree of development, extending to the *maximum* in some, and descending to the *minimum* in others? The animal kingdom exhibits to us the organs of the five senses; those of smell, hearing, and of sight always and necessarily imply the presence of a head. In vain do we look for these in headless animals. Here then is complete absence of many organs. Those which may be demonstrated in the same system among the articulata, are composed in them after a type which is no where else observed. Their head not being capable of motion in various directions, the eyes are multiplied and so placed as to afford the animal an extent of view sufficient for its wants.

—5° *Or in the number of their parts.*

We would arrive at analogous results in running over successively all the organs of the senses. We should find that the parts of these organs are not everywhere in equal number. The eye of birds is much more complex than that of mammals: there are perfecting parts, as the pecten and eyelids which are wanting to the latter, although in many regards of a higher order. The composition does not then increase in perfection as we ascend the animal scale. The fishes have but one internal ear; the cetacea have no shell; the frame of the tympanum is not found in dolphins. Thus in the same class of animals—the mammals, many parts are wanting. Were the system of successive augmentation correct, man's senses ought to be the most perfect; and yet man in this respect is inferior to many animals.

—6° *Or in the number of the parts of locomotive apparatus.*

In the apparatus for locomotion we must pay particular attention to osteology, because it has been selected, as furnishing the principal argument in support of the pantheistic formula, which Goethe has expressed in saying, that 'the whole of an animal is a fixed budget which Nature cannot pass.' The fact is, the number of pieces of the skeleton varies even in the most nearly allied species, and sometimes even in the same species, where even sometimes is found less unity of composition than elsewhere. In every skeleton we must consider the trunk and its members: in the trunk, the vertebral column, the pieces of the sternum, the maxillary appendices, the ribs and the cartaliginous horns of the sternum. Let us briefly glance at a few of these parts.

The vertebral column is composed of a certain number of vertebræ. A complete vertebra is composed of a body with two osseous arcs and divers apophyses. Complete vertebræ exist in the fishes and reptiles, never in the birds; they are found in the tail of cetaceous mammals, as also in a great number of animals of this class, as far up as the apes. But the trained apes, as also man, never have bones in V, and consequently never complete vertebræ.

Not only the parts of the vertebra but the numbers of vertebræ vary considerably. The dorsal, lumbar, sacrum and coccygian vertebræ are so variable that it is almost impossible to infer from one individual to another, the number of coccygian vertebræ. The cervical being fixed, and the coccygian variable, let us compare only the dorsal and lumbar vertebræ. In man, the whole number is 17; in a great number of trained quadrumani, as the semnopytheques and the guenons (female apes) the whole is 19; in the bear, there are 20—14 dorsal and 6 lumbar; in the *felis* (cat) the number is most frequently 20: but the lumbars are more numerous, there being 7, while in the hyena, where the total is 20, the dorsals are to the number of 15 or 16. In an African elephant the number is 23,–20 dorsals; in the rhinoceros it is most frequently 22, of which 19 are dorsals; in the tapir 23 or 24,–18 dorsals and 5 or 6 lumbars. In the hippopotamus, 19,–15 dorsals and 4 lumbars, and yet this animal belongs to the pachydermata. The number then of the most fixed vertebræ varies from one group to another as also in the same group. We will not stop to compare the caudals, the number of which is so variable. Thus in the same order that of the apes, there are species without tail, and others with enormous tails. In the order of cheiroptères, the first species have no tail, and the last have some more or less developed. In the class of amphibians the bactracians have no tail, and the salamanders have very long tails; and yet these two groups are closely allied.

The greatest mobility take place in the vertebræ of the mammals, in the direction of the tail. In the birds, on the contrary, the neck offers the greatest development and variation, since it shews from 12 to 23 cervical vertebræ. In the reptiles and the fish there exist a much greater number of caudal vertebræ than in all the other vertebrates; and in the fish, even where we find most frequently but one cervical, the total number surpasses very much that of the mammals. Thus the variable parts change for each class; the tail in the mammals, the neck in the birds, and both in the fish. Unity of composition then does not exist in the vertebral column: we shall not find it either in the series of sternebræ. The number of sternebræ is 9 in the bear, the dog, and tapir; 10 in tigers and lions, 5 or 6 in the elephants; 8 in the hippopotamus, &c. In the birds the sternum is in one single piece: it disappears in the most part of reptiles, and there is no trace of it in the fish.

—7° *Or in the number of organs of the other apparatus,* *or in the number of apparatus themselves, or in that of their functions.*

We have no need to speak of the maxillary appendices, or of the teeth implanted in them, for there would evidently be too much to say. The members furnish us with the same facts: the number of pieces of the apparatus of locomotion, and of the parts of these pieces, is not then the same for all skeletons. The apparatus of digestion, respiration, circulation, &c., would give us similar results. We would see that it is impossible to find in each apparatus the same number of organs, and in the organs all the same parts and the same tissues; that many apparatus even disappear in the lower animals, and that consequently there is not unity of composition either for the organs, or for the apparatus. In fine, unity of composition does not exist in the functions, since these are derived from the apparatus.

Hence, there is variety, in the number of simple elements and in that of their combinations, not only for each type, but often even for each class and each order;—variety in the structure, the number, the properties, and, consequently, in the intimate composition of tissues: variety in the same organ, taken at different degrees of the series, in the number of organs, and in that of the apparatus and of the functions. These facts are true of all tissues, of all organs, of all apparatus, of all functions. It is then clearly demonstrated that unity of composition does not exist in the animal kingdom. Let us now enquire whether there is unity of form and of plan in the animal kingdom, as the pantheists assert.

UNITY OF FORM DOES NOT EXIST,—1° *Either in the three great divisions of the animal kingdom, or in the grand types.*

The 'simple' and 'immediate' principles, the tissues, the organs, the apparatus, combined to constitute animal organism, present themselves to us under various but determinate forms, —constant and always the same, without which science would be impossible. Do we here found a successive development of forms, advancing from one to the other?

The animal kingdom furnishes us with three great types of general forms, the amorphous, the radiata, and the pair. The form called amorphous, because geometrically undeterminable, that of the sponges, is originally spherical: aggregation deforms it. Geometry could indeed derive the form 'radiata' from this spherical form; but beyond that, it has no principle to derive the form of an earth worm for example from that of a hydrus, although the distance is not very great between these two animals, considered in their functions and in their acts. What would it be, if there were question of a bird, a reptile, a mammal? What analogy of form, unless we confound all ideas, can be shewn in such animals?

—2° *Or for the subdivisions of the same type.*

Under the same type of general form, in the mollusks for example, how could the form of an oyster—which is sufficiently like to be referred to the radiata and not sufficiently like to belong to that class—engender a univalve mollusk, which has a distinct head armed with tentacles, &c., whereas the oyster has no head and has a shell with two valves? How did these two shells change themselves to become but one? It is true, that we might, but very erroneously, consider the cover as a valve; but in those which have no cover where is the other valve? The highest mollusks,—as the sepia, the pulpa,—belong to the general pair form, and to the same type of organization as the oysters. Still, if we endeavour to derive their detailed form from that of the oyster, we shall find how difficult it is to refer an animal with a distinct head and trunk, with tentacles used for locomotion, with sensorial organs determining the form of the head,—to the form of an animal without head, without organs of special senses, and without other instrument of locomotion than a contractile tissue and a single transverse muscle, which is limited to closing the valves. Water is, however, the common habitation of these animals. If the media determine the forms, how can there be so great a difference between beings inhabiting the same medium? But what should we say if it were necessary to derive from the form of an oyster the more complex form of an articulata, and of an ostéozoara?

—3° *Or for the genera and the species.*

It is not only in the types and in their leading divisions that the form is so distinct and so different. It is equally so in the genera and the species, and the simple good sense of the people is never deceived by it. Who could confound the genus 'tapir,' with the genus 'elephant,' or this latter with the genus 'horse?' The first child who sees the species of the genus 'horse' will never confound the ass with the horse properly so-called: the general appearance of this latter, which is derived from his form; the ears of the former, which are equally characteristic, the tail so different in both, the carriage and distribution of the mane, and, better than all this, the very look, without observing any special character, will never permit him to err in his judgment. This form is so inherent in each species that the mule of the horse and the ass has something of the form of both. There is not consequently unity of form; and hence we may already infer that there is not unity of plan; for the form is in fact the result of the arrangement of the different parts of the plan: it expresses their harmony, and is their aggregate.

UNITY OF PLAN *does not exist in the Animal Kingdom.*

The animal kingdom presents to our consideration as many general plans as there are general forms, and in these plans as many modifications as in these forms. As there are three general distinct forms, which are subdivided into five great types, there are also three great general plans; the first, in which the body and its parts are divided into two equal sides and similar pairs along a longitudinal plan; the second, in which these parts are disposed as radii around a centre taken in the body itself which is circular; and the third, in which neither the plan nor the form can be strictly defined, by reason of the want of regularity. Now it is geometrically impossible that a longitudinal plan, frequently contracted and dilated in its length, and carrying divers appendices and variable forms, can have been derived from a circle, any more than that this circle could have been derived from the same longitudinal plan.

The unity of plan then no more exists than unity of form, —no more than unity of composition; and as, when there was question of composition and form, so now we could also follow the same demonstration by applying its principles even to the large types. Comparative anatomy and philology demonstrate that there are five general different plans, as there are five grand types or organizations,—the irregular animals, the radiata, the mollusks, the articulata and the vertebrata. But in each great plan, which is one for the whole type, there exist modifications and harmonious varieties for different ends, according to the groups and the species. The diversity of the great typical plans being once demonstrated, these harmonious modifications attest that, among the species of each grand plan, although there is fundamental unity of plan, there is not, therefore, rigorous unity or identity, but variety; because of the difference in the number and subdivision of the parts for one end and various uses; and consequently far from being an argument favorable to the unity of plan, they confirm our proposition which denies it.

ABSOLUTE UNITY OF PLAN DOES NOT EXIST.—1° *Either in the groups of the same class.*

When we recal to mind that every one judges of the form, we shall comprehend that this alone suffices: for form rules matter, and so rules it that in all things we seize on nothing, and can seize on nothing, but form; it not being given to us to penetrate the substance of things. There are then as many diversities and varieties of plans as there diversities and varieties of forms; because the form expresses the plan, and is the plan itself. As we should, however, endeavour to make the facts, in some sort, palpable, we shall select two examples to demonstrate the variety of plan in each group not only of the same type, but of the same class; that is, the carnivorous and the ruminantia.

In these two groups, the habits and kind of life are very distinct and totally different; and if the organism is the instrument of habits and of life, if there is harmony between them, here two organisms must be different. In effect, the ruminant animals live on grasses; they are timid and have no, or almost no, defence; flight and retirement are their security. Their conservation implies that their organism corresponds with all the exigencies of their position. They have a digestive system which is peculiar to them, which permits them to take hastily a great quantity of food, which they afterwards digest at leisure in retreat. The dental system corresponds with the digestive system; it is made to crunch the grass and to mill it. The papillæ of the tongue, more numerous and more distinct than in the carnivori, permit the animal to take up grass as if with a hand. All the secretive digestive organs are developed in proportion to the labour required to transform vegetable into animal substance. The sense of hearing corresponds with their timidity; and the members, by the modification of pieces,—a very short humerus and femur, forearms and legs longer and of one sole piece, the reduction of numerous bones, of the metacarpus and the metatarsus in a single longer lever, the stronger phalanges of the fingers and these less numerous, which rest on the surface by their extremities, and give also elongation to the member which is nothing more than a series of strained springs and strong levers: the muscles become less numerous and therefore of greater volume, stronger and more able to endure fatigue,—all these things wonderfully facilitate their flight while they obey the counsels of the ear, and are also in harmony with the properties of their stomach.

In the carnivori, on the contrary, which were made to live on flesh, the stomach loses much of its complexity. It is evidently no longer the same plan; there is nothing more in it than the essential digestive portion: the intestinal canal is much shorter and less complicated. The dental system has been necessarily modified; it has gained in number, force, sharpness what the stomach has lost in complexity. The secretive organs, having less labour, have proportionally decreased; the ear not having to catch the voice of an enemy is neither so mobile nor so developed in its cochlea or spiral cavity; the smell, which is to discover prey, is, on the other hand, much perfected. The members, and especially their extremities, are made subservient to the digestive system, by aiding to seize on and prepare the prey; the motions in different directions are more numerous; the fingers and the muscles more separate; they are able to catch and to tear. Cowardly and cruel, craft rather than strength obeys their instinct; their whole body is modified so that they may crouch, stretch out when necessary, draw themselves up, and spring on their prey. Their members are not made for swift running, and it is only by leaps and bounds that they pursue and catch their prey. Thus their proportions, the number and form of the parts, are as different from those of the ruminants as the rest of their system.

—2° *Or in the species of the same group.*

There is then variety of plan in each group, and even in each species. If it is less striking in neighborings species, it is sufficiently so to supply characters by which they may be distinguished, and to prevent not only men but animals from confounding them. A horse, for example, will distinguish between a dog and a wolf, although these are neighboring species. Who could confound a beaver with an otter, which, however, is only an aquatic beaver? Who would confound the (musaraigne) mus araneus of the Cape, which Nature has taught to leap as the grass-hoppers in which it lives, with the aquatic mus araneus, the tail of which is an oar and the feet of which are palmated; and these two species, with our small mus araneus, so different in its proportions? If all parts of organism do not always exhibit this harmonious variety of plan in all the species, generation sufficiently manifests it. The reproductive organs, in male and female, are adapted to one another; and they involve modifications peculiar to each species, whether in the proportions, or in additional organs, as the glands of musks, of civets, &c. Moreover, according to this law, that different tissues form different products, we are still led to conclude for each species generative tissues differently modified; and there must needs be a constant plan for each species, since the form, the resemblance are constant and are transmitted in a constant manner. There are besides other matters of detail for the apparatus of the highest importance. Thus the skeleton presents in such away special characters that by it we have succeeded in recognizing and determining fossil species. The muscular system rigorously follows the osseous system in its development, as in its degradation and its proportions. This is then the first animal apparatus, which, so to say, reveals a special plan for the species. The same might be established in regard to the organs, but it would be necessary to enter into anatomical details which, would be tiresome. I would willingly have spared the reader those that precede, if the nature of this work, and the exactness which I seek to give to my conclusions, had not forced me to enter in a detail of facts, instead of limiting myself to simple results.

We saw, in the commencement, that the school of Lamarck and the German pantheists assign as causes of the transformation of species, either the diversity of media, or the inclinations, wants, and desires of animals. All set out from this supposition, that each animal contains within itself, at least in the rudimentary state, all that is contained in all the other animals, or at least, according to Lamarck, in all the animals of its type. We have also seen that, in the same type, all the species have not either the same number of 'simple' and 'immediate principles', or the same number of organs, &c., and that successive transformations are an impossibility. A mollusk, which has no head would vainly change circumstances ; never would it have a head: a mollusk and an articulata, whatever the change of media and of determining circumstances, would never have a skeleton ; much more, a duck never would become a hen, or this latter, a bird of prey. Besides, the animal comes into the world already formed: it is developed in the egg, interiorly or exteriorly to its mother, according to the circumstances and media in which it is to live. When it comes to light, it has all that is necessary to satisfy its wants in the circumstances and media, far from which, however, it has been formed: it was complete before having in any way experienced their influence. It is then evident that the circumstances and media have no part in the organization, which is formed independently of them, and beyond the sphere of their action although in proportion with them.

All these considerations lead us to recognize the fact that there is neither unity of composition, unity of form, nor unity of plan in the animal kingdom; that, consequently, each animal is not the representative of the whole animal kingdom, since it is not even the exact representative of its own class; that in each individual we do not find the same parts as in other beings even inferior; that, consequently, all individuals have not proceeded from one single type, or from many primitive types, which are supposed to be the sole plan of all the animals of the whole animal kingdom; that there exists, on the contrary, a plan for each apparatus of organs; that the species is a definite reality; that the general plan of each type is modified in each group, in each species: that there are general and totally different plans for each grand type; that these plans tend to a whole as a general end, but do not form a sole plan; that, consequently, individuals are not the parts of one only being, of which they might be organs; but that they are mutually distinct and independent, definite and limited for definite and limited circumstances; in fine, that all these distinct and independent beings, which are never the less subject to the harmonious laws of relation and conservation, which bind them to each other, are the conception and production of the Supreme and Infinite Intelligence.

Geological Proofs.—If it is true, as pantheists assert, that the radiata forms and pairs are derived from the amorphous form, which is more elementary, by means of an indefinite number of ages; if all the types, all the classes have proceeded from one sole type, or from a small number of primordial types, the following geological consequences would follow from this manner of interpreting facts.

All these forms, all these types, all these classes, the appearance of which on the surface of the Globe would belong to such different and such widely separated epochs, would not be found gathered together in the primary layers of our surface.

We must only expect to find in them very simple organizations, and few species; because the deposition of these strata, in all continents, corresponding with the commencement of the first organized beings, these beings had not yet the time to be multiplied in their forms and species.

Our living genera and those which occur in the secondary and tertiary strata, ought not be found there.

The same genera, and especially the same species, ought not to be found at the same time, from these first epochs, on all the most distant points of the Globe, as in Europe and America, at the Cape of Good Hope and in New Holland.

The same observations apply to the vegetables contained in these first sedimentary strata of each continent.

In fine, the actual distribution of animals and plants in seas, rivers, estuaries, dry land, air, &c., ought not to appear at the same time as the first animal and vegetable forms, in a system which considers all the animal and vegetable forms as the slow and painful product of the efforts of Nature, by means of the change of media, of wants and of desires. Let us see if the facts are in harmony with these conclusions.

The primary rocks extend from the first deposits formed by water to the old red sandstone or grauwacke, and even up to the coal-formation exclusively. What is below the old red sandstone has received the name of Silurian: now it is principally in the deposits of this system that we are about to collect facts against pantheism. When indicating the points of the animal and vegetable series to which the fossils are referred, we shall take it in its ascending gradation, that is to say, in going from the simple to the compound or more perfect, these two terms being synonymous in zoology.

ANIMAL KINGDOM.—1° *Amorphous forms.*—The amorphous or irregular animals are wanting in what are called the primary rocks. This is a simply negative fact, because fossilization itself is an exceptional phenomenon. It will however be granted that this fact is not calculated to confirm the idea of the transformation of the amorphous form into the forms of radiata and of pairs.

2° *Radiata.*—The radiata form the second ascending plan and the second general type of animals. They are divided into five classes, which, with the exception of the araneidans,

—soft and easily putrescent animals,—are all represented in the primary rocks by species appertaining to the first as to the last divisions of each of these classes. The species of the lowest class, that of the zoophytes, do not occupy separate strata below others. There is a mixture in the same strata, in the same position; species of all classes and of all divisions of these classes; and consequently species of the most complicated, as well as of the most simple type.

Many species of radiata are common to many countries of Europe, and even to the Silurian-rocks of Europe and America. Such are, to cite but a few examples, in the class of the zoanthus, the *favestria helianthoïdes*, the *syringgopora reticulata*, the *catenipora escharoïdes;* in the class of the polypi,—the *facosites basaltica*,—a convincing proof that the same species were developed on several points at once; that, consequently, they were created there, and that they did not proceed from a primitive globule, one single original individual.

Moreover, a multitude of genera are found throughout all the strata, and many are still living. Among these last we may mention the genera *pentacrinites* (d'Orb.), *retepora* and *alveolites* (La.), and *favastrea.*

3° *Mollusks.*—The pair-form is divided into three types or plans of organization; the mollusks, the articulata, and the vertebrata. Fossils belonging to these three types are associated in quantity in the Silurian-deposits with fossils of the type *radiata.* They were not, consequently, transformations of these last mentioned, or derived from them.

The mollusks are divided into two great classes, which are perfectly distinct,—the acephalous or bivalves, which have no head, and the cephalous or those which have a head and are the most perfect of the type. In the first, the brachiopods are the most complicated species, and in that of the cephalous, the cephalopods are the most complicated species. Now the brachiopods and the cephalopods are as numerous in the lowest Silurian-strata as in the other strata; and they are even there represented by a greater number of species, than the simpler families or orders of the same two classes taken together. Thus the nautilides count more than 14 species, and the ammonites more than 30 in the lower transition-strata of Fichtelgebirge. These two families belong to the order of the cephalopods, which contains the most perfect beings of this type.

The mollusks are extremely abundant in the marine and estuary strata of all the epochs. Instead of presenting, throughout, the mixture of the most various genera,—of the most remote species, they should have left, at least in some points of the primary formation, marks of their successive transformations, and they should be found, at least sometimes, in an order analogous to that observed in the zoological tables of Lamarck. This, however, is not the case, as the facts just mentioned establish.

The same genera, and often the same species, have been observed on the most distant points of the Globe. The genus *orthis* belongs to Europe, to South America, to Vandiemens-Land; the *terebratula Wilsonii* (Sow.) is common to England, France, Sweden, and the State of Ohio; the *spirifer oblatus* (Sow.), brought from Vandiemens-Land, by the ship Labonite, is similar to those of Oïse in Belgium. The *calceola sandalina* characterizes the Silurian-strata of Zanesville, in the State of Ohio, as also those of several countries of Europe. Many primary genera belong to the existing animal kingdom. I have marked the following: *Perna*, *terebratula*, *avicula*, *turbo*, *turritellis*, *murex*, *buccina*, *nautilus*, *cypræa*, *patella*, *natex*. Our genus *terebratula* is represented there by more than 20 species.

4° *Articulata.*—The articulata are divided into ten classes; two only are represented in the primary formation, but one of these is the seventh of the type in the ascending order, that of the heteropods, and the other is the most perfect of all, that of the hexapods, or insects.

In the class of the heterapods, it is the order of the entomostracans and that of the branchiopods or trilobites that have been found in the primary strata of the Globe. In his history of living and fossil crustacea, Milne Edwards has distributed the trilobites into four families, comprising altogether 21 genera, and 134 species. All these genera and all these species, from the simplest to the most complex, are met with in our primary strata, which alone contain more than 77 species of this order of extinct animals.

The genus *homalonotus* (Kōnig) is common to England and to the mountains of Cedar-Berg at the Cape of Good Hope. The Silurian strata of America and those of Europe possess the genera *peltoura* (Edw.) *paradoxus* (Edw.) *trinucleus* (Murchison) *calimena* (Brong.) *asaphus* (Edw.) *isoletus* (Kay.), and many species of these genera are the same in the two continents. The entomostracans are represented by the genus *Eurypterus*, which is common to the transition-schist of Williamsville, on the shores of Lake Erie, to those of Westmoretand, in the State of New York, to the transition series of Podolia in Russia, and to the fresh water limestone of Burdie-House in Scotland.

The hexapods or insects are not numerous in the transition-rocks. Wings of butterflies and impressions of scarabean wings are, however, said to have been found in the aluminous slates of the mines of Andrarum, in the province of Scania in Sweden. These fossils were associated with trilobites. The scarabeus belongs to the order of the coleopteræ, which presents the highest organizations of the type of the *articulata*.

5° *Vertebrata.*—The type of vertebrata belongs also to the pair-form. It is divided into five classes, all of which have not been found in the primary formation. In it have been found fish, reptiles and their subordinate class the pterodactyls, which are precisely the classes the most likely to become fossilized. There are fish in the clayey-schist of Wenlock and of Dudley, in the lower part of the middle Silurian strata. It does not appear that their precise nature has yet been ascertained, and we consequently cannot say whether they belong to the osseous or cartaliginous fish. Agassiz has ascertained the presence of cartaliginous fish in the upper Silurian strata of Ludlow, Great Britain, and that of osseous fish in the lower stage of the old red sandstone of the same locality, as also in the schist subordinate to the old red sandstone of Ruppersdorf, in Bohemia.

In the fresh water limestone of Burdie-House, near Edinburgh, under the marine mountain limestone, numerous remains of reptiles and pterodactyls have been found by Hilberg. The reptiles belong to two different divisions of their class; they are the saurians, and marine and fresh water tortoises. The same observer has met with another species of chelonian or marine tortoise in the Kirkton limestone, near Bathgate, analogous to and parallel with that of Burdie-House.

Thus, all the types of the animal kingdom, with the greatest part of their divisions, and many in their most perfect and complete species, are represented in the primary series. There has not then been a transformation of these types or of their species into each other.

Vegetable Kingdom.—Vegetables are naturally divided into six great groups, four of which especially are very distinct and comprehend the greatest part of the actually living species; these are the agami, the cryptogami, the monocotyledons and dicotyledons.

The agami are represented in the primary rocks by two marine genera of the family of the algæ, the *gigartinites*, and the *amansites* (Brong.). They are common to the transition limestone of the isle of Linoë, near Christiana in Norway, and to that of Quebec, in Canada.

The vascular cryptogami form the highest general division of the second type of the kingdom; the equisetacea, the ferns, and the lycopodiacea, belong to it. Our formations contain terrestrial plants which all botanists refer to these families, such as the *calamites*, the *adiantites* and the *gleichenites* (Gopp.), the *cyclopteris* (Brong.), and the *stigmaria*. The primary calamites are found in France, Germany, and America.

The monocotyledons are represented in the limestone of Burdie-House by the genus, *cyperites* (Lindley and Hutton.), of the family of the *cyperacea*. In fine, the most perfect vegetables, the dicotyledons, existed in the primary epoch. Jackson has recognized the cactus in the anthracite of the grauwacke of Boston; he remarked also in it species of the genus *asterophyllites* (Brong.), an extinct genus of an uncertain family, but which Adolphe Brongniart himself considers as probable indications of dicotyledon plants.[1] Another species of this same genus has been mentioned, the *asterophyllites pygmea* in the transition rock of Berg-Haupten; but it is doubtful.

Thus the primary series contains the most perfect as well as the most simple types of the vegetable kingdom. We find in it the distinction of land plants, as the ferns, and of aquatic plants, as the algæ. On the other hand, we also find in it not only all the general types of the animal kingdom, with the exception of the most simple, that of the amorphous, but also the greatest part of the divisions of the types and almost always the highest or most perfect. On no point have we found indications of these pretended transformations of the more simple into the more complex species, not even in the distribution of the mollusks. On the contrary, we have found the most complex species, simultaneously existing with the simplest, and even in the fossil state before them, from the beginning. Everywhere the animals are associated with the vegetables; the animals and vegetables of the most simple types with the animals and vegetables of the most perfect types; the least complex with the most complex species. From this first epoch a great number of neighboring or identical species appear spread on the most distant points, in the South and North of Europe, in Europe and America, on these two continents and in New Holland. A number of genera traverse all the formations and furnish species of our actual epoch, as if the better to convince us that these great changes of media, which are supposed to have caused the alleged transformations, never occurred. From these first times of the world, the general distribution of species is seen to be absolutely such as we find it now-a-days. They were divided among the seas,—as the trilobites and the greatest part of the primary mollusks,—among the fresh water basins,—as the trionix and the saurians of the Burdie-House limestone,—on the dry land and in the air,—as the butterflies and the beetles. The same holds with regard to the vegetables. These species, this distribution,

(1) Prodrome.

these types, these general plans, are not, and could not be, the result of slow and successive transformations. What the anatomical inquiry demonstrates as to what remains of creation, geological facts demonstrate as to that which has disappeared: both hold the same language as Genesis, and with it teach us, that the vegetable and animal species are real, and that they have been established on earth by the Creator Himself.

Geology also shews that the change of media of existence, assigned as the cause of the transformation of species, has never taken place. No appreciable modification appearing in the respiratory organs of beings, from the most ancient to the present epoch,—a great number of genera having always remained with the same characters from the first dawn of animal life on our Globe to the present day, we must believe that the elements of life have not changed and that the media of existence have remained the same both on land and in the sea. The media of existence having always remained the same on land and water, no change of these media could have brought about the transformation of species and their succession of forms which the geological series presents to us. These observations are taken from the *Paléontologie Française* of Alcide d'Orbigny. If the late appearance, at the commencement of the tertiary epoch, of the mammifers, that is of the animals whose organization is the most perfect and the most delicate, be objected to Orbigny, he replies, that a change of media cannot explain this apparition of the mammals, since three hundred genera of all classes, of all modes of respiration, already existed at the tertiary epoch and have been perpetuated to the present day.

III.

Creation of Animal and Vegetable species in the adult or perfect state.

In genesis it is the vegetable itself that is created, and not the seed which is to produce it,—"the fruit-tree yielding fruit." The Creator commences by the end He proposes to Himself, by the result of His will, something perfect, the existence of a plant. As we also are obliged to begin the creation of beings by something perfect, we should believe that the Creator proceeded by the plant rather than by the seed. To suppose the vegetable creation in the state of seed is to return to the thesis of the creation of the world in its elements, and then the logical principle would oblige us to maintain that God created, not the seed, but—less than that,—the germs, the ovules, which is evidently absurd.

"Organized beings," observes Forichon, "that is, those which succeed each other and shew themselves to be the products of beings like to them, studied in the order of their apparition, in which they shew themselves to be successively effect and cause, all go back, to a first individual, without whom they would not have existed. They present a line of succession, which must be rigorously followed if we will know their origin, and beyond which it would be impossible to find their cause in the rest of Nature, so that their connection may be considered as an order apart, having its own independent existence.

"Although it were possible that organized beings were the result of some unknown laws of matter, as some writers assert, it would be, nevertheless, true that they manifest themselves by a filiation which supposes others of the same character, and preceding, to which is confided the power of begetting them, and that, out of this series, we can see nothing wherewith to replace them. In following the guidance of reason and science we are then forced to go back to a primitive being, who was subjected to special functions for the production of his descendants. Now the functions of a plant point to one only special end, to which they all tend and at which they terminate —the production of seed. This end being accomplished, the plant languishes or dies: and this seed contains within it all the parts of the plant which has produced it, and which, in certain circumstances, the microscope renders visible.

"The seed, on the contrary, does not tend to produce the plant, since it contains it already formed. The seed is a benumbed, folded being, awaiting favorable circumstances to unfold itself and exhibit its parts. The plant tends to represent itself by the seed. The seed by itself is not a being having functions: it is an interruption of functions, a sleep. Now no tendencies without acts: the plant itself alone acts; it alone exercises functions for the production of another being.

"The seed is so much a result that its formation demands the concurrence of two individuals, or of two organs. Then it was the plant that was created, in every hypothesis, and not the seed which it was charged with producing."(1)

Let us now pass to the animal kingdom. It is necessary to acknowledge that the different organized beings were created in the adult or perfect state. For if with regard to the mammals, for example, we suppose that the species were cast on the earth in the state of a *fœtus nascens*, it is impossible that they could have been developed, since, in this state, all are incapable of providing for their wants, and consulting for their preservation. Young animals need for sometime the care of their mothers; and this time is longer as the animals rise in the series. The same is true of birds. A great number remain in the nest until they have feathers and wings sufficiently strong to fly and seek their own food. Those which run, on issuing from the egg, stand in need of being often warmed by their mother. All the inferior animals in early life are exposed to a multitude of dangers, and are liable to the action of destroying causes so much the more numerous, as they are less perfect. For them also the adult state was then necessary in order that they might immediately be reproduced and perpetuated.

These facts attested by exact observation lead us then to conclude that all the animals were created in the perfect state, as stated in Genesis, and that they were from the beginning capable of fulfilling the law imposed on them by the Creator of perpetuating in time and space the work of the Creative Power.

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(1) Examen de plusieurs questions scientifiques.—1837.

CHAPTER XV.

Agreement between Science and Genesis as to the creation of certain animals in the domestic state.

Animal species.—We have seen that in taking the text of Genesis as it has been generally understood, it distinguishes very clearly the creation of domestic animals from that of wild animals. This tradition on the animal and vegetable species, established to be developed under the influence of man, and to serve his daily wants, was preserved even in paganism among the philosophers who admitted the creation of man in the social state and according to the image of the Creator. The domestic animals and agriculture being the base of Society, at whatever state of development it may be considered, it follows, that if Society is the natural and primitive state of man, there must have been, from the beginning, domestic animals and vegetables by creation; or,—what is the same thing,—created with a great tendency thereto, and only awaiting the action of man to become such. The absurd hypotheses which have prevailed as to the origin of man in the savage state, have given rise to similar suppositions regarding the original condition of the animals which are indispensable for man. No proof has ever been afforded of these hypotheses. They are, on the other hand, so entirely opposed to history, to the instincts and habits of the domestic animals,—and some of these species possess characters so essentially and exclusively domestic, that instead of establishing the original domesticity of these species by the creation of man in the social state, we might with equal force establish the creation of man in the social state by the domestic characters of these species, if the study of man himself and of his essential characters, did not furnish, as we shall hereafter see, the most complete and most rigorous proof that the social state is his first point of departure, and his only natural or normal state.

Sufficient attention has not been paid to the great difference between the domestic and the tamed animals. Almost all animals, even the most savage, may be tamed, but they are not therefore domestic. Domesticity appertains to the species; it belongs to its nature, its organization, and its instincts; it is a specific character which man may without doubt perfect, but cannot create; because it does not belong to him to change the nature of beings. His action extends to, and influences, the wild animals: he overcomes them, he tames them in individual instances; he may soften the ferocious disposition of the tiger and the hyena: but as the savage state is also a specific character, belonging to the organization and the instincts, whatever may be the number of individuals tamed, the species does not become domestic; it remains wild, and the tamed individuals do not give birth to a domestic posterity. Thus the tamed animals are individual results of the power of man,—results entirely independent of their nature and organization, whereas domesticity is in the nature, the organization, and the instincts of the animal. This fact shews that the domestic animals are so by nature, and that they were created in this state.

Hence it is only in domesticity that many of these animals can maintain themselves and that all are more easily propagated and more numerously multiplied. It is in this state that their forms are developed and perfected, while the wild animals languish and decay in it. Those even which, by their organic characters or instincts, approach nighest to our domestic animals, will not multiply in domesticity. The elephant, tamed from the most remote times by the people of Asia, has never multiplied in the domestic state. If at all epochs there have been seen tame wolves, foxes, jackalls,—they have never been found domestic, never have these species multiplied in this state; and the tamed individuals have always shewn, on fitting occasions, their natural ferocity and revealed their innate instincts. The dog, on the other hand, is born domestic, with natural talents, with an instinct that has not been learned which makes him capable of guarding a flock that his congeners devour, a house and a master with whose conservation his own appears to be bound up. The domestic species are so well adapted to this state that they are not found in the savage state, although, with the exception of the sheep, they are as strong and as well armed as the wild beasts for defence against their enemies. They are generally herbivorous,—are easily fed, and are docile and submissive, obedient and attached to man by nature. They furnish by their flesh, by their various products, by their size, their strength, the disposition of their members and the whole form of their body—all that he requires for his food, for his clothing, the carriage of himself and of his burdens, the culture and fertility of his lands, in a word, whatever is useful and agreeable to him.

The domestic species are: the dog, the sheep, the horse, the ox, and, probably, the goat and the camel; and among winged animals the house-cock. While briefly reviewing them, I shall shew that they did not originate in the savage state, that they have always been known in the domestic state, and that they possess all the characters of the domestic species. See for the details Blainville's *Osteotogie*.

The Dog.—The genus *canis* contains the fox, the jackall, the wolf and the domestic dog. Of the naturalists who determined to find in the savage state all animal species, some made the dog descend from the wolf,—others from the jackall, others have recognized many species of the domestic dog. Linnaeus, Buffon, F. Cuvier, Blainville, &c., have demonstrated that the domestic dog forms a unique species, entirely distinct from all others of the *genus canis*.

1° All the known races or varieties of dogs, notwithstanding the difference of their proportions, produce with each other and without constraint fruitful individuals, always resembling their parents, from which they seldom differ but by more or less imperceptible shades. They are then of the same species.

2° In the state of liberty, the natural antipathy and hatred which the wolf and the dog have for each other prevents them from approaching each other. It is only by bringing them together from the most tender age that they can be brought to live together, but without ever obtaining copulation. Notwithstanding all his efforts, Buffon failed in effecting it. Spontin had a she wolf which was familiar from her youth with a terrier: she had cubs by him, of which two were sent to

Buffon. This great naturalist describes his experiments on the products of these two individuals to the fourth generation. It results from his observations that the half-breed continued to approximate to the type of their grand-mother the wolf, at each generation. This difference between the products of a wolf with a dog, and the products of various races of dogs among themselves, proves that the wolf and the dog are distinct species. This is also proved by the fact of dogs placed in the wild state for more than twó hundred years in America. These dogs have not become wolves; while the pig, the cat, and the domestic rabbit in similar circumstances become boar, wild cat and wild rabbit. Moreover, the obliquity of the eyes of the wolf is peculiar to him; it is not found in any other race of dogs, or in any other species of this genus. The fact is admitted, but in the opinion of those who maintain that the wolf was the wild root of the dog, the rectitude of the eyes in this latter is the result of his habit of looking, at his masters face in order to comprehend his wishes,—a habit which is transmitted by generation. "If this is not a real begging of the question," says Blainville, "it is at least a very singular assertion, and is without support in any other analogous example. (1)"

3° Despite of all the efforts made by Buffon and others, the copulation of the fox and dog has never been effected. Moreover, by the dental system, the dog is distinguished from the fox and the jackal.

It results from these facts that the dog, in all his varieties, forms a unique species, a species very different from the fox, intermediate, so to speak, between the wolf.—whom it resembles by organization,—and the jackal, some of whose habits it has but perfectly distinct from the jackal and the wolf by its peculiar characters; having, physiologically, a prodigious aptitude for domesticity, and, physically, rectitude of vision, &c., and because it will not produce with any other species in a normal way.

The dog is met with among all people and in all parts of the world, and everywhere in the state of domesticity, perfected

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(1) Ostéographie.

in proportion to the development of human civilization. In America and other countries where it is now found in the wild state, the epoch can be ascertained when it began to live separate from man; but everywhere it returns to man with an invincible propensity.

It was found in the domestic state from the most remote antiquity and among all nations. We read of it in all histories, and in all the documents or monuments of the past, and always as the companion of man. Its name even in the ancient languages is a testimony of its perpetual domesticity; in Hebrew *kaleb* 'most affectionate,' in Greek *kuōn* 'caressing,' in Latin *canis* 'prudent or faithful.'

Every thing then concurs to prove that the dog has always existed in the domestic state. He is not an acquisition that man has made, but a gift of the Creator, Who has placed him in the hands of man to be one of the instruments of his domination on the earth.

The Sheep.—All the races of sheep have the power of reproduction among themselves, as the experiments of Buffon and many others prove; hence they form one single species. It is without reason that the sheep has been said to descend from the goat, or the mouflon, or the argali. The sheep never unites with the goat, except by constraint, and the product is always sterile. The goat and the sheep are then two distinct species, between which no intermediate species has been produced. The argali and the mouflon approximate more closely to the goat, and even to the stag, than to the sheep. Moreover, the sheep differs from these three species by its instincts, its habits and almost all its physical characters. Were the sheep descended from the mouflon or the argali, how would it have lost its instincts and its natural habits, to assume those of an entirely opposite character, whereas the goat, domesticated from the most remote antiquity, has preserved all those of its savage origin?

"If we consider," says Buffon, "the weakness and stupidity of the sheep; if we remember also that this animal, which has no natural means of defence, is unable to seek its safety in flight; that its enemies are all the carnivorous animals, who appear to seek it in preference to other prey, and who devour it voraciously; moreover, that this species produces little and that each individual is short lived, &c., we shall be disposed to imagine, that, from the beginning, the sheep was confided to the charge of man, that it had need of his protection and of his care in order to multiply, since in fact we do not find wild sheep in the desert; that in all places where man has commanded, the lion, the tiger, the wolf reign by force and cruelty; that these animals of blood and carnage live longer and multiply much more than the sheep, and that, in fine, if the numerous flocks of this species which we have so much multiplied were abandoned now on our plains, they would soon be destroyed under our eyes and the entire species annihilated by the number and voracity of the hostile species.

"It appears, then, that it is by our aid and our care that this species has been perpetuated, and that it subsists and will continue to endure: there is then every reason for saying that it could not subsist by itself. The sheep is absolutely without resource and without protection; the ram has only weak arms; his courage is a momentary petulance, useless for himself and troublesome to others." "They are of all quadrupeds the most stupid, the most devoid of resources and of instinct. The goats have much more sentiment; they can guide themselves; they can avoid danger, whereas the sheep cannot either flee or evade it. Whatever need it has of aid, it comes not to man as willingly as the goat; and, what in animals appears the last degree of timidity or insensibility, it lets its lamb be taken without effort to protect it, without passion, without resistance, and without expressing its sorrow by a cry differing from its ordinary bleat.

"But this animal, in itself so insignificant, so destitute of feeling, so wanting in interior qualities is the most precious animal for man; that whose usefulness is most immediate and extensive. It would appear as if nothing had been given to it, but what it surrenders to man." (1)

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(1) Hist. naturelle de la brebis.

The species of the ram and the sheep is distributed in all the climates of Europe, Asia, and Africa, and nowhere is it found in the wild state: it was not found in America, or in any other part of the newly discovered countries. It has been known in all times among all the ancient people. There is mention of it, as a domestic animal, in the history of our first parents. Abel was a pastor of sheep, and Cain a tiller of the earth. (1) It is also the first animal that appears in the religious rites as victim for the sacrifices. Its nature and its instincts do not permit it to live or perpetuate itself independently of man. We must then admit that it has been created at the same time as man and for man.

The Ox.—The genus 'ox' contains six species; the domestic ox, the Indian buffalo, the South African buffalo, the bison of America, the yack of Northern Asia, the aurochs or European bison, which is only found and that rarely in the Crapak mountains, in Moscovy, and perhaps in the Caucasus.

All these species of the ox are more or less domestic in the countries they inhabit, with the exception of the aurochs, and perhaps the bison of America. None of them, however, is so strictly domestic as the ox properly so-called, and, like all other really domestic species, it contains a much greater number of varieties and of races than all the preceding species.

The ox did not originally exist in the savage state. All acknowledge that he is specifically different from the yack and the buffalo, which do not resemble him; and which do not multiply with him. Neither is he to be confounded with the bison of America, although, under the influence of man, they unite, and produce as it appears half-breeds. In fine, the aurochs, as well by its anatomical as by its external characters, its instincts and its habits, forms a distinct species.

There has been found in our strata a fossil species which has been regarded as the savage original of the domestic ox, and which was formerly known in the forests of Gaul and Germany by the name of bison. The resemblance, however, of this fossil with our ox, is not clearly established: and were

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(1) Gen. III. 2.

it ascertained, we might with equal probability assert, that the pretended wild ox had abandoned the domestic state, as we shall see was the fact in regard to the oxen and horses of America.

However that may be, we are none the less obliged to acknowledge that the ox has been a domestic animal from the origin of the human race. As the dog and the sheep, we find him everywhere with man, from the most remote antiquity, and everywhere constituting the base of agricultural labour. The nomade tribes, no less than those having fixed habitations, have always seen in this animal one of the principal sources of their wealth; and hence, doubtless, the reason, why it became with the Egyptians and the Hindoos the object of a particular worship. It appears with man in the earliest countries he has inhabited; and in these most distant from the point of departure of the human race and the last subdued by him, the ox was not to be found, but was brought thither at a later period. Neither South America nor New Holland possessed, at the time of their discovery, any species of this genus. It is very remarkable that there is never question of the wild state of the ox among the ancients, unless we except the oxen of the isle of the Sun in the Odyssey, and they were said to be confided to the care of some divinity. Every thing, then, combines to prove that the domestic ox has been always subject to man.

The Horse.—The genus 'horse,' consisting of five species, is found entire in the ancient continent, that is to say, in the countries whence the human race has spread itself over all the earth. They are the mule, the zebra, the couagga, the ass and the horse. The races or varieties of the horse,—more numerous than the countries inhabited by the species,—in whatever manner they may be crossed, all produce individuals perfectly like their sires, and capable of perpetuating themselves. On the other hand, the horse and the ass produce mules, which are not like their parents. The few efforts that have been made to join the horse and the zebra have also established the difference of these species. The horse is the *one* species in all its varieties, and perfectly distinct from the other species of the same genus.

In the highest antiquity we find the horse in the domestic state. It was always regarded as an animal created for the glory of man, to serve him in war, and to bear him in triumph in all parts of his empire. The beautiful description which Job has given of him, and which Buffon has imitated, exhibits him to us not as an acquisition of man, but as a gift of his Creator. Asia, Arabia, Palestine, Media, and Persia have at all times possessed the most noble and most spirited races of this species. In these countries it has preserved its type of elegance, of beauty, of vigour, and of swiftness, without there being any need, as elsewhere, to cross the breeds in order to improve them. There, on the contrary, the descent has been preserved without mixture. The horse of Juda, the steeds of Solomon, the horses of Cyrus have not degenerated. Africa and Europe received their horses from Asia. They have followed the Europeans to America, where the aboriginal inhabitants had not brought them.

Herodotus appears to be the first who spoke of the wild horses that were found on the borders of Hypanis in Scythia. Aristotle speaks of those of Syria; Pliny, of those of the Northern regions; Straba, of those of the Alps and of Spain. The wild horses of America were transported thither by the Spaniards. But the Bible, and Homer, and all the most ancient authors, speak only of domestic horses. According to Homer the finest races of horses are the gifts of the Gods to man.

The horse, then, appears to have existed in the domestic, before there is question of him in the savage, state. It is in domesticity, that he acquires all his beauty and all his perfection. His wild state does not resemble that of any other species;—he lives there in a kind of society, and as soon as the hand of man touches him, he recognizes it, quits the desert, gives up his liberty, and, after some care bestowed upon him, thinks no longer on his wandering life. Domesticity is, then, natural to the horse; he has been made for it. Like the dog, he follows man everywhere he goes. Half-wild among the people who have renounced civilization, degenerate in the countries where man has left and forgotten him for a while, he perfects himself where civilization prizes him and knows his just value.

The genus 'camel' comprehends two species, which are perfectly distinct; the camel which has two humps, and the dromedary which has but one. This genus is nowhere found wild, but is at all times found in the domestic state.

The camel, properly so-called, is most frequently found in Bactriana of the ancients, now called Turkestan. He loves this temperate climate, but he can support a more rigorous one, since the Buretes and the Mongols lead him to the environs of Lake Baikal. He is also found in Thibet and on the confines of China. Wherever he is employed, the dromedary is unknown. On the other hand, in the South of Persia, in Arabia, Egypt, Abyssinia and Mauretania, the dromedary alone is found. This animal frequents warm climes, but shuns those where the heat is excessive. In Africa and India he disappears; he cannot subsist under the torrid zone or in our temperate climates.

It is very remarkable, that the organization of these two species is in conformity with the countries they inhabit, and the wants of man in these climes. The dromedary furnishes food and clothing to his master. The Arabs look on him as a present from Heaven, without which they could neither travel, nor carry on commerce, nor subsist. With their dromedaries they want nothing and they fear nothing. This animal is the only means of communication between Egypt and Abyssinia, between Barbary and the countries beyond the Sahara, between Syria and Persia. Without him Arabia would be absolutely isolated from the rest of the world.

The genus 'camel' has always been the link of commerce between all parts of Asia and Africa. He has remained as a witness in the countries where man first appeared. Created for man and for that country, it is impossible not to see in him one of those typical forms which bear the impress of their domestic origin and the mark of their destiny.

Carrying our researches further we shall find other animals in the domestic state in ancient times: among other quadrupeds, the goat, the ass; and among the birds, the domestic cock: but they already appear less decidedly domestic than those before referred to, and besides there is every appearance that these species, except perhaps that of the hen, are also found in the savage state.

Vegetable Species.—In the Sacred Cosmogony there is no mention of plants created in the domestic state. We may, however, be certain, according to Genesis and our own scientific researches, that the savage state is no more the primitive state of certain vegetables than it is of man. Merely to be preserved in the domestic state, they had need, as at the present day, of human culture.

We read in Genesis that God gave as food for our first parents and for the animal kingdom all grass and all trees producing their seed. From that time, then, and anteriorly to any culture, there were either herbs, grains, or roots, or seeds, or fruits—fitting to serve as food for man. In the second Chapter of Genesis the inspired writer describes the earthly paradise planted with all sorts of trees, bearing delicious fruits. *Omne lignum ad vescendum suave.* There were, then, trees in the domestic state, the succulent fruits of which were not the result of human labour. After the fall of man, God said, "thou shalt eat the grass of the field,—in the sweat of thy brow thou shalt eat bread." Here 'the grass of the field' designates the cereal plants, as is proved by the agricultural life of Cain, and the fruits of the earth offered by him to the Lord, and the implements of husbandry invented or perfected by Tubal Cain, one of his descendants. It appears, then, certain, according to Genesis, that the first men had not to bring back all the plants from the wild state and make them domestic, but to maintain, by art and labour, in the state of domesticity those most necessary for the support of life. This is real vegetable domesticity, for the idea of domesticity implies not only the destination of the domestic species for the service of man, but also the need of man's care in perpetuating this species and preserving it in its original perfection.

Reason, observation and history are in accord with Genesis on this subject. Reason tells us that man having been created in the social state, and agriculture being the groundwork of that state, he ought, in appearing in this world, to have found domestic plants as well as domestic animals, specially created for his service ; and among these plants,—many of which may also have been perpetuated in the wild state, wherever they found a soil and climate favorable to them,—experience and history bear witness to wheat, as uniting in the highest degree the characters of vegetable domesticity.

In Sicily, formerly celebrated for its fertility in wheat, there was, according to some writers, a soil which produced without any culture. Others deny this, and assert that the wheat is the dog-grass perfected, or some other neighbouring cereal. The truth is, wheat forms a distinct species. The substances which analysis has discovered in it are the amidon, sweet mucus and gluten. This gluten, which predominates in the confection of bread, is exclusively found in the wheat, and there is not an atom of it in any of the other grains of the graminous family.

Were we to judge by analogy we should conclude that wheat comes to us from upper Asia, whence we have also received rye, oats and barley. Nowhere has it been found in the wild state; it grows equally well in cold and warm climates, but it requires culture in order to be perpetuated. From the time of Abraham Genesis makes mention of wheaten bread, but it supposes that it was known from the beginning. Under Jacob, the grandson of Abraham, the wheat harvest failed for many years successively in the land of Canaan, and famine forced this patriarch to send his sons to Egypt, where their brother Joseph, foreseeing this famine, had accumulated grain in the public granaries. In a word, wheat does not exist in the wild state; nowhere will it grow and perpetuate itself without culture. On the other hand, we find it with all the most ancient people: and consequently conclude that this plant has never existed in the wild or savage state.

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CHAPTER XVI.

Agreement of Religion and Science on the dogma of one sole Creator and Ordainer of the world.

The creation and arrangement of the world by the intelligence and will of One Sole Omnipotent Being, is the fundamental principle of the record of Creation, and of the whole Book of Genesis as of the Religion of the Jewish People. This is an unquestioned truth; and the constancy with which this people, at all epochs of its history, protested against polytheism and its deplorable consequences, is one of their proudest titles to the gratitude of the human race; for the doctrine of one only God, Creator and Ordainer of the Universe, is the basis of all morality among men. We have only then to verify on this point the accord which exists between Genesis and Science. To this end we have to answer the following questions:

Organized beings present to us three great primitive sections perfectly distinct, whence result three great categories of beings, called the vegetable kingdom, the animal kingdom, and the social or human kingdom. Does Science require three distinct and independent creations of these beings?

There are five grand series in the animal kingdom, and six in the vegetable. Do all these series enter into the same general system of creation, or must we recognize as many different creations as there are series?

There are fossil animals and plants, of which great numbers belong to extinct species: are they the remains of a former world which preceded ours, or do they belong to the same order of things as now exists? do they enter into the same plan and the same series as living beings?

Three other divisions of the natural world are now recognized: the elementary, the mineral, and the sidereal creation: are they part of a universal creation, implying one general plan, one single conception, and consequently one only Creator and

Ordainer? or were the other kingdoms absent from the thought that conceived and formed these last.

If facts prove that all the extinct species are referred to our actual natural kingdoms; that these kingdoms, as well as the inorganic divisions, are established on plans conceived beforehand; and that all these plans combine to form one sole world, we must infer that the Universe is the work of one only Creator,—a conclusion which is identical with the revealed fact.

I.

Animal Kingdom.

All the living species of this kingdom are distributed on a linear plan, which is called a natural classification or animal series. The animal series has been clearly established by Blainville, during many years, in his course of anatomy in the Garden of Plants, and in his course of zoology at the Sorbonne. The limits of this work do not permit me to reproduce this series in all its details: it will be found with its appropriate developments in the works of this great naturalist. I shall confine myself to stating in what it consists, by what principles it is established; and shall shew that its discovery is not the work of a single individual, as is thought by some who have studied it without entirely understanding it, and who imagine that it is not conformable with the progress of science, because they may oppose to it some facts which do not conflict with it, and of which Blainville was perfectly aware.

I.—*Plan of the Animal Kingdom.*

The plan of the animal creation was long since felt and perceived. The ancients had an idea of this ascending order of beings—this gradual perfection of species. The Stoics and Pythagoreans compared the animal series to the diatonic scale. Aristotle remarked that nature passes from animals to bodies without life by living beings. Towards the close of the 4th. Century, Nemesius, Bishop of Emesa, went much farther than the Stagyrite. He perceived the natural order of the animal kingdom and the two great principles on which it is established, sensibility and motion. "The Supreme Ruler," he observes, "in passing from plants to animals has not all at once bestowed progression and sensibility, but imparts it gradually and by intermediaries. Thus He has made the actinea, a marine species, which are as it were, sentient trees: for on the one hand, He has planted them in the sea, where they adhere and are immovable as vegetables, and on the other, He gives them the sense of touch which is common to all animals. Then, in dispensing to certain animals a greater number of senses and in giving to others more powers of locomotion, He brings by degree to the most perfect species, those which possess all the senses and pass over more space." (1) Albert the Great, Bishop of Ratisbon, not only saw progressive organization in the animal kingdom, but he calculated the greater or lesser perfection of organized beings. He sought even to establish a series, and if he did not entirely succeed, because he attributed too much to motion, he laid down the principles by which it would afterwards be established. He was the first to employ the words, degrees of perfection—"*de gradibus perfectorum et imperfectorum animalium.*" In the 16th. Century, Gesner also admitted an order in organized beings. About the same time, the Jesuit Nieremberg thus expressed the idea which he entertained of this scale of perfection, and of the connexion of beings. "Nature ascends gradually and without abruptness: she proceeds in a continuous route by imperceptible transitions: there are no lacunæ, no breaks, no isolated forms. They are reciprocally united as the links of the same chain, and this golden chain embraces all things." (2) When philosophy was rejected by Science, the animal series which is inseparable from it was also rejected: but Buffon re-established it, while opposing it. It was so evidently true that Lamarck took it up and incorporated it in his epicurean philosophy. He was determined to find in it the effect of circumstances and habits, in place of recognizing in it the plan of the Creator. This was an absurd solution of the problem. La-

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(1) De natura hominis. Cap. I.
(2) Historia Naturæ. Lib. III.

marck involved the animal series in the ridicule which was so justly heaped on himself. The pantheistic Naturalist then endeavoured to find a satisfactory solution, but with as little success as Lamarck had done; because each part did not represent the whole, all forms do not proceed from a single form, the species have not been produced by one or other species, and there is no insensible transition from one type to another, —propositions which the pantheists assumed as principles. For them as well as for Lamarck the series was not susceptible of demonstration. Still these efforts in a wrong direction were not without their advantage; they shewed more and more clearly that there was a real plan of organic kingdoms, that this plan implied the doctrine of a Creator and Supreme Disposer of all things, and confirmed the beautiful theory of final causes. Inheriting the conception of his most illustrious predecessors, and possessing all the facts which the progress of science had accumulated, Blainville appeared at the proper time, to demonstrate completely and in all its parts the plan of the animal kingdom. It is not then suddenly, or by the efforts of a single man, that zoology has reached that degree of perfection which establishes it definitively; there were required for this result the successive efforts of a number of great naturalists, from Aristotle to Blainville. This simple review clearly shews that the zoologists who reject the series are imperfect; they lack studies and elements to see it, and principles to establish it. Like every real progress attained in any department of general science, this beautiful result of human industry shews us that the world has been created by an Intelligence for other intelligences, and as a mirror placed between them and the Creator, that from the consideration of His work, they might rise to Him by thought and sentiment. But in the present state of natural science nowhere has this end been more completely attained on so large a scale as in the animal kingdom, and by the demonstration of its natural classification. Here you read the work even in its most minute details, you distinctly see the place of each organized being in the Divine Plan, and the natural relations of the particular plan of each species with the media of existence and with all the laws of the physical world.

The plan of the animal kingdom is then in relation with the faculties of our intelligence, since it has been able to discover it, to note its laws, and to make it as it were its own possession. The animal kingdom, like all other divisions of nature, tends then to end in man. It requires a being capable of comprehending this wonderful concatenation of beings and their relations. Without this intelligent observer, God would have had no end in manifesting His power and His infinite perfections. Man, an intelligent being, moral and religious, and of all who make part of this world alone able to understand its laws, appreciate its harmonies, glorify their Divine Author, is then the rigorous consequence of the creation and final end of God in His works, as Religion teaches us in the history of Creation.

Let us now see what is the plan of the animal kingdom, and by the aid of what principles its existence is established. The vegetable kingdom is organized, lives and reproduces itself; the animal kingdom is organized, lives, reproduces itself; feels, moves, has the consciousness of its existence; the social kingdom is organized, lives, reproduces itself; feels, moves, is intelligent, perfectible, moral, social and religious.

In this ascending scale the animals are intermediaries between the vegetable and man: the comparison of these two extremes gives the general order in which they should be ranged. The more the animal approaches the human form, the higher his rank in this order; the more he approximates to the vegetable form of existence, the lower will be his rank.

The essential character of animals is sensibility, and if there are degrees in this character, we understand that they must form a series of beings more or less perfect,—from that which most nearly approximates to the vegetable to that which most closely approaches man. Such is the fact: the senses lose in going from the higher to the lower animals; they are not appreciable in the sponges, where the existence of the nervous system is established by analogy rather than by observation. Hence, where the nervous system is most developed, the animal is highest, so that one can serve to measure the other. It is then in the development of this system that we must seek the characters of the classification of animals, and, according to the degree of perfection which is observed in the senses of the various orders, establish the zoological scale.

Are there exterior characters representing sufficiently these various degrees of animal life to enable us to read them without recurring to anatomical dissection? Yes, without doubt. The brain, and especially its forward part, constitutes the nervous system of reflex sensibility or instinct. The cranium gives the general form of the brain, the anterior part of which is indicated by the development of the forehead. We have, then, here an exterior zoological measure of reflex sensibility. The organs of the senses, being necessarily in relation with the exterior world, are necessarily placed outside the organism, on the skin of the animal. They indicate then the nervous system of the general sensibility. The skin limits the animal in space, and determines its form in direct relation with the form and disposition of the nervous system: the form is then the exterior exact representation of the fundamental character of animality.

Sensibility implies the faculty of moving in place. According as a being perceives objects or circumstances favorable or unfavorable to his existence, he will either approach them or flee from them; for without this sensibility would be a useless faculty, a needless torment: the sentient being would resemble Tantalus, plunged in water up to the lips without being ever able to slake his thirst. The power of moving from place to place is, then, a rigorous consequence of sensibility, so that we may often supply the exterior characters of this latter by those of the former. Sensibility and the power of locomotion, expressed by their exterior characters, are then a zoometer, by means of which it is easy to appreciate the degree of elevation of each animal and to read the series. In fine, as a last consequence of the same principle, all the other organs of the animal system furnish exterior characters of more or less value, according as they borrow more or less largely from sensibility and locomotion in exercising their functions, since by this means the functions become more or less animal.

The highest species of the vegetable kingdom appear, however, more perfect than the lowest of the animal kingdom.

They are so in certain respects: but the lowest animals are endowed with sensibility; and by this character of highest value, they necessarily surpass the most perfect vegetables. Moreover, as throughout the rest of his organization the inferior animal belongs to his type, as the highest vegetable to its type, and that the lowest type of animality, taken in its totality, is higher than the highest vegetable type taken in its totality, it follows, that the lower animal must rank higher than the most perfect vegetable. This principle may be applied in the animal kingdom to classes of different types compared with one another. For example, in the type of mollusks, the class of cephalids appears higher than the lowest classes of the following type, that of the articulata, but much lower than the highest. Besides, it belongs to its type by all the ensemble of its organizations, and as this type is below that of the articulata, it follows that the cephalids should be in this place. They prove that the passage from one type to another is impossible: and that, consequently, the series is neither arithmetical, nor geometrical, nor logarithmal, but animal.

All the organs of animals are in constant relation of position, of disposition, of structure, of function with all the laws of the physical world; the number of special senses corresponding so perfectly to all the qualities and properties of bodies, and the apparatus of which is complex or simple, according to the circumstances in which these animals are to live, are, from one extremity of the series to the other, a continual refutation of the error of the materialists, who have repeated after Lucretius, that the eyes were not made to see, nor our other members made for the use to which they are applied; but that we have applied them to these purposes because we have found them made. It is obvious that they must have been adapted to the purposes to which we have applied them; and thus final causes return upon us by the very argument by which they are sought to be rejected. But if all the modifications of organism admirably prove final causes, by shewing that the animal kingdom, in its details as well as in its totality, has been conceived and calculated for various ends and purposes, in relation with all the rest of creation, we must nevertheless remark, that all these modifications are not equally serviceable in establishing the series; and we must distinguish modifications which are essential, profound,—influencing more or less all the species of a type or class for a general end,—from those which are more superficial, and simply in unison with certain organs in all the groups of animals, according to the various circumstances in which different species were destined to live. For example, the place in which an animal is to look for his food will produce, in the same group or the same degree of organization, modifications which are simply harmonic. Thus the insects dwelling—some on the earth, others under the earth, others in the water, others in trees and others in the air, there will be in the animals which feed on them secondary modifications, which will be superadded to the essential normal character of the group, and which will not prevent these animals from being included in it, because they belong to it by their structure, their composition, and the distribution of their parts. The mole which seeks worms and insects in the interior of the soil has the muzzle lengthened in taper form, and the paws made for digging the earth and as it were swimming in it. The *mus araneus* which seeks its food in the water, has its feet palmated, and moves its tail as an oar: an African species of this insect feeds on grasshoppers, and has its hind members lengthened so that it can leap as well as its prey. Other insectivorous animals, being intended to pursue their prey through the air, have their anterior members modified as wings wherewith to fly, as the bats which are mammals of a high order. Among the lower apes, the galeopithecos has the whole body enveloped by a winged membrane,—extending from the arms to the thighs. This membrane also exists in the squirrels these animals use it as a parachute, in leaping from one tree to another. It would be impossible to rank them with the birds, because they are in every respect mammals. Neither could we make them a group passing into the birds; since, by all their organs and all their functions, they belong either to the apes, to the insectivori, or to the rodentia. There remain then merely harmonic modifications which have so adapted the various species of groups to the various circumstances of the

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physical world. Analogous modifications are found in carnivorous animals. The seals, the otters which are veritable castors that feed on fish, have their members disposed as fins as also the tail, and their hearing organs are almost null. The sea-elephants, which are pachydermata living in the water, are modified as the seals. All the cetacea, which are aquatic mammals, are still more profoundly modified, and are like fish ; but they naturally breathe air ; and hence the modifications in all the apparatus of respiration to permit them to dive. The trunk of the elephant, terminating in a species of finger, is a modification of the snout, analogous to the preceeding ones. The enormous size of the head requiring a very short neck to support it, it was necessary to arm it with a trunk capable of gathering the grasses and the branches of trees on which the animal feeds. In a word, there are harmonic modifications in almost all the classes of the series.

Such are the principles by means of which Blainville has demonstrated the plan of the animal creation, the laws according to which organism diminishes, and is modified in accordance with peculiar circumstances and a definite end. In applying these principles he has discovered and indicated the place which animals occupy in a single line or linear series in an order of ascending gradation, from the sponge to the quadrumanous animals, and, descending, from the ape to the sponge, which forms a kind of passage to the vegetable kingdom. Here commences another series, the vegetable, also linear, in the demonstration of which naturalists are at present occupied.

II.—*The extinct fossils belonged to the same series as the living species.*

It was objected to the linear series of the animal kingdom that there were gaps and hiatus' in it. Such, indeed, is the fact: but only for certain epochs of the duration of time and relatively to the actual state of our knowledge. We are certain that these places were not always vacant ; it cannot be affirmed that any void or gap actually exists ; for naturalists are not acquainted with all living animals, and the new species which are often discovered naturally find place in the series and fill up its gaps. Thus the echidna and the ornythorinx of New Holland find their place between the mammals and the birds, and form a connection between these two great groups. The series, however, becomes complete by the extinct species which geology has brought to light. All who have studied paleontology have referred to the types and classes of living nature the beings whose remains are found in our strata. By giving here the list of their names I do not pretend to discharge my obligations towards men without whose labours mine would have been impossible; but I ask, that, this enumeration of learned men, representing all parts of Europe, and, despite of the difference of their religion and of their systems, agreeing as to the relations of the paleontological with living beings, may dispense me from giving the zoological proof of these relations, and from entering into details which would fill many volumes. Klein, Buffon, Pallas, Scropoli, Lamarck, Cuvier, Lamouroux, Goldfuss, Blainville, Alexander Brongniart, Desmarest, Desmoulins, Marcel de Serres, Deshayes, Lund, Brullé, Lazier, Parieu, Agassiz, Desor, Kaup, Straus, Owen, Christol, Munster, Eudes Deslonchamps, Lartet, Michelin, Beehrenot, Ratke, Ehremberg, Cotteau, Hébert, Debuch, Gras, Milne Edwards, Haime, Eichwald, Horner, Germar, Schmerling, A. d'Orbigny, Bayle, &c.,—all acknowledge, that the fossil animals did not belong to a separate system, that they did not form particular and independent series, which might be placed before or after the great living series, but that they have reference to all the points of this same series, and, throughout, form intermediaries to it and fill up its voids. I shall cite but a few examples, taken in the different classes; and, in order to render the relations more sensible, I shall place in series, in synoptical tables, the living and the fossil species, italicizing the names of the latter.

MAMMALS.

Plantigrades.		Blaireau
		Taxotherium.
		Midaus.
		Phocyon.
		Paleocyon.
		Coati.
		Kinkajou.
		Amphicyon.
		Hyœnodon.
Pachydermata gravigrades.	Terrestrial......	Elephant
		Mastodon.
		Telracolodon.
	Aquatic..........	Lamentin
		Metaxytherium.
		Dugong.
Tardigraves.		Sloth
		Cochlodon.
		Hoplophorus.
		Chlamydotherium.
		Armadillo.
		Megatherium.
		Megalonix.
		Ant-eater.

The pachydermata constitute the transition from the carnivorous to the herbivorous ruminant animals. This order does not count more than twenty living species, distributed into seven genera, comprizing the elephants; whereas it possesses more than twenty fossil genera, which fill up the gaps of the series, and form new connexions to bind together the living species with each other. The *mastodon* and the *tetracolodon*, two new subgenera of the elephant, were furnished with a trunk like him, and were even more aquatic than he. The *metaxytherium*, a herbivorous cetaceous animal of the family of the dugongs, is still another link, serving to connect the lamentin with the dugong. It is as near the dugong as one genus can be to another. The species which follow have been only found in the bone-caverns of America, and have only relation with the living species of that continent. Thus the *cochlodons*, the *hoplophorus* and the *chlamydotheria*, find place near the family of the sloth, with which they present remarkable affinities. The megatherium, an animal ten feet long and eight feet high, was a giant armadillo, but he forms a new division in that genus. He had the head and the shoulder of a sloth; his legs and feet presented a singular combination of characters peculiar to armadillos and ant-eaters; he had a tessellated osseous armour as the armadillo. In fine, the *megalonix*, resembling the megatherium by his figure and head, formed an independent genus approaching him, and passing into the ant-eater. This type was intermediate to the ant-eater of the new world, which has no teeth, and the ant-eaters of the old world, which have teeth, as also to the *megatherium*.

All the living orders in the great class of the mammals, all the families, almost all the genera, are represented in the geological strata by a number of species more or less considerable, and often by species which are at once fossil and living. Such are four species of the bat,—the European mole, four species of bears, the blaireau, the greater part of castors, many of the genus felis, the fox, the wolf, the dog, the jackal, the elephant, the rhinoceros, &c.,—the identity of which in the living and fossil state have been demonstrated by Blainville. There are many extinct genera, but these genera occupied the same position as the species of the living genera; they are associated in the same quarries with the remains of living species. The lost species have, then, been cotemporary with the living species; they have lived on the same soil, dwelt in the same countries, made part of the same world—of the same creation. Thus they fill up the gaps of the actual animal series, and belong to its orders, its families, its genera.

Birds.—Birds form so natural a family that it is hard to distinguish them in the fossil state unless we have the beak, the sternum and the toes entire. We have, however, in this state more than twenty genera, which, for the most part, appear identical with, or at least analogous to, living genera. This class is represented in the Wealden sands by some cranes in the tertiary gypsum, by sparrows and nine other species, both rapacious and gallinaceous or palm-footed; and in the caverns and the breccia by species of all families. All these fossils belong to the same system and to the same types of creation as the living species.

	CLASSES.	ORDERS.
	Birds.	
Group of Reptiles..........	I. *Pterodactyls.*	
	II. Reptiles proper or Scutiferæ.	I. Tortoises. II. *Plesiosaurians.* III. Emidosaurians or Crocodiles. IV. Saurians or Lizards. V. Ophidians or Serpents.
	III. Amphibious reptiles or nudipelliferæ.	VI. Batracians. VII. Pseudosaurians (Salamanders.) VIII. Pseudosophidians. *Lepidosirens.*
	IV. *Ichthyosaurians.*	
	Fish.	

This table proves anew that the fossils form part of the zoological series, and that the existence of all animated beings, realized on a single plan, is the effect of the omnipotent will of one sole Creator and Ruler.

The reptiles with the amphibious animals are divided into many classes, all which find place between the birds and the fish and form in the general series a sort of transition group. Now there have been found in the fossil fauna species belonging to all the genera of these classes, and some of which are still living; extinct genera which fill up the gaps in the types, and form new divisions; and, in fine, new orders and new subclasses, which connect the living orders and classes, by occupying the spaces that separated them.

There existed formerly between the birds and the reptiles properly so-called a subclass of animals, which are only known by their skeletons, preserved at great depths in the strata of the earth, and to which the name of *pterodactyls* has been given. They were a kind of amphibious reptiles; partly swimming in water, and partly moving on the earth; they had a long neck like the birds, a large beak, and teeth like reptiles. They lived probably on fish and perhaps on vegetables. The pterodactyls have been found in Scotland and in Bavaria, from the lower strata of the mountain limestone to the middle oolite, where they abound. There are only eight or nine species of them known. After these animals, which connect the class of animals with that of the scutiferous insects, we have the fossil order of the plesiosauri, which unite the tortoises with the crocodiles. The extremities of the plesiosauri were real fins, similar to those of the cetacea; their neck, terminated by a small head, was of disproportionate length, and consisted of at least eighty vertebræ. The body was very broad and almost orbicular, as are the tortoises; and the tail was adapted for swimming, like that of the crocodiles. Five or six species have been distinguished, some of them twenty feet long. The plesiosauri are very numerous in the muschelkalk, and they are found also in the lower chalk.

The group of reptiles had lost its first and last link; it has found its first link in the pterodactyls and the other in two genera of animals,—of which one is living and has been lately discovered, the *lépidosirène*, and the other is fossil, the ichthyosaurus,—which form the transition from the amphibious animals to the class of fishes, and probably indicate a sub-class at the head of these latter. The lépidosirène has the skin bare, as the amphibians, but the derm is enveloped in a sort of scale which defends it. It is the last of the amphibians and not the first of the fishes. The ichthyosaurus,—with the lizard aspect—with members, half amphibian, half fish, with the vertebræ of fish, with the fins of the siren, with organs of sense approximating to those of fishes, &c.,—was intermediate between the fishes and the amphibians, but more approaching the former. It could only live in the depths of the sea. It is found as high as the tufa chalk, also as low as the muschelkalk, but it abounds most in the lias strata. Five or six species of it are known; they vary from five to fifteen feet; still the debris of the lias of Lime Regis indicate an individual twenty four feet long.

The orders of living reptiles comprize a great number of fossil species, especially the orders of crocodiles and of saurians. Among the fossil crocodiles, two at least are identical, without even forming varieties, with the *crocodilus biporcatus* and the *leptorinchus gangeticus*, which are found, at the present day, in great numbers in the rivers of India. The saurian fossils have not been yet studied with sufficient attention, and their relative position in their orders is not satisfactorily ascertained. Many attained gigantic proportions, and may have been as large as the whales. The head of the *mosasaurus* or *lacerta gigantea* was almost four feet long; the head of the living and known monitors and equana is not more than five inches long. The total length of the lost species was about twenty four feet three inches. The *iguanodon mantellii*, another species of the lower chalk and of the Wealden, may have been seventy feet long; but the *basilosaurus*, or king of saurians (*zeugledon*, Owen), surpassed all others by its enormous size. The ranges of its vertebræ, in one specimen, were more than a hundred feet long; and in another, from the banks of the Washita, a hundred and fifty English feet. A great part of the fossil salamanders resemble those that are actually living. In a word, the fossil reptiles present to us the same facts as the birds and the mammals.

The organization and the position of the fossil reptiles prove that they lived near the mouths of rivers; and their gigantic size evidently supposes much larger water-currents than those of the present time. Hence since such vast rivers have been lessened without being entirely dried up, such gigantic animals must have perished, while smaller animals have been able to subsist in the same circumstances. With these reptiles disappeared the mammal ichneumons of the genus *viverra*, the remains of which are found in the same countries, and which lived on them, as the living ichneumons actually live on the crocodiles of the Nile; an additional proof of the influence of the harmonic law of association on beings.

Fishes.—The 8000 known living species are referred to three types of organization, the osseous, the subosseous, and the cartilaginous: but the fossil species having generally left us nothing but their scales. Agassiz has proposed to distinguish them generally by the disposition and form of their scales. On this ingenious principle, which, however, clashes with the natural affinities,—the author of the *Researches on fossil fish*, divides all this class of animals into four great orders: the *cycloïdes*, the scales of which are formed by simple layers with smooth margins, as the gudgeon, the tench; the *ctenoïdes* with scales composed of layers with pectinated or toothed posterior margins as the perch; the *ganoïdes*, which have scales of an angular, rhomboïdal or polygonal form, composed of osseous or horny, enamelled layers, as the sturgeon, the lepidotus; and the *placoïdes*, with skins like shagreen. Now all these divisions exist among the fossil fish: these four kind of scales are found in them; we have the osseous, subosseous and cartilaginous fishes: we have the marine and fresh water species. Thus the same general division, the same form of teguments, the same structure, the same forms, the same types.

Of about 1000 species of fossil fish, Agassiz has determined and classified 638, which he divides among 167 genera. He refers them to various points of the great ichthyological series; often to living genera; still more frequently to new and extinct genera, which, however, fill up gaps in the series, and form transitions, either among themselves or among fossil and living genera, or among genera now living.

The family of the sparoïdes forms an example of these transitions. The fossil *sparnodus* forms a small tribe intermediate to two living tribes,—that of the toothed, and that of the sparnodus properly so-called.

SPAROÏDS.	Dentex,	Cuv.
	Sparnodus,	Ag.
	Pagellus,	Cuv.
	Sargues,	Cuv.

The genus *sparnodus*, says Agassiz, belongs to both these groups by its different characters, without it being possible to assign it to either.

Of the two following families of this author, that of the percoïds and that of the sauroïds, the first, which contains 75 living genera, counts only 8 all of whose species are fossil; and the second, which comprizes 21 fossil genera, has only two living genera,—the *lepidosti* and the *polypteræ* (Geoff.). Agassiz subdivides his family of sharks into three groups, after the dentary system,—the *cestraciontes*, the *hybodontes* and the *squalides.* The hybodontes are all fossil; and of the cestraciontes, comprizing more than ten extinct genera, there is only one living genus, the *cestracion*, of which but a single species is known, 'the Port Jackson shark,' which lives in the sea of New Holland. This author remarks, that the types, which in our day appear isolated, are represented by numerous analogous genera in the strata of the earth; whereas those which predominate in our time have only few representatives among fossils; so true is it, that the living and fossil beings form one and the same series!

Insects and arachnidæ.—The number of known fossil species may be about 1000, or 1200. The strata of all epochs contain them in greater or less number. The insects of the marl of Aix have the greatest analogy with the living species of the same country, with which, indeed, they appear identical. It would appear, however, that the marls of Aix, as also the lignites of Bonn, present some genera which are only now found in the intertropical regions. The insects of the marl of Oeningen appear to differ specifically from those of Aix, but their forms are still those of our European genera: they even approximate closely to those that live in the same country. The amber-insects have nothing which contrasts with those of European countries. With some exceptions, all their genera are still living; but their species, no less than the vegetables that accompany them, indicate a warm climate. Still we find in Europe species identical with the amber-fossils: such are the *trombidium aquaticum*, *phalangium*, *opilio and cancroïdes*, &c. All the species of the lithographic limestone of Solenhofen furnish genera of the same country, except among the arachnidæ, the genus *galeod*, which appears foreign to it, and is only seen in the Southern and Eastern portions of Europe, especially in Greece. The species of the primary rocks and of the coal formation appear in general to approach those of the warmest climates of the earth.

All the fossil insects are, then, referred to the same orders, to the same families, and, for the most part, to the same genera as the living insects; and these genera still exist in the same countries where we find them in the fossil state. The extinct genera, if there are any, shew the greatest analogy with the living genera; there is only one exception, a species of scorpion, found in the coal formation of Bohemia, of which Sternberg has given a particular description under the name of *cycloph-thalmus*, from the arrangement of its eyes, which are placed in a circle. It is perhaps the only one of the articulata which presents considerable differences with the known living genera; and it is as yet very doubtful, if the circumstance of the number and disposition of the eyes can furnish a generic character in the scorpions. It is an important remark to make, that, with one or two exceptions, we do not find among the generic forms of living insects and those of fossil insects any decided difference, so that characters have not been found to constitute new genera. The same may be said of the crustacea; and, if we remember that of all animals insects most easily adopt modifications under the influence of climate and food, we shall not be far from believing, that the greatest part of the fossils are only varieties of living species, as appears to be proved by the insufficiency of the characters which have been employed to distinguish them, and the small number of gaps which the series of this group exhibits.

	Orders.	**Families.**	**Genera.**	**Species.**
CRUSTACEA MANILLATA.	Isopods.		Séroles. Sphéromes.	
	Trilobians....	*Isotelians.*	*Nilcus.*	
		Ogygians.	*Trinucleus.* —	*Ungula.*
		Caliménians.	*Ogygia,* Brong.	
			Asaphus.............	*Caudiger,* Brong. *Limulurus.* *Longicaudatus.*
	Branchiopods.	Apusians.		

The most celebrated crustacea, and those which most abund in the fossil state, are the trilobites. Milne Edward has placed them, as mentioned, between the living isopods and branchiopods. "In all probability," he observes, "these animals should belong to the great division of branchiopods, and they appear to establish a transition between those last and the isopods. They are very like the séroles and the apus. Their shield-form head has much analogy with the apus. In many trilobites we find, on the upper face, tubercules which strongly remind as of the reniform eyes of the apus; and in others there are, at the same place, reticulated eyes, which, in their arrangement, exactly resemble those of the séroles, and of some other isopods. We have not yet been able to discover certain traces of feet in any trilobite; and every thing leads us to the belief that these appendices were membranous and lamellous, as in the apus: for without this, it would be difficult to explain their constant and entire destruction. Many species had the faculty of rolling themselves up in balls, as the spheroma of our seas." (1)

The form of trilobites is not, then, as was at first believed, an unwonted form, foreign to the being that now exist. The trilobites comprize 21 genera; these contain 134 species, which, passing into each other by gradual shades, form a continuous series. Thus the *trinucleus ungula* appears to pass from the ordinary trinucleus to the *ogygia* and the *ogygia* into the *asaphus*. The *asaphus limulurus* is intermediate between the *asaphus caudiger* (Brong.), and the *asaphus longicaudatus* (Murch.); on the other hand, the genus *nileus* brings back the ordinary trilobite into the general plan of the other crustacea; for in it does not appear any trace of the two longitudinal fissures which generally divide the trilobite into three lobes.

The other fossil crustacea belong to 41 genera: of this number 29 are living and 12 appear to be extinct. Many fossil genera approximate closely to their living congeners: the *dorippe of Risso* differs very little from the *dorippe quadridentatus*, which lives in the Indian Ocean: the *leucosia subrhomboïdalis* approaches remarkably close to the *leucosia craniolaris* of Fabricius, which is found on the shores of India; and the *gelasima lucens* is near to the *g. maracoani*,

(1) Hist. of living and fossil crustacea.

which is found in Cayenne. Others are identical with our actual species: the *maia squinado* and the *pagurus Berbardus* live on our coasts, and are fossil in the isle of St. Hospice, near Nice. As for the extinct genera, they are referred to all points of the animal series, where they fill up gaps, and form intermediary connections between the living genera. Thus in the genus *dromolite* (Edw.) the species *D. Bucklandii* passes from the dromies to the homoles. Milne Edward considers as intermediary between the salicoque and the astacida, the genus *coleia*, proved to be a fossil species by Broderip. The two species *macrourites tipularius* and *palemon spinipede* appear to him to belong to the same genus, which finds its place between the palemons and the pandars, In fine, he regards the fossil *macrourites fuciformis*, as probably forming the type of a particular genus, intermediate to the sicyons, the palemons and the hippolytes.

Mollusks.—The calcareous nature of mollusks, and the medium in which they live, have almost necessitated their abundance and preservation at all stages of the geological series. If we accept the figures of paleontologists, more than six thousand fossil species have already been ascertained. The single basin of Paris has furnished 1200 of these. On the other hand, the valve of a mollusk represents his organs of respiration, and consequently imparts his degree of elevation in the series: it can thus give specific characters sufficiently reliable, if it be sufficiently entire in its essential parts. The class of mollusks is, then, one of the most interesting in our point of view: if it be true, as we are likely soon to establish, that the living and fossil animals belong to the same system of creation, this class, so rich in species in our seas and in the geological formations, must fully confirm our thesis. In fact, we find here again the same facts. The fossil mollusks are referred to all points of the malacological series: almost all the existing genera, which have solid parts, are represented in the strata: a great number of species have their perfect or identical analogies in living nature; and all the remainder belong to extinct genera which naturally find their places among the living genera.

1st. Class. CEPHALOPODS.........	Calmar........................	Calmar. *Apticus.* Sepia. *Béloptèra.*
	Orthoceratidæ............	*Belemnites.* *Conilites.* *Orthoceres.* *Baculite.*
	Lituolitidæ................	*Lituite.* Spirula. *Hamite.*
	Ammonitidæ..............	*Discorbites.* *Scaphites.* *Goniatites.* *Ceratites.* *Ammonites.*
	Nautilidæ..................	*Orbulites.* Nautilus.

The class of cephalopods presents us with many examples of this connection of fossil with living mollusks. The genus *apticus* of the ancient strata finds its place between two living genera,—the calmars and the sepia properly called; and the three species it contains form gradual passages from one to another. The *béloptèra* affords the singular combination—so unexpected by naturalists of the bone of the sepia and of that of the *belemnite*—another extinct genus. The belopteræ form a peculiar type of mollusks, forming a transition between the sepia and the bélemnites, and evidently displaying the relations which unite these genera. The great genus of bélemnitida (d'Orbigny) no longer appears as an isolated type, an unusual form, since we find it united with the sepia, by the intervention of the béloptéra. It approximates to it however by other circumstances of organization. Deshayes thought that the shell of the belemnite partaking at once of the characters of the sepia and of those of the orthocera or right nautilus, the animal should have the combination of organs peculiar to each of the families to which these two species belong. The conjecture of this learned conchyliologist has become a certainty, since there has been found in the anterior cavity of some bélemnites, the impression of a sack filled with black matter and quite analogous to that of the sepia or cuttlefish. Buckland mentions another bélemnite of the lias of Lyme Regis with the ink-bag peculiar to all the species of the *sepia* of Linnaeus.

The nautili properly so-called are of our epoch and of all past times: the *climènes* or nautili with sinuous partitions, form part of the family of the nautilacidæ, or, according to Munster, they form a distinct genus. Now the climenes approximate very closely to the *goniatites* of the family of the ammonitidæ, and these two genera form the transition from one family to another. Thus what has been said of the bélemnites, applies also to the numerous races of the ammonites, the whole of which is fossil, and comprizes more than 300 species: both being referable to living genera, and both filling up gaps in the same series.

We have in the fossil state the two great divisions of the group of mollusks, the bivalves and the univalves; and the most of the genera comprized in these two divisions,—with the exception of those which do not secrete solid parts,—which were capable of preservation in the deposits of our soil. Like the living species, the fossil species were distributed on land and sea, in lakes and rivers. The number of fossil and living genera is greater than that of extinct species, although the extinct species appear much more numerous than those found either in both the fossil and living state, or in the living state alone: but the extinct species form between the two extremes of the great malacological series, either new types, evidently intermediate between living types which they connect, or transitions and approximations between the species of the same genus.

We might pursue this demonstration as far as the group of radiata and spongiaria; but wherefore extend this review, which everywhere would furnish us with uniform results? The fossil animals are so clearly nothing more than detached links of our one and only series, that paleontologists have no other means of recognizing and determining them than by their relations to, and analogies with, the living species of this series. It is also by the study of this series that zoologists are enabled to announce beforehand whether there will be few or many fossil species of a particular genus, or of a particular family; and the principle of this prevision furnished by the series never misleads them. On all points where the living species are very nearly connected, there are few new species of the fossil fauna to be looked for; and wherever the living series presents gaps or lacunæ, it is because it has suffered considerable loss. The apes form a series so well connected that we cannot look for the discovery of many more, either fossil or living. The same may be said of the rodentia. The contrary, however, is true of the pachydermata and of the reptiles; there are many gaps in the living series; and hence we find that paleontology has contributed a large number of fossil species to these classes. The same observation has been made for certain families of fishes. Among the mollusks, in the polythalamous shells, there are reckoned at most five or six living species; but there are many fossils of this class. In the helix or limax, the living species are so numerous, and approximate so closely to each other, that we cannot wonder at the small number of new fossil species that are known. The terebratulæ have but few living species, at the most from 12 to 15, whereas in the fossil state there are about 500; the cerites, living and fossil, are in the same proportions: as also the crinoïds, the echinidæ, &c. It is, then, by combining what has been with what is that the great and only series is made up—is demonstrated, shews a connection from one end to the other, and justifies the principle of Linnaeus, that we must count as many species as there were different forms originally created.

Will it be said, that among the species that either exist on the surface of the earth or are found in its strata, and of which many are unknown to us, there are perhaps some which cannot be referred to the animal series, and that by the sole fact of this supposition, the thesis of an only Creator and Disposer, for the animal kingdom, is not rigorously demonstrated? But, in the first place, the small number of living species which are yet unknown to us, by the very fact, that they belong to the actual world, must make part of the same system of creation as the immense majority that we are acquainted with; and those of the extinct species which are unknown to us must also have belonged to the same world as the great quantity of fossils which we know: for these are obtained from the strata of all epochs; and since some enter our series, we are justly entitled to conclude that the others are no strangers to it.

There is, however, an undeniable fact, against which all suppositions are vain, because it excludes them all. The study of organization establishes five distinct types of animality, founded on the disposition of the nervous system, that is to say, of the organs of sensibility, an essential character of the animal, without which we could not have a conception of it. Now these five types, or five dispositions of the nervous system, represented by the general form, contain all the dispositions we can imagine: 1° the pair-form or disposition, with the central nervous system, above the intestinal canal, vertebrates, (articulated interiorly); 2° this same form and disposition with the nervous system below the intestinal canal, articulata, (exteriorly). This plan is the reverse of the preceding type; 3° the pair-form and disposition tending to become circular with the nervous system at once above, along side, and below the intestinal canal: the *mollusks;* 4° the form and disposition of the nervous system, radiant or circular: *radiata;* 5° the spherical or indefinite form in which the nervous system is so confounded with the rest of the animal that it is anatomically undeterminable,—*amorphous.* These five types comprize all the combinations of organs capable of harmonizing with the physical laws and media,—with the conditions of existence, so that it is impossible to imagine other combinations of organs and other types, without imagining at the same time other media of existence, entirely different and even irreconcileable with those of the actual world. There is, then, but one single conception of animality, all the possible types of which are known to us, as well as all the leading degrees of these types, without it being possible for us to intercalate new types. This is what is called the animal series, to which necessarily appertain all the living and extinct animals, known and unknown.

II.

Vegetable Kingdom. — *The fossil species are a part of it.*

There is a natural order in the vegetable as well as in the animal kingdom. It is perceived; there is a constant series of degradation, from the multicotyledons and dicotyledons to the agamous by the monocotyledons and the cryptogami. It is on this fact that the leading divisions of the vegetable kingdom have been established. But what laws presided at such degradations;—what exterior characters, representing the intimate structure of the vegetable, can at the same time indicate its degree of perfection? Botanists are at present occupied with the examination of these questions. The reality of a general or natural order in the vegetable kingdom is then certain; and this is enough. Now the fossil species belong to this order; they are referred to in order to facilitate its demonstration. Here also the testimonies are unanimous. Many botanists, from purely geological considerations, have been of opinion that the fossil plants were created before those now living, but no observer ever thought of referring them to a different system of creation. My authorities are, in Germany, Scheuchzer, Schlotheim, Sternberg, Germar, Kaulfuss, Rhode, Martius, Goeppert, Berger; in Sweden, Nilson, Agardh; in England, Parkinson, Artis, Lindley, Hutton, Williams, Nichol, Witham; in Switzerland, Mérian; in France, Antoine Jussieu, Alphonse Brongniart, Schimper, Mougeot; in America, Steinhauer, &c. Of the extinct plants, some grew in the sea, as the algæ of the primary rocks; others on the dry land and on the borders of marshes, as the ferns, the coniferæ, the equisetacea, &c., of the primary deposits, of the mountain limestone, and of the coal. Others lived in the fresh waters as the marsileacea of the coal-beds and carboniferous strata. Thus we find the same general distribution, as at the present day, from the first ages of the world, as their positions in the strata indicate.

The fossil plants do not constitute a particular class or a series of classes apart, established on different plans from our vegetables, and which find their place before or after them. They belong to the six great classes of our vegetable kingdom: they enter into all its divisions. There are, indeed, some fossils of which the class is doubtful; but, instead of being without relations to the families of our classes, because such are not known, this uncertainty results from their being referable to too large a number of families. The doubt arises from the insufficiency of the remains, from their imperfect preservation, or from the absence of organic characters. Living vegetables would be the occasion of similar doubts if they were found in the same conditions.

More than sixty living families of every class are abundantly represented in the flora of our strata, and it does not appear that botanists have found it advisable to establish new families for the fossil species. Hence we have the same classes and the same families. A number of fossil genera are identical with our living genera. There are also extinct genera, but they form transitions, and connect families and genera that before isolated; the *calamites* and the *lepidodendrons* are illustrations of this fact.

Families.	Genera.	Species.
Equisetacea................	Equisetum.	—— *Columnare.*
	Calamites.	—— *Radiatus.*
Lycopodiacea.	Psilotum.	
	Lepidodendron.	
Coniferæ.		

"The species of the genus *calamites*," says Brongniart, "appear to present all the transitions of a structure very analogous to that of the living genus, *equisetum*, to an organization which only differs from it by the successive diminution of an accessory organ, the *gaina*, which is very much developed in the real equisetum, somewhat less so in the *calamites radiatus* of the transition strata; then is reduced to simple tubercules, and finally entirely disappears."—According to the same botanist, the '*equisetum columnare*,'—a fossil species which differs much from our actual equisetum, appears to form the transition between the living genus and the *calamites*. Sternberg admits also that the equisetum is clearly distinguished from the calamites, to which it approximates very closely. Lindley, however, does not recognize this approximation. According to him, Brongniart must have overloked the presence of wood and bark in the calamites.

The same doubts are not entertained on the transitions formed by the lépidodendrons. "This fossils" 'genus', says Brongniart, "is intermediate between the lycopodiaceæ and the coniferæ: it connects two isolated families. The relations of the lépidodendrons with the lycopodiaceæ are very close, particularly with the lycopodiaceæ of the section of the *selago*. Their internal structure presents the most complete analogy, not with the majority of the actual lycopodiaceæ, but with some plants of this family, especially with the *psilotum triquetrum*. In fine, the organs of fructification, designated at first by the name of *lepidostrobus*, which have been found attached to the extremities of the branches of real *lepidodendrons*, complete the analogy, so that it appears to me impossible to hesitate about placing these fossil plants in the same family, that of the lycopodiaceæ, among which they would merely form a very distinct group." (1) Lindley also recognizes the great analogy between the lépidodendrons and the lycopodiaceæ; and he places them between this family and that of the coniferæ. This new generic type establishes a better transition between the flowering and non-flowering plants than the equisetum and the cycadaceæ. "It is", says Boué, "an assurance that the gaps in the natural series will be gradually filled by the discovery of new fossil genera." (2) The lépidodendrons are very numerous in the coal-beds; they are found as low down as the mountain limestone, and as high up as the keuper. In the largest species the stems are more than three feet in diameter at their base, and they are sometimes found, as in the mines of Werden, sixty feet long.

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(1) Brongniart, Mém. sur les lép. et leurs affinités.
(2) Bul. de la Soc. géol.

Besides the fossil plants the genera of which are distinct from the living, or identical with them, paleontologists have found others which appear to differ somewhat more from certain species of our genera than these differ from one another : but the organ which presents these appearances is not sufficiently important to authorize us to believe, that these plants should be distinguished from them, by their essential organs. There is here motive for doubting if these species formed new genera, or if they were part of our living genera. Many species of the great family of the ferns belong to this category. The rarity of organs of fructification in the fossil state has constrained the botanists, in order to facilitate the classifying and determination of species, to establish artificial genera, founded on the disposition of the nervures or veins of leaves, combined with the manner of division of the stems and the pinnulæ. Still the analogy of these with the living species of the same family is, nevertheless, incontestable, although, up to the present moment, it has not been possible to embrace the relations that unite them, in all their extent. "These fossil boughs", says Brongniart, "do not exhibit those deviations from the ordinary structure of a certain number of living ferns, which might indicate the existence, in those ancient times, of genera very different from those that inhabit our globe." (1) Goeppert entirely adopts this view of the matter. His parallel of the living and fossil ferns concerns the roots, the stems, the buds, the trunk and the fruit. According to the learned professor of Breslau, the examination of the relations that exist between the living and the fossil species, proves that the laws of vegetation of the earliest times of the world were the same as those of the vegetation of our present times, and that if there be nowhere identity of species, there is everywhere analogy ;—the same variety of forms presented by the living ferns in all their parts are almost all found among the ferns of the primitive times. (2) All botanists do not agree with Goeppert, that there is always distinction of species between the fossil

(1) Mém. sur la répartition des plantes fos., &c.
(2) Ibid.

and the living ferns. According to Lindley and Hutton, the fern *tæniopteris vittata* cannot be distinguished from the *aspidium wallichianum* of India. The fossil plant is of the inferior oolite of Whitby, and of the lias of Newevelt and of Hor in Scandinavia. Elsewhere I have cited examples of identity for other vegetables of the ancient formations.

All the fossil vegetable and animal species are referable to our two organic kingdoms; they enter into the same system of creation; they concur in demonstrating for these two kingdoms, one single conception, one Creator and one sole Disposer. This definitive result is the more important, because it rests on facts supplied by all the continents, and at all levels of our geological series,—facts which imply, for all past times, the same media of existence, the same laws of vegetable and animal life, as prevail at the present day.

III.

Union of the Vegetable and Animal Kingdoms.

Although the fundamental characters of the vegetable and animal kingdoms are different, since in the former it is reproduction, and in the latter, sensibility and locomotion; they are nevertheless united with each other, not only by analogies of structure, of organs, and of functions,—which make them enter into the same general system of creation,—but moreover by mutual relations of conservation, which render them functions of each other, necessary to each other, and do not permit us to doubt that they are the result of the same Creative and Disposing Will. Diderot required merely the butterfly's wing, in order to establish the existence of God: here we have the harmonies of all the natural kingdoms which concur in demonstrating this first of all dogmas.

Analogies of structure and of functions.—There are several analogies of structure, between the perfect bark of the plant and the skin of the animal. The bark is composed of many distinct parts; first the epidermis, a transparent and colourless membrane which covers all parts of the plant that are exposed to the air. It is perforated by cortical pores called *stomata*, and derives its origin from an external cellular tissue, modified by atmospheric influences. Below the epidermis extends the herbaceous envelope,—a cellular tissue, which unites it with the cortical layers: it covers the trunk, the branches and their divisions, and forms the parenchyma of the leaves. Analogous to the central marron-sap, with which it communicates by medullary prolongations; it is coloured by grains of chromula, and often contains the juices, peculiar to vegetables in simple or combined canals: in fine, it is the seat of the decomposition of carbonic acid. Under the herbaceous envelope, or, perhaps, in the middle of its extended tissue, is the bark properly so-called, composed of concentric layers, which are with difficulty distinguished from each other. There are distributed bundles of fibrous tubes, separated at first among themselves by cellular spaces, which are the prolongation of the medullary radii, and afterwards by the ligneous body by a layer of utricular tissue.

Such is, in general, the structure of the entire bark; now, if two parts only are recognized, the muscular layer placed below and the nervous papillary net must be wanting, since the functions are wanting, we find a continued analogy with what anatomy discovers in regard to the skin of animals: 1° in proceeding from the interior to the exterior, the liber or cortical layer, properly so-called, is the analogue of the dermis; 2° the herbaceous envelope—with its latexferous vessels, and those that contain the appropriate juices,—corresponds with the vascular net; 3° the grains of chromula which cover it represents the pigment; 4° the epidermis is the analogue of what bears the same name in the animal. There are, for this latter, two perfecting parts, the cryptæ and the phaneræ, which are represented by the thorns of the vegetables, while the skin and stings of the latter, which are regarded as more superficial, and growing out of the epidermis, would answer to the scutella of the reptiles, which are also epidermic.

Analogy of structure supposes analogy of functions. In effect, the stomata or cortical pores, with which the epidermis of the vegetable is pierced, like the pores of the skin, serve for respiration. The bark and the skin serve equally the excretions; but there is moreover in animals an inner skin to form a digestive and absorbing apparatus.

The skin of animals is distinct from all the organs placed under it: the different parts of this skin are also distinct among themselves in the higher animals; this distinction afterwards diminishes and is lost in the confusion of all the parts in the lower animals. We find also in the higher vegetables, multicotyledons, the bark distinct from the wood, and the different parts of the wood distinct among themselves. In the following ones, monocotyledons, the envelope is still distinct, but it has no longer cortical layers; then in the ferns the lycopodiaceæ, the mosses, &c., the bark is not more distinct: in fine, all the parts are confounded in the lower vegetables, which are merely an utricular tissue, and in which the product is simply the continuation of the adult.

In the animals, the blood, become vital by respiration, is carried to all parts of the animal, which find in it elements of restoration; each tissue has the property of assimilating to itself what it finds most suitable. We find the same thing in the vegetables, which all appear to be governed by the same law of organization and increase, as they all appear subject to the same law of serial degradation that is observed in animals.

Thus the vegetable and animal kingdoms not only present particular analogous plans, united on a great analogous serial plan, ascending and descending; but the animal kingdom reproduces the characters of the vegetable kingdom, because it is organized, lives, and is perpetuated by analogous functions; and, in its turn, the social kingdom reproduces all the essential characters of the two other kingdoms—organization, life, perpetuity, sensibility, locomotion, while it is at the same time distinguished from them by differential and higher characters, as the animal kingdom is distinguished from the vegetable kingdom by its peculiar and superior characters. They are consequently three distinct and definitely perfected kingdoms, conceived and realized by the same Supreme Intelligence.

Mutual Relations of preservation.—The air we breathe is composed of two elementary principles, oxygen and nitrogen, which are in the proportion 21 of oxygen to 79 of nitrogen. This proportion between the two principles of the vital fluid is necessary to the free and easy respiration of animals. If it be increased or diminished, the animal suffers, languishes, and dies. But this air, which alternately enters the lungs and issues from them, undergoes great modifications in the short space of time it is in contact with the organs. On issuing from the lungs the proportion of its elements is no longer the same; instead of 21 parts of oxygen, there remain only 18, the other three are mixed and combined with the pure carbon of the blood, which they render more fluid and warmer. These changes were necessary; but for them the heart would cease to beat, and life would be suddenly suspended.

These three parts of oxygen do not remain in the blood; they unite with one of the elements of this fluid,—the carbon, or perfectly pure carbon. This combination gives rise to a new kind of gas, called carbonic acid, which issues from the breast of the animal at every expiration. Combustion also develops carbonic acid, a gas which is unfit for animal respiration. If an animal be placed in an atmosphere containing a certain quantity of it, it speedily dies. This is the case also with man, whenever be is exposed for any length of time to the concentrated vapour of carbon, or carbonic acid. How has it happened, that this fluid,—of which animal respiration, heat and combustion are such abundant and continual sources,—does not entirely corrupt the air, so necessary for animal life, in the long time during which combustion and animal life have existed on the earth's surface? This indeed would have occurred long since, as is proved by experiment and very exact calculations, if this gas were not absorbed by the vegetable kingdom. It is, then, to the plants that we owe this great benefit, on which our life and that of the whole animal kingdom depends.

In order to grow and attain their full development, vegetables, as well as animals, have need of an element diffused throughout the air; and this element is precisely that which would corrupt its purity, and render it unfit for the maintenance of animal life, namely carbonic acid. It is their respiratory nutriment, as oxygen is that of animals. During the day, the animals and the fires give out a great quantity of carbonic acid; during the night, the vegetables absorb this acid by the innumerable pores which cover the surface of their leaves. In the morning another phenomenon takes place. Carbonic acid is a compound of carbon and oxygen. When the first rays of the sun strike the plants, the oxygen which they absorbed during the night, disengages itself from the carbon, exhales through the atmosphere, which it refreshes and purifies, while the pure carbon remains in the plant, which it nourishes. Thus fire and animal respiration continually change the atmospheric air; and the respiration of plants continually correct this alteration, and restores the air to its primitive purity; and the influence of light and of the sun is necessary for the accomplishment of these phenomena. These beautiful harmonies of preservation establish a mutual dependance between the animal and vegetable kingdoms, and, moreover, connect both with the elementary world from which both derive their peculiar respiratory aliment. The vegetable and animal kingdoms, which could not exist independently of each other, which are to each other functions, were not conceived alone but in mutual connexion, and are consequently the work of the One Creator. From this reciprocal dependence of the two organic kingdoms we must conclude that the vegetables did not long exist without the animals. Hence there is no appreciable interval for geology between the appearance of the vegetable and the animal kingdoms, since they present themselves together in all our continents and in all the most ancient strata of the globe. Because carbonic acid is one of the vital fluids of plants, we must not infer that their augmentation is in proportion with the quantity of this gas in the atmosphere. We know that seeds plunged in carbonic acid do not fructify, and that plants no less than animals die in it. A surface impregnated with too much carbon would consequently be a cause of destruction to both animal and vegetable kingdoms: it is the combination of these elementary bodies in certain proportions which produces and maintains these kingdoms.

IV.

Harmonies and Connexion of all the naturai Kingdoms.

We may distinguish in the Universe six kingdoms founded one on the other, and which respectively gain in complexity by superadding to the qualities and properties of the one immediately lower in the scale those which are peculiar to each. Matter, in the elementary state in the first division, receives in the mineral kingdom a form and a kind of structure to which, in the sidereal kingdom, is added a continuous and regular motion. The Supreme Ordainer of things makes it a living organization in the vegetable kingdom; in the animal kingdom, by elevating it one degree, He renders it capable of using organs, of sensibility and of voluntary motion; and finally in the social kingdom, it becomes the habitation, the companion and the instrument of an intelligence made to comprehend all the kingdoms, and to rise by means of them to the contemplation of the perfections of their Sublime Author. All the kingdoms are a function, one to the other; and although established, each on a particular plan, limited, and perfectly distinct; they mutually harmonize in the general plan which constitutes Nature or the Universe.

I.—The elementary kingdom comprizes the ethereal fluid, water, and the different gases or atmospheric elements. It occupies and penetrates all bodies in nature; it is the medium of all the other kingdoms, and without it neither animals nor plants could exist. It is not living but vivifying: it has, however, as it were a phenomenal life, by the continual motions in all directions which decompose and reorganize the material elements of the other kingdoms, which thus become necessary for its phenomenal life. It is a function of these kingdoms, and these are functions of it.

The ether is the agent of the chemical compositions and decompositions which take place in the air, the water, and the earth, and perhaps also the regulating principle of the astronomical motions. A principle of vegetation, as light, and electricity, it continually acts in germination, nutrition, the increase of plants; and under the name of the electric nervous fluid, in the organic life of man and animals. It binds in mutual interdependence the natural kingdoms; it is the vehicle of their reciprocal influences, of which if one were wanting its action would be incomplete; for there is an exchange of electricity among the sidereal bodies; between the earth, the water and the atmosphere; between these bodies, and animals and vegetables, so that by the absence of the other kingdoms, the ether would be without action, without result, without object.

The air, or, more generally, the atmosphere, is subject to the action of the ether, but it is also its function, since it serves as its vehicle and recipient. The air is necessary to man and animals, who breathe it on earth; to the aquatic animals who breathe it in water; to all the vegetables, which if deprived of it, fade and are unproductive. The air, in its turn, is modified by the waters, by the plants, by the animals, so as to become unsuitable to the life of some in the absence of the rest. From the reciprocal action of the ether and the atmospheric elements result the various meteors,—the winds, rains, storms, &c., which modify the surface of the earth and affect all that inhabit it.

Water contains air and ether, which latter, under the name of heat, and according to the quantity absorbed by it, renders it liquid or gaseous. In its turn it supplies the air with elements by its evaporation and its decomposition; it is necessary to man under the two forms of liquid and gas; it is, then, a function of these beings; it is also a function of the earth; either directly, by disintegrating, softening, and transporting its rocks, or indirectly, by the animals and vegetables which it nourishes, and the remains of which increase the cortical envelope of the globe. If the vegetables derive aliment from water in the liquid or gaseous state, they contribute also to its restoration, to its atmospherical condensation, to its collecting in springs, to its flowing on the surface, and in the interior of the earth, wherever they exist in sufficiently large quantity to produce these phenomena.

II.—The mineral kingdom has for distinctive character the solid, and geometrically determinable form. Included in the elementary kingdom, which acts upon it, and is in turn reacted upon by it, it is the base of all the higher divisions; it is susceptible of change by addition and more or less by mixture; it augments by the decomposition of the organic kingdoms, to which it is necessary, and which are also necessary to its end and its destiny.

III.—The sidereal kingdom having for peculiar and distinctive characters, regular and continuous motion in space,—which is mathematically ascertainable,—acts on the preceding kingdoms, by the aid of which it produces the alternations of day, night, seasons, &c.; all necessary for the maintenance of the higher kingdoms, of which, consequently, it is a function; but it could do nothing, and would not even exist, without the mineral and elementary kingdoms. The earth is subject to all the influences of the elementary and mineral kingdoms; but, in its turn, it is the seat of all their phenomena. By its annual and diurnal motion, it maintains salubrity in the air and in the water, in connexion with the sun and moon, the combined action of which contribute to the same result by producing the atmospheric and sea-tides. Every one knows the influence of the sun on vegetation, and its beneficent action on the animal and social kingdom. The moon, in its turn, acts powerfully on the periodical ascension of the sap and the development of plants. In fine, these bodies determine some of the conditions necessary for the existence of organized beings on the earth.

IV.—The vegetable kingdom, of which the characteristic is organic structure capable of self-reproduction, is based on the mineral kingdom; it cannot dispense with the elementary kingdom on which it reacts, nor with the sidereal kingdom, and it is the foundation of the other two higher kingdoms. These latter kingdoms are, however, in turn necessary to it; there is an exchange of the vital fluid between them and it; and without them it would not have either end or destiny.

There is a harmonious equilibrium between the respiration of vegetables and that of animals: the former inspire the gas which the latter expire, and reciprocally; so that if there were merely vegetables they would die by exhausting their elements of respiration. Vegetable and animal electricity form an equilibrium equally necessary to each; the animals disengage electricity and absorb it: so also the vegetables; and thus there is an exchange between the two kingdoms. If the animals feed on vegetables, a great number of the vegetables are fed by the remains of animals, either in the liquid state, or reduced by decomposition into the form of gas. The two kingdoms are then a function, one of the other, and were mutually made for each other.

V.—The animal kingdom is distinguished from the preceding ones by sensibility and voluntary locomotion, of which the cause is in itself. It has need of all the preceding kingdoms, and reacts on the elementary, mineral, and vegetable kingdom, of which, consequently, it is a function, in as much as it maintains in them an harmonic equilibrium, and itself contributes to the life of vegetables. Moreover the various parts of this kingdom are functions of each other; if the higher have need of the lower species, these latter have need of the former. The green hydrus, which is merely a bag covered with tentacles, seizes insects and other articulata, higher in the scale than itself. The same is true also of many polypi. The sea-urchins, which are merely radiata, feed on crabs and other crustacea much more complete in their organization than themselves. The cephalopod mollusks, such as the pulpa and the calmar, eat fishes. A multitude of articulated animals live as parasites on mollusks, on fish, on birds, on sea and aquatic mammals, and on man himself, and are not found elsewhere. Many reptiles feed on birds and mammals. There are also birds, whose only prey are mammals. This observation applies to each genus of each family; and it proves that the animal kingdom is one, and could not partially exist in these great groups as many geologists maintained. For if it be true that one species, in default of that which it ordinarily attacks, has made, and may still make, other species its prey, this fact has its limits: it does not extend to the whole kingdom; and, besides, it does not prevent the parasitical species from having need of the higher species, with which their existence is connected.

VI.—Man, or human race, has for differential characters, intelligence, and, consequently, morality, which renders him perfectible and sociable. He has need of all the other kingdoms of which he is the end. They are intelligible only by him, and his action on them is immense; for, if we except the sidereal kingdom, he can, within certain limits, modify all the others, and modify himself. By the knowledge he acquires of the laws of creation, he brings back to them the other kingdoms, wherever the predominance of one interrupts the equilibrium necessary for the maintenance of life and the development of the others. Thus he confines the water by dykes; he drains the marshes; corrects the insalubrity of the air; clears and plants the earth's surface; precipitates the mountains, &c. He is the highest function of all the kingdoms, and the soul which animates their vast solitude; he is the voice, the pontiff of nature: by him God is known and glorified in His works, and the end of creation is fulfilled.

The laws which govern the world being the result of the various properties of the natural kingdoms, and of their relations or harmonic combinations, as all that has been said shews, they could not have existed before the creation and establishment of these divisions and their relations. They cannot, then, be invoked as causes of the arrangement, and of the disposition of the different parts of the world; but only of the modifications which it has undergone since the epoch of its establishment. Moreover, the study of the kingdoms exhibits them to us as forming a series of plans and descending degrees, perfectly distinct, and yet made to be adapted—one to the other—in the general plan which embraces all. The kingdoms are so subordinate and necessary to each other, that if one were wanting, the rest, either would not exist, or would cease to perform their functions, and would no longer present any motive of their existence. We are, then, forced to admit, that there is in this world a single conception, a single general plan, realised by one God, Creator and Disposer of all: a conclusion perfectly in harmony with the teaching of Genesis.

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CHAPTER XVII.

Agreement between Revelation and Science on the Unity of the Human Race.

God, says the Sacred Historian of Creation, created the first human couple, Adam and Eve. He blessed them, and said to them "Increase and multiply and fill the Earth." (1) These words clearly established the universal paternity of the first man. After the recital of the deluge, and of the destruction of the human race, with the exception of Noe and his family, Moses tells us, that the whole earth was peopled by the three sons of that patriarch. "These are the three sons of Noe; from them is the whole human race spread over the whole earth." He shews us this one species divided into families, peoples, nations with their different tongues and the countries they dwelt in. "These are the families of the sons of Noe, according to the different nations that sprung from them: of these families were formed, after the deluge, all the people of the earth." (2) In fine, he shews us the points whence the first families of the human race set out to cover with their posterity all the surface of the earth. (3) This tradition as to the origin of nations, and common descent from one source of the first men was everywhere preserved, and particularly by the Jewish people. The genealogy, so precise and so accurate, of the antediluvian patriarchs, extends from Adam to Noe: three lives of men suffice afterwards to fill up all the interval between Noe and Abraham. Sem the son of Noe had lived with Arphaxad; and this latter had known Thare, the father of Abraham. After Abraham the tradition was transmitted by

(1) Gen. II. 8. 9. (2) Ibid. (3) Ibid.

his descendants down to Moses; and afterwards by the writings of this latter, and by those of the authors of each age, the psalmists, the prophets, the hagiologists. It was so certain at the time of Our Lord Jesus Christ that St. Stephen recalled it to his nation, and that St. Paul reminded the Areopagus of it. "He has made to descend from one sole blood all the race of men."(1) St. Luke gives us the genealogy of Jesus Christ, which re-ascends, by proper and historic names, to the first man in Genesis.(2) Such are the elements of the historical and traditional proof of the primitive unity of man,—elements which would be esteemed as invaluable were they found among the Hindoos, the Chinese, or the Mexicans; but of which many of the philosophers of the last century appeared to make little account, for no other reason than that they are found in the Bible.

It is true, that these learned men are the same who maintained that man issued from the slime of the earth, as Bory de St. Vincent; or derived him from an unsymmetrical infusorium, as Telliamed and Lamarck; or from the junction of two electric currents, as some others gravely stated: or who derived the human race from some certain elevated points of the globe, the latitude and longitude of which they assigned, without ever thinking it worth their while to inform us how the first men came there. These writers made no account either of history or tradition, or of the affinity of languages and resemblance of customs, or of the community of ideas among all nations, or of the fruitfulness of the union of all races, or of so many other considerations, which, however, so justly demanded their due appreciation in the solution of this question. Out of France their opinions found but few partizans. They did not agree among themselves on the specific characters of the human race, or on the number of species. Some, with Virey admitted only two: Desmoulins made out near a dozen of them. Bory de St. Vincent unhesitatingly advanced the number to fifteen. The first grounded their opinion on the facial angle; the others decided, according to the state of the hair,

(1) Acts XVII. 26. (2) Luke III. 23.

the disposition of the features, of the teeth, and the colour of the skin. Had these writers appeared after Cuvier, Blainville, Flourens, &c., and had they seen the numerous observations collected by Caillé, Lesson, Dumont-Durville, &c., it is probable we should not find them crossing our path.

At the present day there are few if any naturalists of note who do not assent to the teachings of history and tradition, as also to the doctrines of our most celebrated natural philosophers, Linnaeus, Buffon, Cuvier, Blumenbach, Blainville, Owen, &c.; who—with our most distinguished travellers. Forster, Chamisso, Humboldt, Durville, &c.,—all agree that the human race is composed of one single species. Durville, who has seen more of Oceanica than other travellers, and who has passed over 216,000 miles in visiting the various peoples of the Earth, could, better than any other, deduce motives to establish the plurality of the human race, if this opinion could be maintained with any degree of plausibility on immediate observations. This learned navigator recognizes but one single species, which he divides into three races, of which the peoples of Oceanica are merely offshoots. I shall not, then, have to dwell long on a subject where I have such little opposition to encounter, but shall content myself with collecting the principal elements of the demonstration of the unity of the human race, and shall make their application to the negro race.

Classification of races, and proofs from authority of the unity of the human species.—Naturalists give the name of species to beings who perpetuate themselves in time and space, by giving birth to individuals who resemble them and who inherit their reproductive power. This resemblance however is not as perfect as that which is found in characters cast in the same mould. From various and frequently unknown causes, the descendants undergo modifications in form, colour, size, &c., which at once distinguish them as individuals. When these modifications are of a nature to effect a considerable change in the form, colour, &c., they give rise to what are known as varieties of the species. If the characters of these varieties are perpetuated by generation in the individuals, they constitute permanent varieties or races.

All the great naturalists have seen in the human race nothing more than varieties of the one species, or races in the sense already explained. Linnaeus recognized four races of men, whom he distinguished by their colour:—the American or Copper-coloured, the European or White, the Asiatic or Yellow, the African or Black. Buffon admitted eight varieties:—the Laponian, the Tartar, the African or Black, the Malay, the Ethiopian, the Hottentot, the European, and the American. Lacépède established five divisions, grounded not only on physical but also on the moral and intellectual qualities of various peoples, and on their advancement in arts, science and literature. Blumenbach divides men into five races: the Caucasian, the Mongolian, the Negro, the American, and the Malay. But he acknowledges that all these differences approach each other by such delicate shades that they cannot give place to any other than arbitrary and by no means well defined distinctions. Thus Cuvier reduced all the varieties of the human race to three: 1° the Caucasian or White and Japhetic race, particularly remarkable for the beauty of the oval outline of the head and the whiteness of the skin; whence have issued also the Aramean or Syrian branch, which produced the Assyrians, Chaldeans, Arabians, Phenicians, Jews and Abyssinians, considered as an Arabian colony, and the Egyptians: also the Indian, Germanic and Pelasgic branch, which is much more widely diffused, and which produced the Pelasgic tongue, the Gothic or German and Sclavonian, many of which are merely derivative: and the Scythian and Tartar branch, directed at first towards the North and the North-East. 2° The yellow or copper coloured race, known by the name of the Mongolian and the Altaï, which commences at the East of the Tartar branch of the Caucasian race. It is the most numerous and most extensive on the earth. Its characters are, projecting checks, a flat visage, eyelids obliquity cut, hair,—hard, straight, rare and black, a thin beard, a yellowish complexion. It comprizes the Manchous—conquerors of China, the Japanese, the Calmucks, the wandering Kalkas, whence sprung

Attila, Gengis Khan, and Tamerlane: also the inhabitants of the Marianne Islands and of those nearest the Indian Archipelago. 3° The black race, confined to the South of the Atlas Mountains, scattered from Senegal to Cape Negro, and characterized by a deep colour more or less dark, projecting jaws, and thick lips.

Cuvier did not find in the Malays (5th race of Blumenbach) characters sufficient to distinguish them from their neighbours on both sides—the Caucasian Hindoos, and the Chinese Mongols. He did not feel himself authorized to make the American Indians (4th race of Blumenbach), a special race, not finding in them precise and enduring characteristics. If, on the one hand, their black hair and beard would seem to refer them to the Mongols; on the other, their features no less distinctive than our own,—their projecting nose, large and open eyes, correspond with our European forms.

Following Forster and Chamisso, Admiral Durville refers all the people of Oceanica to two varieties. "The Melanesian, which is only a branch of the black race of Africa; and the Polynesian or Copper-coloured, which is no more than a branch of the yellow race of Asia." (1) Lesson, the naturalist who accompanied him in La Coquille, far from referring the people of Oceanica to different species, does not regard them as of different races. His words are: "To suppose the people of Oceanica to have sprung from the soil on which they dwelt, would be a ridiculous exaggeration, at variance with physical facts. Their establishment in the isles of the South-Sea must date, at farthest, from the primitive times of the Hindoo civilization." (2)

We have some remarks to make on the foregoing. 1° This view of most learned naturalists, who, while admitting one single human species, recognize three, four, five, or eight races, proves, that varieties of form and of colour may, in certain circumstances, take place in the human species. 2° When we find these same naturalists admitting—some more, others fewer races, and establishing their distinctions principally on colour,

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(1) Relation de La Coquille. (2) Ibid.

as Linnaeus, or, as others, on other physical characters, or, with Lacépède, on physical and moral characters, we easily see that their divisions are not grounded on any primitive or specific quality; that they are arbitrary, even as characteristics of races; and only useful for the purpose of putting order in a philosophical view of the great families of the human species. 3° Of all organized beings, man being the one who has been most studied in himself, and in comparison with others, and who is also best known to us, if he consisted of many species, we would long since have discovered their distinctive qualities. Now the characters which distinguish the human species are not specifically differential characters: hence there are not many species in the human kind. But the study of the changes effected in the same race, in the same sub-race, in the same people, and the comparison of these variations of the physical man with those of the species of the animal kingdom shews us still more clearly the absolute insufficiency of all known characters to establish a plurality of species for man.

Proof of the unity of the human species, by the insufficiency of all the characters which have been employed to establish the plurality of species for man.—If the domestic animals, the conditions of whose existence have most analogy with those of man's, exhibit in the same species great differences of size, form, colour, qualities, &c., we shall have a right to conclude that less or equal modifications in man do not prove that there are many species of men: and if these modifications of men are found in the same race and even in the same people, and the same family,—they will evidently have no importance and especially no specific value: they will fall into the category of the variations to which every species is liable.

1° *Variations in size.*—When we examine the animals that are subject to the influences of domesticity, that is to say, of the circumstances under the influence of which man himself has always lived, we find their species undergo changes whence result races so well characterized that we might easily take them for so many distinct species did we not witness, so to say, their formation. Let us examine first some changes of size. The Holland horse is, in the mean, above five feet high: the Lapland horse does not exceed in height that of our largest dogs,—from 33 to 34 inches. The small horses of the island of Sardinia are not much larger than sheep. The same contrast is found in the large oxen of Flanders and the small oxen of Bengal. The canine species contains varieties of every dimension; it has dwarfs and giants. This difference is found in the same race; the male and female greyhound, especially the English one, supply remarkable examples of this observation. The hen also has great varieties of size with well characterized forms. The animals whose habits repel every instinct of domesticity concur to prove the variations of size in the same species. The lion of Atlas is larger than that of Senegal: the white or polar bear exhibits in size variations which amount to 18 inches. The wolves of Lithuania are five feet long; those of Spain and Italy, scarcely three.

Having seen the nature of the changes in size which animals of the same species present to us, let us pass to man. The influence of climate is seen in the proportions of the human stature among people similarly situated on the globe, and even among the inhabitants of the high mountains. The people of the coldest climates of Europe, of Asia, and of America,—the Laplanders, the Simoiedes, the Esquimaux are all small: the same relations are perceived in the Southern hemisphere. When we see near the poles, in Greenland, New Shetland, animals become dwarfish and trees diminish to bushes, it would be absurd to ascribe to any other cause than that of climate the diminished size of the Laplander and the Esquimaux. Moderately cold climates appear more favorable to the development of size. The Swedes, the Finlanders, the Saxons, the inhabitants of the Ukraine, many people of Asia, America and Oceanica, in parallel positions, resemble each other in size. In a word, two general laws explain the differences in the size of men: it diminishes in proportion as we approach the poles, and it increases as we draw nigh to the equator.

There are, however, other causes; to the influence of climate we must add that of food, of the mixture of the varieties of the human race, and of change of habits. In narrating the invasion of Rome by the Gauls, Livy remarks on the gigantic stature of our ancestors. Those who gave their name to Normandy were distinguished for their high stature. Apollinairus describes the Burgundians of his time as a species of giants,—seven feet high. The Germans of Tacitus were also remarkable for their lofty stature. (1)

In general, the human size is almost everywhere the same. There are varieties of size in the domestic animals, one double of the other: but between men of the largest and those of the smallest size; between the mountain Bushmen of the Cape and the Esquimaux, and the inhabitants of Navigator's islands and the Patagonians, there is not more than 18 inches difference. The size of man does not appear to have varied much from the most ancient times; as may be seen in the Egyptian mummies and those taken from the tombs of the ancient Indians, which are found in Siberia, on the banks of the river Detzora. "I have seen," says Bernardin de Saint Pierre, "bodies of the Guanches, of the Canary Islands, enveloped in their skins: I have seen the skeleton of a Carthaginean—all whose bones were of violet colour—taken from a tomb excavated in the solid rock where, perhaps, he reposed from the time of Dido. All these bodies were of the ordinary size." Although every nation may have some dwarfs and some giants, there is no nation of dwarfs or of giants. The giants of the Bible are, probably, the result of a faulty translation of the Hebrew text, in which, interpreters are agreed, the word translated by 'giants' may simply mean strong and violent men. The context is in perfect harmony with this meaning, and can scarcely be said to accord well with the other.

To resume; while we see such considerable variations in the different races of the same species of domestic animals, although they generally inhabit the same country, live in the same climate, and are nourished by the same food, we find uniformity of size in the human species, notwithstanding the difference of climate, of food, of habits, and the mixture of

(1) Agricola. Ch. II. — De moribus Germ. C. IV.

the different varieties. Moreover the causes of these differences are known to us; they are extrinsic to organism. These differences are found in the same race. The Laplanders and the Hungarians equally belong to the great Finnish family, as is shewn by the affinity of their languages: yet the Laplanders are remarkable for the smallness of their stature and their deformity; and the Hungarians, on the contrary, are tall, beautiful, and well made. These differences are seen even in the same people: thus at Port Jackson it is ascertained that the children of the emigrants grow to a larger size than that of their fathers. The Hollanders, who in their own country are not beyond the ordinary height, are found at the Cape of Good Hope to be of almost gigantic dimensions. In no case then can size establish a difference of species for man, since it does not even prove a difference of race, or nation or family.

2° *Varieties of colour.*—The dog, the horse, the cat, the sheep, the goat, the ox, &c., produce, in each of their subdivisions or varieties, individuals of the most opposite colours. The hen displays feathers of every shade. The pigeon and the pheasant have races which differ from each other both in colour and in form. Climate exercises a great influence on the colour of our domestic animals. The ox of the Campagna of Rome is generally grey, and in other parts of Italy it is generally red. The sheep of central Italy are almost universally black: in England, white is the predominant colour. In Corsica, the dog, the horse and other animals become handsomely spotted. In Guinea, the hen and the dog are as black as the men. In the savage state animals also experience a change of colour. The leopards and the jaguars have races entirely black. There is a variety of partridges which are white, as also a variety of white fawns. The colour, especially of the mammals, is so changeable that it is never a character of species. In all, the colour of the hair presents, at the same time, the two extremes of white and black individuals.

Were difference of colour to imply difference of species, we would have as many species in any one of the great races of men as Bory de Saint Vincent found in the whole human race. The black race, for example, is not everywhere composed of jet black men: it contains, as far as regards complexion, a great number of distinct varieties. The Koussas, in maritime Caffraria, are of the colour of newly forged iron; the brown skin of the Caffre Betjouanas holds a middle place between the brilliant black of the Western negro and the pale yellow of the Hottentots. The Foulahs of Irnanké have a light chesnut colour; that of the Hottentots is a pale yellow, not much unlike that of the land in Umbria. The Toaariks, near Timbuctoo, have the brown complexion of the Moors. In the islands of the South Sea, the black race is of a dark brown; often they are of the sootish colour; sometimes, as black as are in general the tribes of Caffraria, where however it presents different shades. The inhabitants of the isles Viti are of a chocolate colour; that of the Papous is of a brown ground mixed with yellowish. The inhabitants of New Ireland in the port of Praslin incline to a fuliginous colour. In a word, a great number of Australian tribes approximate to the yellow race by their tawny colour. The variety of complexions of the Mongol raçe are not less numerous. In America, its colour is that of red copper approaching to that of tan; in Asia, it ordinarily presents itself with the yellow hue of ripe wheat, or the bark of the dried citron. On the maritime continent it is more or less of an olive yellow; and in one of its varieties of New Zealand it has chesnut-hair, and its colour is not much deeper than that of a dark Sicilian or Spaniard. When we find this multiplicity of shades in the colour of man, we can understand, as well in regard to ourselves, as to the domestic mammals, that variety of colour is too accidental and too variable a character by which to establish a distinction of species. In fact we find these differences of colour not only in the same race, but in the same people, in the same family, and even in the same individual at different periods.

The Laplanders, the Tchermisses, the Hungarians have black hair and brownish eyes, while the Finlanders, the Permians and the As-Jacks have red hair and blue eyes. Blumenbach, however, assigns all these tribes to the Mongol race; and Balbi, on philosophical grounds, places all the languages spoken by these people in the same family—the Uralian. A portion of this Mongol race must, then, have varied from the primitive type, and, consequently, these differences of colour do not imply a difference of species. The Caucasian race presents a similar phenomenon. The predominance of a language essentially the same from India to Iceland proves a community of race among the nations that speak it; and yet the Indians differ so much from us, both in form and colour, as to be classed in another race. Hence Bory de St. Vincent makes them a particular species; and to explain the physical differences between nations united by the same language, Klaproth supposed, without any reasonable ground for the opinion, that the deep colour of the Hindoos had been produced by their mixture with a blackish race, which existed before them and which had escaped from the deluge by the mountains of Malabar. (1) We must then admit that a nation may change its colour and form so as to pass, by its physical characters, into a race different from that to which its language proves that it originally belonged. The indigenous inhabitants of Abyssinia, a people who belong to our race by their figure, which is decidedly European, and by their language, which is a Semitic dialect, are deep black. The language of the Senegambians has striking analogies with the Arabic. These people have preserved the circumcision of Ismael—a traditionary practice—observed by the ancient Arabs, as the historian Josephus testifies. The Senegambians, notwithstanding their black colour, and the Arabs would thus belong to the same race, which should not, however, astonish us, as these changes of colour, are found in the same people. Tacitus and Cæsar represent the Germans of their time with blue eyes and fair hair; but Haller, in his Letters against Voltaire, remarks, that the colour of the hair and of the eyes of the Germans has changed since the Northern irruptions into the Roman Empire; from blue and fair they have passed into black. The Jews, who do not mingle their blood with that of any other people, combine all shades of colour, from the white complexion they preserve in Poland, Germany and

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(1) *Asia polyglotta,* p. 43.

England, to the deep black which they have acquired in Hindostan, according to the relation of Dr. Dwight, and in Abyssinia. The Portuguese who are settled in various parts of Africa have become as black as the natives of that region; the Arabs and Turks have also acquired this colour on the African coast of the Red Sea. "Among the natives of New South Wales,"—observes M. Durville,—" we have seen some who, when cleansed from the fat and smoke, appeared as black as the African: whereas others had only as light copper complexion, like that of the Malays." The reports of the *Astrolabe* have also verified the relation of Forster,—that the lower classes of the people of the Sandwich Islands, obliged to till the earth or pass their lives on the reefs almost entirely naked, contract a dark colour which renders them very like the black race. Everywhere the influence of the sun is in proportion to the habits of the people. Those of Cambogia, mostly placed on islands in the middle of the sea, have a very dark complexion; but the women of the palace have a light colour; some of them indeed are of a white skin that glistens like jasper. (1) The Moresco women who remain in their appartments and are rarely exposed to the sun have a very white complexion, and women of the lower class, whom nothing protects from the ardors of a burning sky, experience the ordinary effects of such exposure: their skin contracts from their infancy a colour like that of soot.

Colour also varies in the same individuals. The children of negroes are at first of a yellowish white; their father's colour appears somewhat later. This change of colour is observed also in the yellow race. Humboldt relates that in North America there are tribes where the children are white, and, only at the age of virility, exhibit the bronzed colour of the natives of Peru or of Mexico. (2) In the negro race, a man arrived at adult age may still undergo a complete decoloration of his skin. The English have observed this state in the blacks employed by them. They have seen individuals of the deepest black

(1) *Voyage aux régions équinoxiales.*
(2) Ibid.

change to a dim white so as to be no longer recognizable. This phenomenon differs from Albinism: the constitution of those in whom it occurs, does not appear to be affected by it.

Dr. Dwight saw in Virginia a negro whose skin lost its colour in a few years; the change did not affect health, the hair became white and glossy. Original Albinism, so common in the negro race, is a transition from black to white. But, in our race, we find individuals pass, in a short time, from white to a jet-black, under the influence of some strong emotion. In 1746, a woman, learning that her daughter with her two children had fallen out of a window, was so horror struck on the occasion that the following day she was quite black and remained so. (1) The transition from white to black takes place among ourselves in the sickness called *melanosis.*

It is, then, established that colour in man is not a specific character. We may, however, advance further, and discover the source of this diversity of shades which distinguish the varieties of the human race.

The human skin presents, not only on its exterior surface, as we have just seen, but also in its thickness, modifications of colour, the cause of which was long unknown and which appeared to belong to some portions of the human race and not to others. At the present day this cause is no longer a secret; it is well known that the structure of the human skin is everywhere essentially and fundamentally the same. The skin of the white man is known to consist of three layers or distinct membranes superimposed on each other, the dermis and the two epidermis. The pigment or variously coloured matter which gives the skin its peculiar complexion, is not easily discovered in it. Three membranes, identical with those of the skin of the white man, constitute also the anatomical structure of the skin of the Kabyle, the Moor, the Arab, all of a darkish tawny colour, of the native American, or Red-Skins, of the man of Oceanica, of the mulatto, and even of the negro; but in all these races the pigment is very distinctly seen as a sort of point, placed between the dermis and the interior epidermis.

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(1) *Bulletin de la Faculté de Médecine,* t. V, Année 1817, p. 524.

The only variations is in the intensity of the colour. All the varieties of the human race, as far as regards the skin, are ascribable to the greater or lesser development of this coloring substance. This difference has nothing of a fundamental or primitive character, for we often see, in health as well as in sickness, that the coloring substance can diminish in the black, and increase in the white man. In a word, the secretion of which the pigment is the product is very liable to vary in intensity, as do all other secretions. Age, the passions, sickness, food, climate may suspend, diminish or increase it; and as a result of an original disposition, some part or parts of the integuments may secrete more or less of this pigment. If it exists in very small quantity, the skin is very white, the eyes are blue and the hair fair. When it increases somewhat, an auburn colour is produced: a still further increase gives black eyes, black hair and dark complexion. Partial albinism often produces in coloured people white spots in different parts; they are the portions of the skin which has lost its coloring matter. In total albinism, the black man becomes white; in melanosis, the white man becomes yellowish; his articulations are marked by a dark colour, and the skin shines like that of the negro. But in the normal state, it is to the influence of temperature, developing more or less, in its different degrees, the coloring substance, that must be attributed the innumerable shades of colour which the varieties of mankind exhibit.

It is undeniable that only in countries which are excessively warm, are black men found: none are naturally found beyond the limits of the torrid zone. The coincidence of the deepest colour with the most intense heat already suggests that one may be the effect of the other. This suspicion is changed into probability, when we remember that the blacks are under the line, the tawny in the South, and the white in the North; but when we find the human colour pass from one extreme to the other by shades that are in proportion with the various degrees of temperature, we may be satisfied that the influence of climate is not foreign to its cause, especially as it is acknowledged by all to be the case in regard to animals. Haller and Buffon had already remarked this. "When the heat," says the historian of Nature, "is excessive, as in Senegal and Guinea, man is quite black; when less intense, as in the Eastern coasts of Africa, he is less black. When it moderates, as in Barbary, Mongolia, Arabia, &c., men are merely dark coloured, and when it is a temperate heat, as in Europe and Asia, man is white. We only observe some variations in it which arise from the manner of living." (1) We find then that the colour of the skin and of the hair is lighter as we travel Northward, and present a deeper dye as we go to the South. This is the general law, confirmed by the exception of which Buffon writes.

These varieties not only arise from the manner of living, but especially from certain local circumstances, such as the proximity of the sea, low or elevated plains, &c. The Americans who live under the line are only tawny: but the forests which on all sides protect them, the large rivers which traverse their country and spread their vapours over it; the coolness which the gradual elevation of their territory from the shores of Brasil to the mountains of Peru; the winds which blow day and night and cool their atmosphere,—all these particular causes, by modifying the too strong effects of the sun's heat, explain the comparatively light complexion of these people.

As far as regards the colour of the hair another cause than that of climate is indicated by some facts. In the civilized nations of Europe, the colour of the hair becomes lighter as we go Northward, and this law does not vary; but for certain barbarous people of Asia, of Africa and of America, we find the same colour of hair in very different climates. Thus, while the dark haired Italian and the light haired Scandinavian, although belonging to the same race, shew the effects of the influence of climate, the Laplanders of Europe and the Samoieds of Asia have hair as black and as rough as the inhabitants of China and Mongolia. Medical naturalists must investigate the cause of this strange influence, or reduce this fact to the general law, as in the case of the colour of the Americans.

The phenomenon of coloration is thus reduced, to a secretion, to the presence among all races of an inorganic substance, the

(1) *Discours sur les variétés de l'Espèce humaine.*

quantity of which depends on food, the development of the skin, age, health, sickness, and especially climate; which is often local and not unfrequently entirely disappears.

3° *Variations in the development of the body and of its extremities in the hair, in the form and volume of the head.*—All these kinds of differences occur in animals of the same species, and often in a more remarkable degree than in man. There are at present about thirty varieties of the horse-species, which are very distinct. Without speaking of the Arab steed with its square head, its stag-like chest, its fine haunches and superb tail, we need only look at the Andalusian courser, with its thin body, its long and flexible members, and compare him with the massive dray-horse—of a compact and firm form, with heavy feet furnished with a tuft of long hair. The hair is generally formed of short hairs in the most part of our horses; but in the crisped race of Asia, the Baskir is covered with long white hairs, thick and curled, while other races are entirely bare. The various races of the dog are as different as it is possible to imagine. Observe the enormous difference between the large mastiff with his short and thick head, his erect forehead, and the development of his body; and of the greyhound with its prolonged muzzle, its attenuated head, its thin and pliable body and its shortened abdomen. Compare with the greyhound the terrier with its short and often crooked legs. The poodle and Turkish dog are also of opposite forms: the former has the front head erect and is covered with rich wool; the latter has the skin bare and the head prolonged, What difference between the small lap-dog with its round head, veiled as it were by a long and silky fleece, and the great Denmark dog with its short hair and head so different! The shepherd-dogs of the Esquimaux have the ears short and erect like those of the fox: others have them long, hanging, and charged with hair, as the spaniel. All the domestic species have undergone similar changes, which have been perpetuated by generation; and these form at the present day distinct races and varieties.

The study of animals, in their passage from the domestic to the wild state, or from one climate to another, shews that these changes can take place in a short space of time. Our domestic variety of the boar—the hog,—transported in 1493 to the forests of Columbia, where it has spread from the 25° N. lat. to the 40° S. lat., has laid aside during this time all the characters of its former servitude. Its ears are erect; its head is increased in bulk and raised at the upper part; its colour has become completely black, and remains constantly in this state. Its hair is thin in the vallies of Tocayma and of Melgar; but in the mountains of Paramos, at 2500 metres of elevation, it has thick and crisped hair. The adult, like the young wild boar, has a livery formed of a yellow line. In a word, this animal presents all the appearance of a wild boar. In America the wild dogs of European origin have a form and physiognomy which approximate to that of the wolf and the jackal. Their ears are short and erect, and their muzzle is prolonged.

Other facts prove that the simple change of climate does not require much time to produce in a species the most important modifications. Our animals, when transported to America, become in a short time, unrecognizable. In the plain of Meta, when the shearing season is permitted to pass without shearing the sheep, the wool thickens, becomes clotted, and piles away in pieces, and instead thereof there grows a short, brilliant and well fitted hair, like that which covers the goat in the same climate. This new covering remains: no wool grows where this hair has been developed. All efforts to produce wool in the West Indies have been fruitless: our flocks there have hair or bristles. This phenomenon occurs in other warm climates, and especially in Guinea. "There," says a traveller, Smith, "every thing appears reversed: the sheep have hair and the men wool." Azara had already observed that among the animals transported to America, the teguments had changed their character. He saw in Paraguay, cows, horses, dogs, hens, and other fowl with a crisped bristly hair, and in certain localities of the same province, horses without hair. He speaks also of goats without hair in Tucuman. More recently, Roulin saw, in the warmest parts of the province of Neyba, horned cattle, whose skin was entirely bare like that of the Turkish dog, and this variety was perpetuated by generation.

The creole hen, produced by the race originally introduced into America, produces a chicken which at its birth is covered with a little down, which it soon loses and remains entirely bare, except a few wing-feathers which grow as usual. The regions of Angora present us with another spectacle. The sheep, the goat, the hare, the cat, are there covered with a long silky hair, so celebrated in the manufactures of the East. Other animals are subject to this change. Heber tells us that the dog and the horse brought from India to the mountain country are soon covered with hair, as is the goat with the celebrated down of those climates.

The differences which distinguish men of the various nations of the globe are slight in comparison with those which we have seen introduced in our domestic animals. And first, the thin members of the inhabitants of Port King George, in New Holland,—of Port Jackson, of the bay of Sea-dogs,—of those of Vandiemen,—of Alfourous,—of the New Irelanders, &c., are a character of no value, as has been established by the natives of Vandiemen's Island, taken by the English in this state of emancipation, and who, when well fed, had their extremities well developed. It is, then, to the want of proper food we must attribute this disgusting slimness. The blacks are more exposed to the action of this cause than others on the sea coast, where they seldom congregate except in small populations, and are often reduced, by the unhealthiness of their climate or the poverty of their soil, to a very precarious existence. With better conditions of existence the isles Viti, in the great Pacific Ocean, are inhabited by black men, who are at once handsome and well proportioned. The four thousand Indians of the isle of Bourbon, men of our race, but descended from the poorest class of pariahs, have also, according to the reports of the missionaries, the lower members of excessive slimness.

A certain determinate volume of head is not an essential character of the species; it varies in the same race. The head of a young European of 15 years is as large as that of a Hindoo of 30 years. According to the observations collected by Combe, an English writer on phrenology, "the mean circumference of the head in contact with the hat is in London the minimum dimension of North Britain. The head of the Norwegian is larger than that of the English sailor. The hats which are sent to the North are larger than those destined for the interior of England." (1) If any one be inclined to deny our relationship to the Hindoos, notwithstanding the community of the Semitic language between us, and their numerous customs, identical with those of the ancient Israelites, he will at least acknowledge that the inhabitants of France, England, Scotland and Norway belong to the same race. The volume of the head is then too variable to establish a difference of species.

The advocates of the plurality of the human species have generally laid more stress on the form than on the volume of the head. When they contrast the negro of Guinea—with his shining black colour, his woolly hair, his flattened nose, his receding forehead, his projecting jaws, and thick lips,—with the Chinese and the English, it seems to them as if the whole question was decided, and that such contrasts between three men could never have proceeded from the same type. At the present time, when the study of the physical man is so complete, this manner of argument is scarcely allowable. The extremities of the same series of forms and of complexions, are held up as distinct species,—the intermediate forms and complexions being unknown or kept out of sight. When these latter, however, are put in their proper place, it is found that they constitute passages from one form or colour to another, and that it is impossible to perceive a primitive line of separation between differences which are lost in each other by such imperceptible shades. The Caffirs of Eastern Africa have the cranium elevated, the nose almost arched, the hair crisped but not so woolly as that of the negroes of Guinea, the features more regular, the jaws prolonged; but their lips are thick and their cheek-bone projects. In maritime Caffraria, ascending the coast of Natal from South to North, are found the Koussas, who are represented by travellers as having a fine head, a lofty

(1) *British Review*. t. IX. p. 22.

stature, regular forms and a stately gait. Between the 20° and 25° of latitude the Betjouanas are said to have more elegant forms than the Caffres. The outline of their figure is that of the Koussas, but the nose is more arched, and the lips thicker. In the interior of Africa, a great number of negro tribes, inhabiting the regions of the Soudan, present varieties of form the more remarkable as they approximate to ours. Thus the Foulahs of the country of Irnanké, have a beautiful face, the forehead high, an aquiline nose, thick lips ; the form of their head is almost oval ; they hold themselves erect, and walk with an air of dignity. The inhabitants of Buleya have almost the same characters. Those of Toron form another variety ; their face is somewhat round, their nose short but not flattened, and their lips thin. The blacks of Sangaran differ from the preceding, by a clearer complexion, an aquiline nose and a head almost oval. The Dirimans and the Kissours are well made ; they have fine features, aquiline nose, thin lips and large eyes. In the neighborhood of Timbuctoo Caillé saw nomad tribes called the Toaariks, who have long hair, a dark complexion like the Moors, an aquiline nose, large eyes, a fine mouth, a long face and the forehead somewhat elevated. The expression of their physiognomy is wild and barbarous. They are regarded as a variety of the Arabs, some of whose habits distinguish them : they speak however a peculiar language. In fine, the Hottentots, regarded by most naturalists as a variety of the black race, and who are distributed from the environs of Cape Negro to the Cape of Good Hope, have the woolly hair of the Guinea Negroes, their thick projecting lips, their depressed forehead, but their face is somewhat triangular, and their colour is a pale yellow.

The forms of the head are also different in the various isles of the sea-coast. The blacks of the isles Viti are very fine looking men ; "many of whom," say the naturalists of the *Astrolabe*, "might serve as models. They present that vigour and that grace of forms that are seen in the statue of the Gladiator fighting." Their colour is that of black chocolate ; the upper part of their forehead is broad ; also the nose, thick lips, crisped hair, which is very much tufted but not woolly. The inhabitants of New Ireland have the hair arranged in small tresses; small eyes somewhat oblique, a flattened nose, a face broadened by the projection of the cheek-bones; little beard. Blainville, however, saw among this people, at the village of Enkiliki, children who had faces like those of Europeans, and whose skin was of a clear complexion. On another point of Oceanica, the Papous present still greater variety of form in the head. The Papous who inhabit the coasts of New Guinea, the isle of Waigiou, of Santa Cruz, of Salomon, &c., form a fine variety of black men. They have the hair of the blacks of Viti; the cranium of a very good dimensions, the forehead high, the head well made, the cheek bones projecting, the nose flattened, the mouth large; but the inhabitants of the Port of Dorey, who certainly belong to the same people, differ very much from them. "We were not a little surprized," say Quoy and Gaymar, "to see faces with projecting cheek-bones, salient lips, foreheads more or less receding; the colour alone was that of the Papous, and yet these men were undoubtedly of the same race; they were born there; they were, as they very energetically declared, as good Papous as the rest."

The Mongol race on the sea-coast exhibits us many various forms of head as the others. Of the people who belong to this race, some, as the Malays, for example, have a yellowish complexion more or less deep, the deep-set eyes and salient cheek, of the Chinese; but in Malaysia itself, the inhabitants of the interior of Célèbes differ from their neighbours the Malaysians, by a whiter skin and a more rounded face; their eyes, which are oval and handsome, have nothing in common with those of the Chinese, as is the case with the Malaysians. Of the two varieties which the *Astrolabe* found in New Zealand, one consists of the most handsome individuals of the yellow race. They are tall, well made, robust. Their complexion is not much darker than that of a very dark Sicilian or Spaniard: their physiognomy is agreeable and as varied as among the peoples of Europe. Our travellers found striking resemblances to the busts of Socrates and Brutus, among them. Many appeared to Sainson to possess the beautiful countenances which are so frequently met with among the Jews. Thus the races pass into each other as well by forms as by colour.

We are not, however, obliged to go out of our own race to find in the same people differences as considerable as those which distinguish the races from each other. Thirty Egyptian mummies, examined in the Museum of Turin by Dureau de la Malle, have the auricular hole on a level with the middle line of the eyes; and the head is much more compressed in the region of the temples than with us. The elevation of the ear is from an inch to an inch and a half, compared with our European skulls. This variety still exists in Upper Egypt, and Champollion assures us that he there saw more than 300 individuals assembled, named Kennous, all presenting the striking characteristic of the height of the frame and of the hole of the ear. The Israelites, who have preserved the very type of their physiognomy, have this resemblance with the Egyptians. With many of them, the ear, without being placed so high as in the mummies and in the Copts, is much higher than with us.

We would find another variety in the fossil man, whose cranium and bones are associated with those of the elephant and rhinoceros on so many points of Europe. But why evoke extinct varieties, while the great number of those that live is already so embarrassing for our adversaries. In fact, differences in the form of the head exist not only in what it has been agreed to call the great divisions of the human species; they are found in the same race, in the same variety, in the same people: they are consequently too variable to supply specific characters. It is from the constancy of this variation of the forms of the head that is derived the common observation, that every individual has his peculiar physiognomy whatever his resemblance with those of the same place and of the same family. There is, then, a law established in living nature in virtue of which the forms of the species receive in each individual modifications which distinguish it more or less from other individuals of the same species: and hence it is a recognized principle in zoology, that in order to determine the characters of a species we must collect the greatest possible number of individuals of that species. This law which thus affects individuals would, perhaps, alone, in the course of time, or through the concurrence of certain circumstances, affect considerable changes in the character of the species and give occasion to different races. There is, however, more than one cause of these changes. Without passing through the intermediate modifications, races far removed from the primitive type may be produced instantaneously because anomalously. A number of examples might be adduced of the domestic animals. In the species *canis*, an entire race, the bull-dog, has the upper jaw-bone so much shortened that the incisors of the lower are entirely outside. This race owes its existence to the hereditary transmission of this vicious conformation. In the ox-species, a race observed by Azara, at Buenos-Ayres nas the head one third smaller than the ordinary size: the nostrils open upwards. This variety naturally shews somewhat the teeth. In the estancia of the Jesuits, called the *Corner of the Moon*, a bull in 1770 grew up without having horns, and from him was derived a race without horns. This fact is related by Azara. There is another species of ox which, instead of horns, has merely horny protuberances adhering to the skin, which, not being rooted inside in the osseous prolongation of the cranium, are extremely mobile, a circumstance which made Ælian, who saw this race in neighborhood of the Red Sea, say that the oxen of that country shook their horns as well as their ears. The products of a species born with a vicious organization give rise in this way to a new race, which is immediately derived from another. The anomalies of form to which man is liable is equally transmissible by generation. This has been long since proved by the *sexdigitarii*, or persons having six fingers, whose children are ordinarily born with the same number of fingers. It has been found also as far as the fifth generation in those who have come into the world with their skin covered with thorns an inch and a half long. The British Review, (1) speaks of a Birman sent to the King of that nation, at Ava. "The fleece that

(1) T. IX. p. 253.

covered this man was 8 inches long on his head, including his face, and 5 inches on his shoulders, his breast and the rest of his body. He had two daughters by a Birman woman, whom the King made him marry; the eldest resembled her mother, but the younger was covered with a white fleece, like that of her father during his infancy, although it is now changed into a dark, almost into a black colour. All this family is remarkable for the beauty of its forms, the size, health and strength of each individual. The country which has produced this anomaly is that wherein we find most Albinos." If the individuals marked with these anomalous characters had espoused others similarly marked,—as may often happen in small populations where marriages between brother and sister take place,—it is very probable that they would have given birth to a constant variety, as it is well known in natural history that the unions of individuals of like colours and forms cause accidental modifications to become hereditary; the race is thus established and perpetuates itself. The concurrence of anomalies in the production of races is the more probable as this sort of variations are most common and the parts of the body which most frequently present them are placed at the extremities of the organism. "The form of the human head," observes Isidore Geoffroy, "presents such innumerable variations that it would be almost impossible to determine by it the limits of the normal and abnormal state."(1) Among the general causes which modify the form of the head, we may assign the great number of flat or lamellous bones,—which are the more on that account liable to get out of shape,—that compose the head. A modification in a single bone of the head suffices to change its general form, and give to the individual an entirely different physiognomy. A shortening of the bottom of the orbits of the eye may displace the eye itself and give it more or less of inclination.

To the law that modifies individuals, and to hereditary anomalies, must be added the crossing of races and varieties, the influence of climate, and artificial deformations. From South

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(1) *Histoire des Anomalies de l'Organisation*, t. I. p. 281.

Carolina to New Mexico, all the Indians have the cranium depressed, because they place their children in the cradle so that the top of the head, covered with a bag filled with sand, bears almost the whole weight of the body. We know also that many of the blacks, the inhabitants of Brasil, the Caribs, the people of Sumatra and the Society Islands, carefully flatten the noses of their children as soon as they are born. Elsewhere a peculiar form is given to the heads of infants by means of bandages or instruments of compression, or by pressing on it with the hands. This barbarous custom has been found in many parts of Germany, in Belgium, in certain districts of Italy, among the islanders of the Greek Archipelago and among the Turks. A National Council interdicted it in Spanish America: it continues to this day among the Georgians, the Peruvians, the blacks of the West Indies,—among people separated by a distance of 9000 miles, among the Chinooks, on the banks of the Columbia, North of California, and among the Choctaws. Now it has been proved by experiments made on our domestic animals, that artificial deformations, extended through many generations, become hereditary; and were such not the case in the human species, it is at least evident that such customs render exceptions impossible or extremely rare.

4° *Variations in the degree of development of intelligence among different races.*—Many distinguished travellers and naturalists have attested the inferiority of the black race compared with other races, in the development of the intellectual qualities; and we have to regard this fact, taken in a general sense, as established by observation. But, the same might be said of the yellow race compared with the whites; and as much might be advanced with regard to certain varieties of each race when compared with other varieties of the same race. This inferiority of the black race is only an actual fact, from which we cannot draw the same inferences as if it extended to all time. It is also a fact which has been too much considered apart from the circumstances that occasioned and explain it, and which naturalists have been very wrong in regarding as the result of a peculiar conformation of the negro race. Cuvier gives us the measure of this exaggeration with which many judgments pronounced on the black race are imbued. "The negro race," says he, "the most degraded of human races, is one the forms of which approach nearest to the brute, and the intelligence of which has nowhere risen to the conception and execution of a regular government or to the least appearance of consecutive science." (1) If we pay attention to the anatomical characters which Cuvier assigns to the negro in general, we shall find that he took one of the most degraded of the varieties of this race, that of Guinea, for its type. After what we have seen of the features and forms of this race, it is not more exact to assign to it as its characteristic, a flat nose, projecting muzzle and thick lips, than it would be to represent the white race by the features and form of the Laplanders.

The other assertion regarding the intelligence of the black race is not more in harmony with facts. Do those who treat it so severely know the history of its primitive times? It is, on the contrary, well clearly proved, by the testimony of historians, that the black race anciently founded great empires and that it ruled over Egypt. Herodotus, (2) and Diodorus Siculus (3) speak of an Ethiopian called Sabacco; and Strabo, after Megasthenes, of another called Tharaca, who reigned in the land of Mesraim, the name given by the ancient Jewish writers, and by the blacks of Senegambia at the present day, to the valley of the Nile. Elsewhere, speaking of the Colchians, Herodotus says: "I think that they are a colony of the Egyptians, for like them they have the skin black and the hair curled." (4) Whether the opinion of Herodotus on the origin of the Colchians be correct or not, it is at least certain, that, having visited Egypt and seen its people, he could not have been mistaken as to the colour of their faces and the character of their hair. They were then the Ethiopians who reigned in Egypt when the historian sojourned in that country. To these testimonies of history we may add those of archæology. The Sphinx, engraved in Norden's collection, has evidently all the

(1) *Discours préliminaire des recherches sur les ossemens des quadrupèdes fossiles.* (2) Lib. II. c. 139. (3) Lib. I. (4) Lib. II.

characters of an ethiopian figure. Volney made this observation. As to the Copts, whom he regarded as real mulattoes, because, says he, their blood, mingled for centuries with that of the Greeks and Romans, has made them lose the original intensity of their colour, without essentially altering the original form of their countenance, he mentions that among the mummies dissected by Blumenbach there are many which the German naturalist himself referred to the Ethiopian race. (1) These testimonies are decisive, and the domination of the black race in Egypt is a fact historically attested.

This is the only fact which has come down to us regarding the primitive history of this people ; because neither they, nor the Egyptians their neighbors, had annalists. The little we know of Egypt we have derived from the Greek historians ; as we only know the Gauls, our ancestors, those powerful and obstinate enemies of Rome, from the historians of that republic and from those of Greece. Whether since that time the black race cast a halo round its name in Africa, or remained there in the savage state, concerns us not at all : so many nations have remained in the same state ! What were the Arabs before the sixth century? What are they to-day? In the middle ages they were our masters, and at present, the perfection of knowledge for them is to read the Koran. Thus from the supposition least favorable to our thesis—according to which the black race never re-entered on the course of social and civil perfection since the fall of its power in Egypt, we could not conclude against the intelligence of this race. This supposition, however, is contrary to facts ; it is false that the black race has been without regular governments in times not far distant from ours. On all points of Africa where the blacks are any way numerous they have established an authority. Timbuctou counts only from 10,000 to 12,000 inhabitants ; it is, however, the seat of a negro king, who rules with patriarchal authority. The discussions of the people are judged of in a council of the elders. Jenné, with a population of from 8,000 to 10,000 souls, forms part of a small kingdom

(1) Voyage en Egypte et en Syrie.

governed by a warlike Foulah, a conqueror of many countries south of Bambara, where his authority is recognized and obeyed. He is a Musulman; he has founded a city on the right hand of the river, and has established schools where the children are taught at the expence of the state to read the Koran. In Zanguebar, the blacks have a republic named Brava. The chief of Fouta-Dhialon is named by the grandees of the State who assemble to elect him. In Senegambia, Sackatou, capital of the empire of the Foulahs or Fellatahs, contains a population of 80,000 men, according to the calculation of Clapperton and Lander. In Guinea, there is the kingdom of the Ashantees. A few years since, these people nearly succeeded in driving away the English from all the colonies they held in these countries. In Southern Nigritia or Congo, mention is made of the empire of Sala (the Azico of the maps). In fine, in Eastern Africa, the Moravi who occupy the former empire of Monomopata; the Macouas, to the West of Mozambique; and the Sowali—are black nations which are powerful enough to be formidable to the Europeans. It is true these people have become known to us, for the most part, of late years, and the naturalists of the last century never calculated on their discovery.

The black race has produced souls of sublime virtue, warriors, skilful artists, eloquent writers, learned men, and poets. Was the intellect of Toussaint Louverture different from ours? This man at an advanced age, and scarcely knowing how to read, looked with the eye of genius on the circumstances of St. Domingo, and conceived the design of making his countrymen an independent people. Albeit all obstacles, the blacks of Hayti achieved for themselves an independent nationality as Toussaint had predicted. In Guyana, the busch-negroes, descendants of those ancient black maroons, who resisted the forces of the colony of Surinam, and treated with its government on terms of equality,—these busch-negroes have not degenerated from the courage of their ancestors. They are to this day distinguished from the other populations of the province by energy of character and development of intelligence. Travellers have observed, that wherever the black race communicated freely with other people, they were much superior to isolated tribes. Is it, then, outside their race that naturalists seek the conditions of the moral and intellectual development of a people? When a people has made for itself a country, by imposing on itself government and laws, will not the term of its wandering life be the term of its wild existence and of its habits of ignorance and vice? The advantages of climate and of soil, where it has fixed its seat, its relations with civilized people, the doctrine more or less sound wherewith its spirit is nourished, the wants which arise from an assemblage of great numbers of individuals,—these are the principal conditions which will elevate it, whatever be the race, from the state of barbarism to the various degrees of social perfection.

Now, in general, the blacks of Africa, like those of Oceanica, only form small groups, removed from contact with civilized nations, and having with one another few and these unimportant relations. According to the most recent researches, the population of the principal powers of all Africa is not more than the third of that of France. How could such a small body of men, grouped at great distances in that vast peninsula, form states of an importance comparable to that of the nations of Europe and of Asia, while the yellow race, the most populous of the three, counts itself but so small a number?

It is certain, in the second place, that, all things being otherwise equal, the people shew more social aptitudes and political activity, as the climate in which they live is agreeable; whether it imparts more energy to the body and at the same time more vigour to the imagination, or that, contributing to the increase of the population by the abundance of its products, it causes the want of a complicated social form to be more strongly felt. Now this circumstance has been wanting to the black race. It lives under the most debilitating of climates, and the shores of its continent, the warmest of all, are, even in the torrid zone, the unhealthiest countries of the globe. The people of the frozen zones are the only ones who are not better off: hence, although belonging to the Caucasian and Mongol races, they exhibit but very rude governments, limited to the first necessities of the social order. Placed like the blacks under the influence of climates which depress and enervate their physical constitution and dispose them to habits of indolence, they live content with little, and have no higher ambition than to repose in tranquillity.

We must not, however, exaggerate the effects of climate. A fertile and healthy soil exerts more influence on a people than the different degrees of temperature intermediate between extreme cold and extreme heat. If the climate acts on the moral character, it does not determine it; and, although this supposed determination be regarded in many books as the basis of the legislation of a people, there is no opinion less in harmony with the testimonies of history. It is not by our thermometer that we are to regulate the intelligence of peoples—their governments, their virtues, their happiness. It is education, it is learning that forms the intelligence and heart of man, and such is its potency that it triumphs not only over latitudes but also over the temperaments of men. Man is a being who essentially requires to be taught; his reason is the result of the communication of ideas. As with an individual, so with a people: it does not become civilized by itself, and without the aid of another people more advanced in the career of social life. The Greeks were civilized by the Egyptians; the Romans by the Greeks; the Gauls by the Greeks of Marseilles and by the Romans; the Franks, the Germans, the English and all modern nations, at once by all these ancient peoples, and especially by Christianity.

But if the doctrine which is to recall a people to intellectual life entirely ignores the relations of man with God, with himself, with his equals, and with Nature, instead of developing his faculties it will paralyse them. With the advantages of a fine climate and the most favorable position for communicating with all nations, what has been the intellectual progress of the Turks,—men of our race? Where are the learned men, the artists, the poets, the publicists they have produced, since Islamism has deadened their intellect by a doctrine as lethargic as the opium that intoxicates them? Fatal destiny of the black race! Of all the doctrines which have hold on man, they have received the worst,—Islamism. The breath of inspiration ought to have been communicated to them by the Christian nations of Europe, but it might appear that they preferred to execute the ancient anathema of the common father of all the races against the father of the black race. "Cursed be Canaan, a servant of servants shall be unto his brethren." (1). They have crushed it with their civilization, instead of rendering it an object of desire. During three centuries they have visited its coasts for no other purpose than to enslave: and the number of blacks torn from their country by this infamous traffic averaged in the 18th century, 100,000 a year.

Thus the black race does not appear to have been favored by any of the circumstances the concurrence of which has so often favored the development of other peoples: in itself and in its members it is not very numerous. The islands, oftentimes insalubrious, which they inhabit on the Ocean weaken them, by isolating and dividing them. In Africa the excess of heat oppresses them, and the Mohammedans give them no other alternative than slavery or their enervating religion. Since, however, on certain points, they have had freer relations with Christians, they begin to improve, and will no doubt rise in the intellectual scale, until shall gradually disappear those more prominent differences which have been a pretext for the whites to enslave them, and those characters which some naturalists have assigned as motives for referring them to a distinct species from that of man.

As with the moral, so with the physical differences of peoples. They are the result of purely accidental circumstances; they are continued, as long as these circumstances remain; they change with them. Neither the one nor the other prove that the whole human kind has not one and the same origin.

Direct proof of the unity of the human race.—If we cast our eyes on the species of the animal kingdom, we see their differences, as species, revealed by corresponding dif-

(1) Gen. IX. 25.

ferences in station, progression, manner of dwelling, and of living, in their instincts, in their voice, in their song,—in fine, in a thousand circumstances the whole of which forms what we call their instincts and habits. What is, however, particularly worthy of observation, these differences partake of the immutability of the species. Thus in the domestic animals they endure without it being possible for us to change them; they defy our power; our efforts are fruitless against those barriers which the Creator has placed as limits between the different species which they serve to distinguish. In the human race we find nothing of the kind, and after abstracting from all that is variable in the parts which compose it, the residue remains identical. We have shewn the instability of their greatest physical and intellectual varieties; we have seen that they may be made to disappear with the circumstances that produced them. The intellect, in its different stages of development, varies exceedingly in various epochs of the same people in all races. Size, colour, the proportional development of members, the volume and form of the head,—vary to infinity in the same race, in the same people, and often in the same family. These differences are explained; they are traced to their accidental causes; moreover, they are much less considerable than those which are observed among the varieties of the domestic animal species. It is, then, clearly proved that they do not constitute primitive or specific sections of the human family.

If these differences—the only ones from which the naturalists of the last century derived their objections against the unity of the species—are so changeable, how much more liable to vary are not those others of which they did not speak. The customs of nations differ; but if these customs are connected with ignorance or barbarism, the civilized man adopts others; if they are grounded in climate, soil, or other local circumstances, we shall conform to their customs when with them, as they will adopt ours when with us. All varieties of mankind may live in the same latitudes, feed on the same food, lodge and clothe themselves in the same manner. Each people has a particular language; but besides that they are the same sounds differently combined, and almost in equal number,—and that the diversity of words and their arrangement are approximately the same, all people learn each others tongue, and they could all speak the same language as they could all sing the same songs. All people have experienced, in a greater or lesser degree, the consequences of the social state; and may rise, by education, even to complete civilization, that is to the acquisition of our handicrafts, our arts, our sciences, our laws, our governments and our religious belief. It is a well ascertained fact, that the people who had been thought most removed from the civilized nations have acquired by education all the qualities of these nations. Our religion, so sublime and perfect, announced in all tongues, received and understood everywhere, has everywhere produced the same effects. It formerly civilized a part of Africa and of Asia; fifteen centuries after, it made human beings of the cannibals of the new world; it created among ferocious savages so perfect a republic that imagination in all its dreams never conceived of its like. At the present day, it mildly reclaims to civilization the Arabs of Africa; and on all points where pacific relations have been established between barbarous and savage and civilized and Christian peoples, it attracts to itself, leading by the way of truth to perfection, all the varieties of the human race.

It is then true that there is something constant in these innumerable differences that distinguish men, that is, their inconstancy itself, in which we may discover the wise laws that govern beings. The end towards which this law incessantly advances, by replacing, each day, by new characters, those that every day disappear, is to leave nothing in the shade, and by the effect of contrasts, to place every thing in a strong light. But for this, confusion would be in the family, whence it would pass to the people—to the race—to all mankind.

If we lay aside all those characters which are too variable to be specific characteristics, all the rest is identical in all divisions of the human race. All speak an articulate language, all have the same fund of intelligence, reason, sensibility and imagination. In all the cranium, the skeleton, the intimate structure of the skin, and all the other systems of the body are exactly the same; and what is particularly decisive, the alliances by which the races mix the most various forms,—all varieties of colour and of figure, are all fruitful, and produce a fruitful progeny. Hence all the varieties of men form but one and the same human kind.

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CHAPTER XVIII.

Agreement between Religion and Science on the Divine Origin of the Social State and of articulate language.

Articulate language, like the social state, of which it is a necessary consequence, is a primitive fact. Hence those who, placing themselves outside the laws of nature, have endeavoured to recognize in the social state the work of man and not of God, have been led to consider language as a human invention, while they acknowledged that they could not discover the necessity of this invention for man in the natural state, or its possibility on the part of man. To demonstrate the divine origin of language is to demonstrate at the same time the divine origin of the social state, in the same way that the creation of man being once proved, the divine origin of articulate language is rigorously deduced from it. We join, then, these two important facts as they are united in the very nature of things. The teaching of Religion on these two points is known to all. It exhibits to us man immediately after his creation giving names to the animals; it relates to us the verbal communications of the first human pair with the Creator,—the source of doctrine and moral and religious duties; the children Adam, divided among the pastoral and agricultural life, forming two small nations near each other; the city of Enoch and the rise of all the arts necessary to the preservation and advancement of society. Thus in Genesis, the first men do not pass through the state of mutism or the state of savage nature. Let us interrogate science, and see at first what she teaches us on this supposed state of nature.

I.

Origin of the hypothesis of the State of Nature.

The poets of Greece, who were also its earliest historians, supplying by fable their vague notions of the history of their ancestors, imagined the state of nature. They said; time was when men, scattered through the forests, were united by no social tie; naked, dumb, without faith, without morals, without laws and arts,—their condition differed little from that of savage beasts: it was the state of nature. The Greek philosophers accepted these conjectures and made them the basis of their systems. These passed thence to the Romans—these faithful echoes of the Greeks, and were subsequently introduced into their codes by sophists. At the revival of learning in Europe, a blind admiration for the writers of Greece and Rome, and the study of the Civil Law gave currency to these principles among ourselves. Hobbes and Spinosa undertook to draw from them their consequences; they survived the work of Puffendorf who merely purified them. They were subsequently developed with a new vigour, so that a celebrated Academy had so entirely lost the knowledge of the beginning of society as to propose for investigation the question: "what is the origin of the inequality of conditions among men, and whether or not it be according to the Natural Law?" This question received a reply in the celebrated work of Rousseau, who maintained that the state of nature being the primitive and normal state of mankind, the man of society, the man who thinks, is a depraved animal. Had good sense been the order of the day, this reply would have discredited the principle which was involved in the question. But Voltairianism had then turned the heads of every one: the doctrines of Rousseau, based on the paradox of the state of nature, penetrated the mass of society and accelerated the revolution. This was natural: if man has been thrown on the earth, without master, without law, without religion, without moral culture; if it is of himself, by his own sole will, by the power which he discovered and approved every thing that now exists, every thing that constitutes him a social being, then we must acknowledge that he is always master, and is independent in religion, in law, in government;—that he is rightful sovereign of his belief and of his actions. Nay more, thought and language, not being natural to man, the man who speaks and thinks violates the law of his nature; he is a being, or rather an animal that has degenerated. Language and Reason being abrogated, there is nothing to distinguish man from the brute.

Such, in few words, is the origin and history of this folly,—authority for which is vainly sought for in the history of man. The annals and monuments of nations always suppose a pre-existing social state. The wild nations of America and those of the South Sea archipelago were not, when discovered, in the state of nature. They had a language, they were collected in society; their state was indeed one of degradation, instead of presenting, as in this foolish theory they should, the aurora of civilization. Let us learn from Rousseau himself what he thought of the state of nature. "We must not take the researches which may be made with regard to the state of nature for historic truths, but for hypothetical and conditional reasonings; better calculated to throw light on the nature of things than to shew their real origin. Religion does not forbid us to enquire what would have become of man, if abandoned to himself.—It is evident from the Sacred Books that the first man, having received immediately from God revelations and precepts, was not himself in the state of nature: and if we give to the writings of Moses the faith which every Christian philosopher owes to them, we must deny that before the deluge, men were ever in the state of pure nature, unless they had fallen into it by some extraordinary occurrence;—a paradox very hard to defend and entirely impossible to prove." (1)

The distinctive characters of man prove that he was created in the social state.—Outside the society of his fellows, it is easy to shew that man cannot attain his physical, intellectual, and moral development. The science of zoology proves

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(1) *Discours sur l'origine de l'inégalité parmi les hommes.*

that, as far as regards the instincts of animals, the higher the species are in the animal scale they more need have their progeny of the assistance of their parents in their development. Thus, while the lowest of the mammals, the ornithodelphi, appear in this as well as in many other respects to approximate closely to the birds, who are so attentive to the wants of their young, the quadrumani, or the highest of the mammals, are also those who occupy themselves most with their progeny. They even generally live in herds. Now of all organized beings, man is the one who in his birth is environed by most wants, and who stands most in need of assistance on the part of his parents. He has less instinct than the animals, whom he is to govern by his reason and morality: but these qualities are only developed in society. Meanwhile, he cannot prepare his food, nor speak, nor walk, nor clothe himself: of himself he can only—weep: *flens animal cæteris imperaturum*, observed Pliny. Most frequently also he finds no resource in his mother, who after having given him birth finds herself almost in a dying state, so that both mother and child would perish together were they abandoned in these critical circumstances. Hence the family is absolutely necessary both to mother and child. But what would become of the family itself, but for society that protects, defends and supports it? The animals, especially the carnivorous, abandon for ever their young ones when they are able to look for their food, and often drive them away never more to recognize them. Admirable law of Providence! By this means more space is left to each pair wherein to find food; each couple takes a position in order to fulfil its destiny. By this means each species finding everywhere a hostile species, the excessive multiplication of all is prevented, and a general equilibrium maintained: by this means wars of extermination between the species are avoided; individuals fall but the species is saved. What is the safety of the animal species would be the ruin of man, who, scattered over the earth in couples or small families, could not sufficiently protect himself against multifarious and widely spread evil influences of climate, against the laws of matter which incessantly tend to the destruction of organized beings, or against the animals that attack him; or subject and overcome the useful animals, or till the earth to constrain it to yield him a subsistence. Isolated families might, indeed, live some time; but they would not fail gradually to disappear, and the multiplication of the human race would be impossible.

Man is not only a physical being; he is also essentially an intelligent and perfectible being: *capax scientiæ* (capable of knowledge) said Aristotle; and intelligence renders him susceptible of education. What is called education in the animal is, to place it in the circumstances most favorable to its conservation. The animal nourishes its young, and by that means develops its organism; the pap where the young drew in life dries up; hunger urges them, and they partake of the food of their mother: she however soon refuses to share with them, and necessity compels them to seek food elsewhere: their instinct directs them, they have no need of the example of their mother. The animal, then, does not transmit any knowledge to her young, because she herself has none. The animal perfects nothing; it does what its sire did without any addition, and it does it instinctively without having learned to do it. If certain domestic animals transmit acquired habits to their progeny, as race dogs, they owe this to the lessons of man and not to those of their sires. The animals improve nothing, and are themselves incapable of improvement and cannot acquire knowledge. They have nothing to learn from one another: each knows naturally all it should know in order to attain the end of its creation: they have then no need of living in society.

Not so man: intelligent and reasonable, he can know, can systematize his knowledge, increase and transmit it: he is susceptible of improvement. But we must observe, knowledge does not belong to the individual but to the society. Each individual may drink at this source, and even increase the stock, but society alone owns and preserves all. Hence, education in man is not merely the education of the individual but of the species: society acquires for the future as for the present: in it there is really education, because there is knowledge and the transmission of knowledge. The individual does not bring with him, at his birth, knowledge: he is born merely capable of receiving it; but if it be not taught him, he will never possess it. He must receive its elements from without, and, by the aid of these elements, he may advance and augment each day his knowledge. This proves that his intelligence of itself is active, but that to enter into activity it has need of being excited by an extrinsic cause. Hence the necessity of organic instruments by which intelligences may communicate among themselves. Language, of which we shall speak further on, is the first of these instruments. Animals have no language; they have only cries,—expressions of their passions and of their wants. Man alone possesses an articulate language and its formulæ, because his intelligence is active and thinking. Now, out of society, man could not speak; his intelligence could not manifest itself; it could not at once grasp the past, the present and the future. The present would be all for him; his individual present conservation would entirely absorb his thoughts. Although an isolated man might acquire, by his intellectual activity, certain sciences useful for his conservation and his existence, they would die with him, but for social education; and consequently each individual would be obliged to recommence his education, which also would end with himself, and the species would never gather its fruits for future generations. The isolation of individuals would be an eternal obstacle to the improvement of the species. Perfectibility, then, being a character essential to man, which can only be developed in the social state, we must needs conclude that society is the natural place for perfectible man, as the air is that of the bird, the water of the fish, and, consequently, that man was created in the social state. This conclusion is so rigorous that in setting out from the state of nature we are logically bound to deny the perfectibility of man, and to say, with Rousseau, that the man who improves himself is a depraved animal.

Another character of man, and the highest prerogative of the free activity of his understanding, is his morality. As a moral and religious being, man is in relation with the physical world, which he has to use in the limits which his wants prescribe, without ever passing them, under the penalty of injuring himself and of destroying the work of God. He is in relation with his fellows by a mutual exchange of duties ; he is in relation with God, Whose creature he is, and Whom he should recognize as his Supreme Lawgiver. But out of society, his morality is null and without application. It is without application because he is isolated : it is also entirely null, since out of the social state the *pabulum vitæ* (bread of life) fails his intellect which is ignorant of itself, of its equals, of the world and of its Creator. In vain do men endeavour to explain human development in the hypothesis of a state of nature ; it cannot hold its ground against these facts. The organic nature of man, the study of his nature compared with that of animals, the laws of development of any natural being whatsoever ; human intelligence, its morality, all demonstrate that man, endowed with social qualities, has been made for society. The study of articulate language will lead us to conclusions no less rigorously demonstrated.

II.

Language is not a human invention. Man does not speak, unless he has learned to speak.

In the higher classes of the animal kingdom, each species has received from the Creator a voice or utterance which is peculiar to it, and which it uses instinctively without extrinsic succour. The bird, separated from its birth from those who gave it life, sings with exactness the paternal chant which had never struck its ear ; the lion's whelp, taken at an early age from its cradle and its forest, will roar at a later period like those of its species. Man also has a voice, an utterance, an articulate language, but of himself he will never speak it, unless he has heard it spoken. With him the organs of respiration, the most perfect that exist, can rise to utterance, even to articulate language : the tongue, the teeth and the lips will take part in his high function of intellectual communication : but all these organs will for ever remain unmoved in the individuals if they are not called into exercise by society. This law admits no exception. The infant does not speak until after a long apprenticeship in language. All the experiments made by the ancients never produced speaking men. All those who have been lost in the woods, the two men mentioned by Condillac, the two children of whom Rodwith speaks, were completely dumb. The wild man of Aveyron, whose history is related by Bonald, after two years' instruction, gave no signs expressive of any thought, he merely shewed with his finger the present objects which had reference to his corporal necessities. It was the same with the child which was found in 1694 in the forest of Lithuania; he gave no sign of reason, as Condillac mentions; had no language and formed sounds which were any thing but human. He was a long time before he was able to utter some words. As soon as he could speak, he was questioned as to his former state, but he had no more recollection of it than we have of what happened in our cradle. Louis Racine has left us details no less authentic than interesting on Mademoiselle Leblanc, a poor wild girl, found near the village of Sogny, four leagues from Châlons, in 1731. She was from 14 to 18 years' old when she came out of the woods, and was caught. She knew no language, articulated no sound, she merely formed a guttural cry, which was terrifying. She could imitate the cry of some animals and that of some birds. When found, her intelligence was extremely limited, her memory recalled very little of her wild life, and absolutely nothing of that which preceded it. Those who spoke first to her of religion did not discover in her any idea of a Supreme Being.

In all these individuals the vocal organs were formed as are ours, since once restored to social life, they learned to speak as we do, by hearing their fellow creatures speak. If they did not articulate as well as we do, this was owing to the fact that the various parts of the vocal apparatus had had time to contract a certain inflexibility which rendered their motions more difficult. They were then dumb because they had not heard any one speak; or, more correctly, because they had ceased too soon to hear spoken language; for it does not appear probable that they were lost in the forests or had been abandoned there by their parents before the age of five or six years. An an earlier age they would not have escaped the wild beasts, or have been able to provide for their subsistence. At five years of age a child speaks. They spoke then when they were abandoned to this wild life; but separated too soon from society, which imparts the science of speech, they soon unlearned and at length totally forgot it.

Since men are dumb only because they have been long separated from the society of their fellows, have never heard, or have ceased too soon to hear spoken language, it follows that complete deafness should produce with us the same result. Since the labours of the Abbé de l'Epée and the Abbé Sicard have caused the establishment of two houses of public education for the young deaf and dumb of both sexes, it has been possible to observe them with care in all the great cities of Europe: and observation has given the following results. "Every person who is deaf from birth is also dumb: dumbness is the effect of deafness, that is, the deaf-mutes from birth are dumb because they have not heard spoken language. The vocal organs are as perfect in them as in other men. The moral and intellectual world does not exist for the deaf-mutes; it is instruction that introduces them to it; material objects alone have fixed their attention. The idea of a first cause, the distinctions between just and unjust, between vice and virtue—have not shed their light on their intellect. Their habits are those of the society in which they have lived; for the rest they resemble those who have been found in the forests."

Thus man is not born with speech; he only brings with him the faculty or capability of speech; and in the child this faculty requires to be exercised by a long apprenticeship in a society that speaks. In passing from infancy to adult or mature age, the dumb man, unless he hears others speak, remains dumb: and it would be the more impossible for him to invent a language, as, on the one hand, the vocal organs become more and more firm and inflexible, and on the other, his intelligence, instead of being gradually developed, like that of men who had matured in the midst of society, remains, on the contrary, buried in complete ignorance of itself, and of moral and intellectual objects, as is proved by the fact of children, brought up together and deprived of all verbal communication with their speaking fellows, and of individuals found in pairs in the forests. Hence the necessary inference, that articulate language is not a human invention.

Moreover, intelligence, perfectibility, morality,—these distinctive characters of man are developed only by articulate language, and for the deaf and dumb, by means of written language. If man has invented language, the development of these essential characters is nothing more than an accident and the consequence of a fortuitous discovery. It is then by accident that man speaks, thinks, exercises his free activity, perfects himself, is moral and religious. It is by accident that man is superior to animals, instead of being their inferior, as would be the case, if he did not speak; in a word, it is by accident that man is man; and as in all the hypotheses which have been framed on the human origin of language, the theory and application of language would not have been the work of a day but would have required ages, we should regard the first men as contradictory beings, having faculties without exercising them, organs without functions, morality without moral acts, perfectibility without possible perfection.

Absolute impossibility of the human origin of articulate language.—The supposition of the human origin of language, presented—not seriously it is true but as an intellectual joke—by Condillac and Rousseau, has had the advantage of preparing the demonstration of the divine origin of language and the investigation of its elements. Unable to educe articulate language from the state of nature, Rousseau soon ceased to argue on this hypothesis, and, following Condillac, he supposed society already constituted, and reproduced some of the arguments of this author, to contest or modify them by his own observations. Thus, as Rousseau acknowledged, the use of an articulate language would have been impossible before the formation of society, because it could not be established without a prolonged convention for many generations, and such a convention presupposes society to be already formed. Rousseau does not tell us how mankind could have passed from the state of nature to the social state without the aid of language, and what other mode of communication could have been employed by that first society to determine the reciprocal duties of the associates, and to place it in the condition of exacting them from each other. "The difficult problem,—which is the more necessary, society already established before the introduction of language, or language already established before the formation of society,—he leaves to be discussed by those who may be willing to make the examination." (1)

For whoever knows how to read, the whole discourse of Rousseau is a profound refutation of the state of nature and of the human origin of language. In fact, even in the hypothesis of a pre-existing society, he finds that scarcely can a person form a tolerable conjecture on the origin of this art of communicating thought. He sees at every step he makes a multitude of embarrassing objections for which he does not discover any solution. He asks, "how could man, by his own energy and without the aid of language, clear the distance between pure sensations and the most elementary knowledge?—Whence would he derive the idea of a language the model of which did not exist in nature? How could its necessity be felt by men who had no other than material wants, and to whom the easy language of signs would have sufficed for their supply? Or, how could those men, whose vocal organs had become stiffened by a long silence, have subjected themselves, without a pressing necessity, to the painful exercise of articulate sounds? How, without language, could men have agreed to substitute articulate sounds for signs? Who were the interpreters of this convention for the ideas which, not having a sensible object, could not be indicated by voice or gesture? He could not conceive by what means these new grammarians extended their ideas and generalized their words, &c., &c. In fine, affrighted at these accumulating difficulties, he frankly acknowledged himself convinced of the almost demonstrated impossibility of languages having arisen and been established by purely human means."

(1) *Discours.*

The principal difficulty of the hypothesis, is the necessary relation that exists between thought and its expression,—a relation which Rousseau clearly perceived, which he often referred to, but which has been expressed with greater development and at the same time greater precision by Bonald in his *Philosophical Researches*.

"Man," he observes, "cannot *speak* his thought, without *thinking* his word. As he cannot think of material objects without having in him the image, which is the expression or representation of these objects, so he cannot think on incorporeal objects, which do not fall directly under his senses, without having in himself and mentally the words which are the expression or the representation of these thoughts, and which become discourse when he makes them heard by others. In a word, we can only think by means of words, when we do not think by means of images: hence a mental word, or word-thought was necessary, to enable man to think on the combinations of language,—to think even of inventing speech."

This made Plato say: "thought is the discourse which the mind holds with itself." Leibnitz observes that "language is the mirror of the understanding." Dugald Stewart says: "it is impossible without language to occupy one's self with objects and events which have not fallen under our senses: words are indispensable to enable man to think of genera, and universals." Rousseau: "We must enounce propositions, we must speak in order to have general ideas, for as soon as the imagination stops, the mind can only advance by the aid of language. Words alone can present general ideas to the mind. Abstract beings are only conceivable through language.

"In a word, man not having been able to invent language without agreeing to do so with himself and with others,—or to agree without thinking of it, or to think of it, without knowing his thought, or to know his thought without being able to name it, it follows most rigorously that language was necessary, if language was to be invented."

Finally, Lamennais in his *Essay on Indifference*, traces the law of this phenomenon. "The reason of this so intimate connexion between word and thought is the connexion between body and soul, in virtue of which thought, like all other human operations, has its appropriate organ. To every thought corresponds a certain modification of the brain and something sensible, as the mental, or oral, or written word : so that an idea without expression would be an idea which would leave no trace in the brain, which would not affect the organ of thought, and of which the mind would be unconscious. Hence, as a consequence of his nature, man—a corporeal and intelligent being—can no more think without words than he could see without light. Hence he could not have invented language, since this invention would imply pre-existing intellectual ideas and the means of communicating them."

To conclude, " There is," " says Rousseau, " a very specific quality which distinguishes man from the animals, and in regard to which there has never been any dispute,—the faculty of perfecting himself, a faculty which, aided by circumstances, develops successively all other faculties, and appertains both to the species and to the individual; whereas the animal, at the end of some months, is all that it will ever be, and the species, at the end of a thousand years, is what it was the first year of that thousand."—Now, man perfects himself, he develops his essential characters, his intellect, his moral and religious character by means of written or spoken language. The example of all the deaf-mutes, of all the children abandoned in the woods, proves it conclusively. Rousseau himself acknowledges it. " General ideas," he says, " can only be communicated to the mind by means of words, and the intellect can only grasp them by the propositions in which they are expressed. This is one of the reasons why animals cannot form such ideas, or acquire the perfectibility which depends on them." (1)—Thus, although man does not of himself speak, he has been made to speak, since the word is necessary for the operations of his intellect, for the development of his perfecti-

(1) There is here a logical fault as regards the animals. If the animal does not improve it is not because he has not language, but he has not language because God has not created him perfectible : for in this case He could not, without inconsistency, refuse him the means of perfectibility.

bility and of all his other distinctive characters. Hence of all beings he is the only one in whom the organs of respiration are susceptible of rising to articulate sounds.

This so necessary instrument of language man receives only from society, and preserves it only in society. Hence the social state is the natural—the necessary state of man. This conclusion is confirmed by the fact, that everywhere man speaks, everywhere he lives in society. The state of isolation which in general is a means of preservation and of perpetuity for the animal species, would be the death of the human species; the life of his body as the life of his mind, demands the social state. Moreover, if mankind had ever been in the state of nature, he could not have got out of it, since he never would have been able to arrive at language, this instrument of his sociability. The state so badly called the state of nature was not the starting point of humanity, and this senseless hypothesis of Condillac and Rousseau is only made philosophical when we use it for the purpose of shewing the profound wisdom with which God has proportioned the means to the end, by creating man in the social state, as Genesis teaches us.

Languages differ from each other only by the vocabulary and some secondary rules of syntax. These varieties are the result of human intelligence, which, once in possession of language, can modify it, and develop it in proportion as its ideas and sentiments extend and multiply. Still the first supply of language is not its work: language would have been necessary for man that he should invent language. But man does not, of himself, speak; he brings into the world only the faculty of speech: this faculty then must have been put in exercise by God Himself. Rousseau acknowledges that language could not have been established by purely human means. Was this superhuman means, this divine succour,—which has put the human race in possession of articulate language,—granted to all the members of a perfect society formed by the assemblage of pre-existing families? In this case the establishment of the organic social instrument would have required as many miracles as there were individuals in this first society. It is, moreover, supposed that this society could have been organized without language, and that the pre-existing families might have lived in an unnatural state, in conditions which would not have permitted either individuals or the species to develop their perfectibility, their activity, their morality,—a supposition the absurdity of which is evident. The divine aid was then given to a single family and to the first family; and Moses in fact represents Adam and Eve with their children using language. This is our second accord of Science with Religion.

In fine, what were the means employed by the Creator in communicating language to man? Did He speak to him, as a Mother does to her child, when she wishes to form his organs to the articulation of sounds and to teach him to speak? Did He give him language by infusion, as Jesus Christ gave it to the deaf-mute of the Gospel? These two means of communicating language are equally supernatural, and it is of no importance to decide for one rather than for the other. The first, however, appears to me more logical and profound. In fact, we stand at this moment at the cradle of the human race, at the origin of the moral laws of society: there is question not only of establishing language, but also the law which should preside over its perpetuation; and of making known to man this law, of which he was himself to be the minister in every succeeding generation. Language given by infusion would not attain this triple object. It is an exceptional—extraordinary means: that is, it derogates from the general order established by the Creator; whereas in speaking to our first parents, He created language, established the law of its transmission by the organ of hearing; and made known this important law, the observance of which by the parents renders the child perfectible, and introduces him into the intellectual, moral and religious world. Thus Moses does not tell us of the infused gift language, but he exhibits to us the Creator in frequent verbal communication with the first ancestors of the human race, commanding man to give names to the animals and thus laying as it were the first foundations of language,—of this "sublime art," says Rousseau, "which is already so far removed from its origin, but which the philosopher still finds at so great a distance from its perfection, that there is no man bold enough to say that it will ever attain it, although the revolutions that time brings were suspended in its favour, and the Academies could occupy themselves with this subject during an uninterrupted series of ages."

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CHAPTER XIX.

Agreement of Genesis with Science as to the point whence all people emigrated; as also whence Mammals have been distributed over the earth.

According to Genesis the continent of Asia was the one centre of the creation of mankind, and probably also of the land mammals. After the Deluge it exhibits to us the whole human race gathered together on the plains of Chaldea. The harmony between the chronologies of the earliest nations, the identity of their traditions and of various customs, and the analogy of their languages depose in favour of the community of their origin and of their point of departure for the various countries to which they emigrated. All the early nations recognized the Creation and the Deluge with a number of identical circumstances regarding each;—the human race created in one single couple and made to the image of God; the names of our first parents; a state of innocence followed by a state of fall and degradation; the division of the week into seven days; the observance of the seventh day; the long life of the first men, &c. You find these traditions among the Chaldeans, the Persians, the Egyptians, the Phenicians, the Chinese, the Hindoos, the people of Thibet, the Mexicans, the Senegambians, &c. The Asiatic colonies brought them to Europe, where they were collected by the Greeks, and thence passed to the Romans.

The chronology of the Chaldeans does not go back farther than 2237 years before Christ; that of the Egyptians to about 2200; that of the Persians to about 1769. I speak of their positive chronology, rejecting as fabulous what every one at the present day regards as such. No pagan chronology makes the human race more than 2 or 3000 years before Christ; that of Moses is the only one which assigns to it an earlier origin. The date assigned—by the Chinese, the Indians, and the Samaritan text—to the great event of the deluge is almost the same. The Indians place it about 3100 years before our era; the Chinese 3082, and the Samaritan text 3044; and the event is related in the most ancient books of these people with the identical circumstance of the ark, the dove, eight persons saved, Noe, &c. In order to explain this fact we must admit the assemblage on one point of the globe of the founders of these nations—so far removed from each other and so different in every respect.

In the second place the assemblage of mankind in Chaldea, before the departure of the first colonies for the different parts of the earth, is a fact entirely conformable to the route they are known to have followed. Every thing proceeds from the East, men, arts, animals; every thing advances slowly towards the West, the South or the North. History shews us already monarchs and great empires in the heart and on the coasts of Asia, when there was no knowledge of other more remote colonies; these latter did not then exist, and the former were occupied in founding and consolidating their establishments. Every instructed and upright mind will feel itself irresistibly impressed by the exact correspondence which is observed, from age to age, between the various details of Sacred History and the contemporary condition of society.

The population of Europe came by the chain of Caucasus, and hence its name, Caucasian race. Asia Minor first, then by the Balkans, Thrace and Macedonia were peopled; by the same also came the Leleges and the Hellenes, the first inhabitants of Greece, to the South of which subsequently emigrated the Phenician and Egyptian colonies. The migrations continued on the one side by the northern Balkans and the Carpathians, whence came the people of Germany; on the other side by the Alps, whence came the Etrurians and the ancient inhabitants of the Alpine regions, the Gauls, &c. The original inhabitants of Egypt dwelt in the chains of primitive mountains which slope down into eastern Africa and extend towards the South. The southern slopes of these mountains, with their vast plateaus, were anciently illustrated by Ethiopian civilization, which, at a later period, descended into Lower Egypt in proportion as human skill and labour triumphed over the waters. The first migrations to America may have taken place at an early period by the isthmus—now the Straits of Behring, or in times less remote by the sea which separates it from India and China. As for Oceanica it was detached from the continent as well as the greater part of the islands of the India archipelago: the Hindoo traditions attest the fact in regard to many of these islands, and their form confirms the statement.

All naturalists assign the East as the original seat of our domestic animals.

Not only has error been imbibed with regard to the high antiquity attributed to the Chinese, the Hindoos and the Egyptians, but also as to the part they performed in the civilization of other people. History shews us the first germs of the progress of the human mind issuing from Chaldea. To Greece belongs the honour of having especially methodized the positive sciences. India and China remained in the back ground; since we can assign their appreciable progress—much inferior to that of Greece, in later times—to a period not long probably before the commencement of our era. Egypt does not appear to have cultivated science before the Greco-Egyptian Dynasty. The attempt to make China, India and Egypt teachers of other nations is opposed to the most positive teachings of history.

Thus the annals of all ancient people, their traditions, the history of the sciences, tell us, as does Genesis, that Asia was the starting point of mankind. Geology and paleontology hold to us the same language. The position of the sedimentary rocks on the slopes of granitic mountains shews that the first habitations of men and animals were plateaus of mountains, forming islands or extended peninsulas. In proportion as the gradual emersion of the sedimentary surface permitted them to change residence men descended into the vallies. Thus, we see the early Hellenes scattered on the mountain-chains, surrounded by the marshes of Thessaly; the first Egyptian tribes occupied in redeeming their land from the encroachments of the Nile; the Chinese of Jao labouring in reclaiming the marshes. Now the granite-plateaus of central Asia are the most elevated and the most considerable that exist. The thickness of sedimentary strata increasing, and the strata becoming more complex as we advance from the eastern regions towards the western basins, and from the polar regions towards the equator,—this proves that the sea retired in the direction of from East to West, at least in Europe and in a great part of Asia, and afterwards from the North towards the South; so that the western and equatorial parts were still under water when the others had long presented, in their primitive plateaus and their emerged sedimentary surface, large and suitable habitations for men and the mammiferous animals. Hence it is from East to West that the migrations of men and animals must have taken place. The distribution of fossils on the surface of the globe confirms this conclusion. We find them, setting out from the elevated plateaus of central Asia, diverge in every direction, to the North, in Siberia, and afterwards in Russia by the Ural mountains, then descend towards the Caspian and Black seas. The western division advances by the Caucasus, Taurus and the Balkans; casting to the right and to the left, in the Danubian and Adriatic basins, the remains of their inhabitants and especially of the lamellidontal elephants, of rhinoceri, and of various carnivorous animals,—it continues by the Carpathians and the Hartz mountains, which distribute the same fossils on their two slopes, towards the Baltic and the Black sea on one side, and on the other in the vallies of the great rivers. These two radii of emigration follow one another to the western extremity of Europe, to France and England, which present the thickest and most numerous aqueous rocks and at the same time the lowest levels. From central Asia another division goes southward: it begins to shew traces of its inhabitants in the lower Himalayas, and it continues by the primitive surface as far as Africa; but we are not sufficiently acquainted with its fauna to speak of it. In fine, a fourth division advances from central Asia eastwards and penetrates America : it may have anciently joined America and Asia by the Atlantis, which would have terminated at the chains of Atlas and those of the Spanish Pyrennees. In this vast tract, at least in that part which is freed from water, that is in America and the sub-Pyrennean basins in Spain and France, it is almost the same fossils that prevail, the mastodon-elephants ; whereas the lamellidontal-elephants are more numerous in the other divisions.

The human race in its migrations has followed the same routes, opened to the animals by the lowering of the level of the sea. Asiatic geology has not yet been studied ; but as soon as we leave Asia to enter Europe, human fossils appear with those of living and extinct animals. Human crania have been found at different levels, in the valley of the Danube, between the Balkan and Carpathian slopes, consequently in the same circumstances as the fossil animals placed on this western line of emigration. Various parts of Germany, the slopes of the Carpathian and Hartz mountains, have yielded similar fossils. They have been found between Messen and Dresden, with the remains of extinct animals ; as also in the caverns of Kostritz, at various depths and associated with extinct species. They have been then successively transported thither, like the bones of animals ; and consequently man dwelt in this country at the same time as the extinct species. The territory of Baden has given human bones and crania, lying at various depths, with the remains of lost and living species. In the breccia of Saxony, human bones are associated with those of the rhinoceri and fresh water shells. Various works of art and remains of ships have been found in the marl and sea sand-layers near Stockholm in Sweden : the country was then inhabited and navigation exercised when these layers were formed. On the two banks of the Meuse, on those of the Vesdré, in all the caverns of Belgium, human bones have been met along with those of bears, rhinoceri, elephants and other lost and living animals. Some English caverns have yelded human fossils, associated with the bones of elephants, of rhinoceri, &c., and accompanied by pottery, bone-needles, axes and knives of silex: these last are the well known arms of the ancient Celts and Gauls. Thus from the eastern point of the Balkans and Carpathians to the western slopes of the Hartz, the Vosges, and the Ardennes, and even in England, human fossils occur in the same circumstances as those of animal remains. The human race then followed the same line of emigration as these latter; but as the animals are found from the lowest tertiary, and human remains are only met with in the caverns and in the most superficial of the free alluvions, we must conclude that mankind followed the animals, but at a subsequent period; and it is probable that to human agency the disappearance of so many animal species should be attributed.

If we now follow the line of the Alps and the Appenines, we find fragments of sculpture, of pottery, remains even of houses in the marine strata, at Pozzuoli near Naples,—circumstances which prove that these strata were formed at a time when the arts begun to flourish in Magna Grecia. All the caverns of Byze near Narbonne, those of Salles-les-Cabardes, of Miollet, of Poudre, of Sommières, of Sauvignargues, contained human bones with the remains of human industry, associated with the bones of various animals. In that of Miollet, a Roman statuette and copper bracelets have been found. These caverns have consequently been filled since the occupation of Gaul by the Romans; and as they contain extinct species, we must conclude that these animals existed at that time. If we connect this fact with the great destruction of all kinds of animals which the Roman shews and circus effected in the first ages of our era, it will be difficult not to see in it one of the causes of the disappearance of many species, and of the commencement of the rarity of others. We know that in less than 500 years near 30,000 animals perished in the games of Rome; and that even from Great Britain were sought Caledonian bears, on account of their peculiar ferocity.

Hitherto human fossils have not been found on the line which advances from the centre towards the North of Asia, neither in Siberia, nor in the slopes of the Ural mountains; but on the other hand, we know that if China was peopled at a very early period, it was visited from the remotest times by the Tartars and the Mongols, who descended from Siberia and from all the northern countries of Asia. These countries must then have been peopled as soon as China, if not earlier. Siberia has only primitive rocks and alluvions; they appear to owe their origin to the disintegration of the two chains of the Altais and Ural mountains, which make Siberia as it were a large island. The coal-beds found there were deposited by the same rivers that caused the alluvions. Its geological constitution and fossil animals shew, that if Siberia was originally covered by the waters of the sea, it was one of the first continents from which the waters retired. Its rivers were formerly swelled and its climate rendered much more temperate by the Caspian sea, which washed the feet of the southern Ural, and by the North sea, which covered Russia in Europe and extended to the western slopes of the same mountains. The elephant and the rhinoceros might soon arrive on the plateaus, in the vallies, and round the lakes of the Altais and the Urals. After their death they were carried away by the great rivers of Siberia into the alluvions which cover it.

The eastern line has left even as far as America traces of its animal emigration. North America has furnished fossils of man and of the products of his industry; at St. Domingo human skeletons in marine limestone recently emerged; in the isle of St. Laurence, in the heart of a marine stratum have been found fragment of cotton thread, of platted reed, a head of Indian Corn: human remains have been found in the geological strata of Tennessee. In South America the bone-caverns of Brasil contained a human skull with the remains of extinct animals. These human remains may in part be posterior to the discovery of America; but many, and especially those associated with extinct species, are anterior to the arrival of Europeans.

Thus geological facts, history and the traditions of nations, agree with Genesis as to the point of departure for the human species and the mammiferous animals, and as to the routes they appear to have followed.

Geological facts also teach us that the tertiary rocks in our European countries were formed before, during, and after these migrations. These are subsequent to the deluge as is proved by history. It is also proved by the fossils which succeed each other without interruption from the first to the last tertiary beds, to the caverns, the loose alluvions and the bogs, presenting, at all the levels of their series, the mixture of lost and living species associated in the caverns, in the marine strata of Pozzuoli, in the loose alluvions and in the bogs with human skeletons, or the products of human industry, which do not reach back farther than the civilization of Magna Grecia and the occupation of Gaul by the Celts and Romans.

Another interesting circumstance which I should not omit, although unconnected with Sacred Cosmogony, is the condition of Europe when it received its first inhabitants. Geology exhibits it to us in these early ages of the world, forming by its most elevated granite rocks a great number of islands surrounded by a vast primitive or secondary sea. Now it is precisely thus that Moses describes it, when speaking of the children of Japhet who peopled Europe: "by these were divided the islands of the nations in their regions; each one according to his language and family." (1) They divided among themselves the islands of the nations. This is the name the Scripture gives to Greece and to all Europe.

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(1) Gen. X. 5.

CHAPTER XX.

REVIEW OF THE POINTS OF AGREEMENT.—EXAMINATION OF THE VARIOUS METHODS OF ACCOUNTING FOR THIS HARMONY.—CONCLUSION: GOD HAS SPOKEN TO MAN.

An Infinite Intelligence does nothing without an end. The world exists: what is its end? Doubtless the glory of Him who made it. But among so many animated beings, which proceeded from the hands of the Creator, one only is capable of fulfilling this end,—one only can offer to God his own homage and that of all creation. This creature is man, who has relations with all the departments of nature, and cannot in his present condition dispense with their service. Man, in the designs of the Creator, is then the sole link between the world and God: it is then his duty to render Him the glory He looks for in His work. Man has thus a great mission to fulfill in this world, which has been made for him since it is made subject to him,(1) and of which, by fact and right, he is the master and the ruler in a manner however that must not pass the laws established by the Great Mandatary of this delegate, the Sovereign of this vice-roy; the God of this demi-god. But man, alone capable of glorifying his Author and that of the Universe, is also the only being endowed with liberty. His reason enlightens him without imposing any necessity in the use he makes of his free will. Hence the necessity of moral laws, to regulate this free will and prevent man from abusing it, and of being unfaithful, by this abuse, to the mission he has received. Moral laws are no less necessary for the world than physical laws; since if these latter assure the maintenance of the divine work, the former secure its end, the glorification of the Creator.

Has then God revealed Himself to the Master-piece of His visible creation, to make known to him the duties of his mission, as Genesis teaches us, when it exhibits Him placing in the

(1) Gen. I. 26.

hands of man the sceptre of this lower world, subjecting him to a law of labour, interdicting him the use of a sensible object, that he might feel more deeply and perpetually his dependence, questioning him after his fall, and reproaching him with his disobedience. Thus all the writers of the Old Testament, and especially the author of Ecclesiasticus.—"He shewed them good and evil;—and their eyes saw the wonders of His glory, and their ears heard His glorious voice, and he said to them: "Beware of all iniquity." (1) This is also the teaching of the New Testament; (2) as it was the sentiment of Plato, Epicharmis, Cicero, Lucan, and other pagan philosophers. This was also the belief of all the ancient people, since all believed in a religion revealed to man by God Himself at the beginning of time. After having created man, has God then condescended to speak with him, as one man speaks to another? This is the question which we have to answer from the results of science.

And let us observe, at first, that it is nothing wonderful that He who gave organs to the soul of man, and refused him every other way of communicating with other souls and of ascertaining their existence, should use organs to communicate with man, and manifest to him His existence, His perfections and His works. I do not speak of the evident possibility of this mode of making Himself known to man: I speak of its suitableness, and of its analogy with Nature. Would it have been suitable that the Creator when He had just established laws, should dispense with them in His relations with our first parents? By one of these laws we receive every thing from society,—language, instruction, &c.; now the only possible society for our first parents was that of God Himself; and was it not eminently suitable, that, having received from Him all our faculties, all our faculties should concur in bringing us to Him, and convincing us of His Existence? In what is the action of God on our eye or on our ear more wonderful than would be His action on our brain, to which the partizans of the

(1) Ecclesiasticus XVII. 6. 11.
(2) S. Matthew, XIX. 4. 5.—Mark, X. 5.

so-called Natural Religion wish to limit Him, apparently because this system was never the Religion of any people? Articulate sounds are nothing more than modifications of air; and the Being who possesses creative power possesses that of modifying the creatures He has made, a power which man himself possesses in an extraordinary not to say mysterious degree.

Let us also observe that primitive Revelation did not wait, in order to have a title to human belief, until the ultimate development of natural sciences. And yet its demonstration by these sciences is nevertheless a fact of great significance, inasmuch as it shuts out rationalism, deism, and pantheism, —systems which boast either of not admitting the testimony of history except for purely human facts, or of not recognizing any facts which do not proceed from science and which are not its immediate deductions. Let us then pass in review these various points of agreement which we have established between the history of creation in Genesis and positive sciences, and we shall find that they supply a new and unanswerable argument in support of primitive revelation.

Moses teaches us that the world had a beginning; and geology on its part attests that there was a time when there was neither water, nor vegetables, nor animals, nor mankind. (1) —And yet how many philosophers, since the time of Moses, maintained the eternity of the world! How many asserted that individuals alone die, but that the species are eternal; admitting thus an infinite succession of mortal beings, without assigning a cause for such series.

Moses teaches us that the earth was created in a solid, liquid and gazeous state: and this mixed state is attested by the absolute inadequacy of the neptunian, plutonian, or chemical theories, which suppose the origin of this earth in one of these three conditions, to the exclusion of the rest. (2)

Moses teaches us that God created certain bodies under determinate forms. Experience and observation always present matter to us in composition or the elements of composition. We can only conceive matter in one or other of these two

(1) Chap. X. (2) Ch. II. V. VIII. IX.

states, and consequently always in the form of a body.—And yet Lamarck admitted a general matter, a pure abstraction of his own mind; and before Lamarck, Buffon had also admitted a primitive organic, and a primitive inorganic, matter of which all bodies were made. (1) When I mention Buffon, Lamarck and others, I render homage to the thinkers of sixty centuries; I name honorable and honored men. I do not mock at humanity in its eminent men: they were mistaken, but they were honestly mistaken. They represented the general state of science in their times, as Moses represents tradition.

Moses distinguishes light from the sun, which is only the instrumental cause of its vibration: and this separate existence of light, and this function of the sun, which is now taught in all our science-books and schools, (2) was rejected by the great Newton. Before him, Origen conceived that no man of sense could see any thing but an allegory in the Mosaic narrative. St. Augustin could form no idea of this primitive light, which preceded the creation of the sun. Pagan philosophers laughed at the statement; and it was a source of boastful mirth for the infidel writers of the last century.

Moses states that God made the *firmament*, and this expression is rigorously exact as a designation of celestial space; since, agreeably to the latest results of science, the expanded fluids in this space are the bond of equilibrium, the cause of the stability of the motions of the heavenly bodies and of the earth. (3) Still even to our day this word 'firmament' afforded occasion to certain minds to ridicule what was called the natural philosophy of the Scripture. A great number of ancient philosophers, particularly among the Greeks, considered the heavens as a solid vault, to which were attached the heavenly bodies. This is not the philosophy of Moses.

Moses shews us the surface of the primitive earth, divided, as at the present day, into seas, rivers, mountains, vallies and plateaus. This division geology demonstrates. (4) Still Burnet asserted that before the deluge, the surface of the earth was equal, uniform, continuous, without mountains or seas.

(1) Chap. VIII. (2) Ch. XI. (3) Ch. IX. (4) Ch. XIII.

Scheuchzer also supposes, that the earth was without inequalities of surface before the deluge. Buffon, in his "Theory of the Earth," attributes all mountains, without excepting granite and porphyry, to deposits accumulated by the sea; and Beaumont assigns the formation of the primary mountains to a period subsequent to the deposit of the transition series.

Moses teaches us that on the third day of Creation, the waters were gathered into one basin—'*into one place*,' and geology confirms this statement of Moses. (1) The celebrated astronomer Whiston thought that the basin of the sea did not exist before the deluge. Before this event, in place of the immense valley which contains the ocean, there was, according to him, on all the surface of the globe many small independent cavities, containing portions of this water and forming so many small independent seas. Moses had stated the contrary; and this fact for the first epoch of the world geology establishes. The formations of the second and third epoch were deposited in *smaller*, *independent* and *separate* basins.

Moses describes the universe as the work of one only God, Creator and Disposer of all things. All modern sciences combine to give the demonstration of this great fact. (2) And yet among the ancient philosophers some attributed the formation of the world to hazard; others, while admitting a Creator, subjected Him to fate; while others again saw in the world the work of two powers,—the Good and the Bad principle. The cosmogonic fragments of Buddhism and of the Edda admitted also the concurrence of many Gods in the arrangement of the universe. Other philosophers regarded the order of the world as eternal. Thales derived it from water; Parmenides, from air; Democritus, from the full—plenum—and the empty—vacuum; Heraclitus, from fire; Epicurus, from the motion of atoms. Among the moderns, Fichte makes it spring from idealism; Schelling represents the world not as a creation properly so-called, but as a manifestation of God, and man as a reflected form of the universe,—a system which has some resemblance with that of Menu. Buffon, in his *Epochs of*

(1) Ch. XII. (2) Ch. XVI.

Nature, and Lamarck, his follower, believed they could dispense with a God, Creator of matter ; and asserted the creation of the elements of matter, and its subsequent arrangement by the laws of Nature.

Moses exhibits to us an Eternal God, One, Creator and Disposer of all things, Supremely Powerful, Free and Independent, Most Holy, Good and Just, Supremely Wise and Intelligent, Immutable in His will as in all His perfections. (1) The ideas he communicates of the Deity are as sublime as those we receive from our philosophy enlightened by Christianity. The God of Moses, then, has nothing in common with those gods, imagined at the same time by the wisest nations of antiquity;—gods who were indifferent to man's lot, and who abandoned him to capricious change or inflexible fate.

Moses shews us that the heavenly bodies, no less than plants and animals, were made for man. There exists an intimate relation between the heavenly bodies and organized beings; and astronomy makes known to us by what peculiar constitutions and combinations the heavenly bodies present to the three great natural kingdoms favorable conditions of existence. (2)

Moses says that species is a reality, and zoology demonstrates it. (3) Yet, how many naturalists and philosophers, confounding the general and abstract idea of plant and animal with that of species, have taught that species was a mere abstraction!—Buffon and Lamarck, not to mention others, were of this opinion.

The Mosaic narrative implies that all the species were created and established, each one on a different plan, determined beforehand. Comparative anatomy, zoology, and paleontology —both animal and botanic—agree entirely with Moses, and demonstrate that the species are distinct and mutually independent; that they are definite and limited for circumstances no less definite and limited; that they are not the product of physical laws, nor derivations from a small number of primitive types, by means of successive transformations, or modifi-

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(1) Ch. IX. (2) Ibid. (3) Ch. XIV.

cations. Paleontology establishes, in an unanswerable manner, that the variations of the media of existence, by means of which the transformation of species is supposed to be effected, have never taken place, and shews that, at the same time, from the earliest sedimentary rocks, all the great divisions of the two natural kingdoms appeared simultaneously, being represented by species of the most complex as well as of the simplest form. (1) — Contradictory assertions against the creation, and against the independence and perpetuity of the species, have not been wanting. Many philosophers and naturalists adopted the theory of the change of species. Buddhism derived man from some winged and luminous genii ; it attributed the loss of his wings and radiant body to his moral degradation ; and the existence of his physical functions to his necessities. The Hindoo philosopher, Kapila, derived woman from the desire of man ; and from this first species, he derived all others, from the ant to the elephant. Epicurus and Lucretius taught that the earth was the producing cause of the first individuals of each species, whether vegetable, animal, or human. Pliny also regarded the earth as the source of all the beings that live on its surface. Nearer to ourselves, we have seen Robinet unconsciously reproducing the doctrine of Buddha and that of Kapila, and affirming that the organs, and consequently the species, are the result of inclinations, necessities and desires : we have seen Lamarck accepting this same idea, and deriving from a primitive monad, produced by motion in a liquid, primitive type of each grand group of animals ; and Goethe, looking in plants and animals for a primitive type which should be the perfect image of all plants and animals. Oken inferred from the thesis of Goethe that nature is a single living being, whose organs are all its parts : and G. Cuvier himself made little account of the stability of aquatic species.

Moses says that God created the plant and not the germ or the seed which the plant is ordained to produce :—botanic and animal zoology shews that, for the vegetable as well as for the animal, such should be the natural process. (2) And are

(1) Ch. VIII. XIV. (2) Ch. XIV.

there not even in these days botanists who maintain the contrary, forgetting alike the laws of reasoning and the filiation of beings?

Moses says that the vegetables were created before the sun and the animals; and physiology both finds this order natural, and rejects the hypothesis of an atmosphere almost exclusively composed of carbonic acid for the use of vegetables and the thousands of ages which paleontologists were not afraid to place between the creation of the vegetable kingdom and that of the sun. (1)

Moses supposes that certain animal species were created in the domestic state. The hypothesis of the original wild state of all animals denies this; but science rejects it, and speaks as Moses spoke. (2)

Moses says, that each species, animal and vegetable, was created in more than one pair, and this assertion is in perfect harmony with the facts of Natural history. (3)

Moses says that God gave the plants and the whole vegetable kingdom as food for the land-animals, the birds, and all that moves on earth: this supposes the existence of herbivorous animals in all the groups of the animal series, and this also Natural history teaches. (4)

Moses has distinctly marked the differential character of the three great divisions of organized beings, the plants, animals, and men. (5) Now these characters were not definitely accepted by science as leading characters until the time when science achieved the demonstration of its principles through Blainville.

Moses shews us from the first days of the world the organized beings distributed in the water, the air, and the different parts of the dry land: and this primitive and general distribution of beings perfectly accords with the observations of geology, which already finds land vegetables, fresh water reptiles, insects, &c., in the transition-strata, that is to say, at the same time as all the classes of marine animals. (6) These facts have been denied, first by the old geologists, who believed that the rivers and the seas had been long time without inha-

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(1) Ch. IX. (2) Ch. XV. (3) Ch. IX. (4) Ib. (5) Ib. (6) Ch. XIII.

bitants; then by the geologist, who believed that the waters were peopled long before the dry land, then by Deluc, Ferrusac, Cuvier, Ampère, &c., who thought that the various classes of vegetables, and those of the animal kingdom, were successively brought to existence, and that each of these creations was separated from the rest by a long interval of time.

Moses teaches that mankind consists of a single species, and anatomy and the laws regarding species rigorously demonstrate the fact. (1) Yet it is known how many objections against the unity of the human race have been suggested by the difference of colour. Virey admitted two species of men: Desmoulins, eleven, and Bory de St. Vincent, as many as fifteen!

Moses says that the social state vas the original condition of man, and the distinctive characteristics of the human race invincibly establish the fact. (2)

Moses shews that articulate language is not a human invention, and the essential relation that exists between thought and its expression ought to have taught this truth to the advocates of the state of Nature. (3)

While paganism and philosophy taught gross errors on the nature and origin of mankind, Moses taught that man was made to the image of his Creator, that he is His master-piece, the object of His care, the lord and end of creation, the being through whom the world is connected with God, and on whom rests the end or object of the Divine Plan, the glorification of its Creator. (4)

Moses says that mankind was created in a single pair, and its point of departure, to go and people other countries, was Asia. Now, the traditions of all nations, their annals, the history of the progress of science, geology, &c., agree on this point with Moses. (5)

Moses gives us the history of a creation by parts, but unique and forming a harmonious whole; and geology, paleontology, zoology,—all the natural sciences agree with Moses. (6) Still

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(1) Ch. XVII. (2) Ch. XVIII. (3) Ib. (4) Gen. I. (5) Ch. XIX. (6) Ch. VII.

there have been geologists who sought to look on the world of Genesis as a different creation from that which contains the fossils.

Moses relates the creation of the organic kingdoms in less than four days;—and geology, agreeing with him on the short interval of time which separated the creations, attests the simultaneous presence of animals and plants and of the greatest part of the divisions of the two natural kingdoms, from the earliest deposits. (1) And yet, how many geologists have maintained that the two kingdoms, and even the various groups of which they consist, were separated in their creation by long indeterminate intervals.

In a general successive creation, each being should precede in time that for whose use it is intended. Now it has been scientifically demonstrated that the various parts of the world appear in Genesis in this order of subordination of parts to the whole. (2)

Moses implies, and geology demonstrates, that organic life once establised on earth has been uninterruptedly maintained there. (3) Yet many geologists have asserted that the globe has been frequently peopled and devastated. According to Whiston and Woodward, the whole earth was dissolved in water at the epoch of the deluge,—a supposition which led to the necessary conclusion that all living beings were destroyed. Nearer to our times, Deluc, Cuvier, Ampère, and others admitted general deluges of fire and water, which destroyed all beings before the appearance of man.

Moses shews that since the establishment of rivers, seas, organic kingdoms, the relations of our globe with the atmosphere, light, the moon and sun have never ceased to be what they are at this day; and geology in fact demonstrates that this order of things has not varied essentially from the epoch of the earliest deposits to that of the latest. (4) And yet, if we were to believe Deluc, Cuvier, Chalmers, Buckland, and others,—the laws which regulate the relations of this earth with the other parts of the solar system are of recent origin,

(1) Ch. III. (2) Ch. IX. (3) Ch. XIII. (4) Ibid.

and the beings whose fossils we study had different relations, in regard to light, and the celestial bodies from those which we at present have.

The proof being always in favour of Moses in regard to all the preceding facts, we are to ascertain if these facts thus scientifically established supply a solid independent argument in support of primitive revelation. Now one of the following six propositions must be admitted :—

Either God Himself revealed these facts to our first parents;

Or, our first parents were the witnesses of creation, and in either of these suppositions transmitted the history of these events to their posterity;

Or the author of Genesis was divinely taught;

Or these facts are nothing more than logical deductions from the scientific principles of the first ages;

Or Moses attained their knowledge by the unassisted efforts of his own mind;

Or, in fine, it was by chance that they flowed in this order from his pen, and that he conjectured so accurately on so many difficult points. Let us examine these various solutions, the only ones we can imagine.

I.

The agreement of Genesis with our Sciences could not be the result of knowledge acquired in the early ages of the world.

Considered at first in itself the Biblical Cosmogony has all the characters of a true narrative, and none of those which distinguish a scientific summary. There is no reasoning, no scientific terms, no classification, no philosophical reflexion. Let it be compared with that of Menu, and it will be seen what a difference there is between a simple tradition, and a tradition recounted by a philosopher. (1) Menu places in the number of creations, time and its divisions, the human passions, anger, desire, pleasure, austere devotion, &c.; his subtile

(1) See at the end of this volume a parallel between the two cosmogonies.

philosophy causes him to take abstractions for realities; he speaks of the four elements, the five senses, he discusses at each verse on the nature and attributes of the Creator; and, far from giving his cosmogony as a simple tradition, he is very careful to inform the reader that it is he, Menu, who philosophizes in this wise: "After having so produced this universe and *me*, He whose power is incomprehensible, &c."—Here we have the philosopher combining his ideas with tradition. There is nothing like this in Genesis; the historian is forgotten, and his narrative addresses itself to the faith, rather than to the intelligence, of the reader.

If we afterwards examine this narrative with relation to the time in which it was written, it will be impossible to find in it the result of the sciences which at present attest its exactness: for at that time these sciences did not, and could not, exist. Instead of harmony with the facts narrated in Genesis, ancient philosophy which comprized all the knowledge of those times presented nothing but assertions and systems contradictory of these facts. Before establishing this point, it is necessary to define science, and state the question with accuracy and precision.

"A science in particular is the knowledge of the body of the laws which govern the facts that concern it, in their succession as in their generation or reason of being, so as to deduce from them by principles the truth of those which are current or known, and the prevision, more or less immediate, of those which as yet are obscure or hidden. And by the word, 'principles,' in a well constituted science, we must understand with Newton the logical or mathematical expression of the laws which govern the part of material or phenomenal beings which it comprizes."

"The science of organization, taken in a general sense, and consequently embracing man, animals, and plants, which constitutes anthropology, zoology and phytology, is that which teaches by principles the laws that govern these three great classes of natural bodies, regarded in the normal and abnormal state, as well in their form and structure as in the phenomena which are produced in themselves and in the acts which they exercise on the rest of the co-existing beings of their own or different species, without neglecting the study of the rank they hold in the general harmony of things." (1)

Different views of the same science have given occasion to as many distinct sciences, at least in appearance, under the name of *anatomy*, in which we study the form, structure of organized bodies; *comparative anatomy*, when we compare the organs of these various bodies with one another,—*physiology*, when we apply to the study of their functions; *natural history*, if we limit our attention to the acts they exercise in regard to others, that is their habits and instincts, and *paleontology*, if fossil bodies are the objects of our investigation. Such are the different parts of the science of organization, or zoology as it is often called. Like all other sciences, this presupposes antecedent knowledge, by which the intellect of man is exercised and sharpened previously to any application of its powers. This knowledge consists in that of logic, dialectics, the art of method, of nomenclature and expression.

We have then to speak of sciences duly constituted, comprizing the knowledge of the laws, which govern facts or phenomena,—that is to say, their general causes,—and sometimes rising to foresight, as before explained. Before arriving at this state of perfection, they did not yet contain the principles which so fully confirm the sacred record of creation. The facts revealed in this record could not then be made so fully to harmonize with the natural facts established by science. We must not lose sight of this principle. We do not, then, intend to say that the primitive ages were ages of ignorance; we even believe that the germs of science, more or less fully developed, existed among all ancient civilized people,—germs which were insensibly developed, and which the great number of observations successively, and as it were separately, made, and circumstances more and more favorable, have elevated to our perfected sciences. Every one acknowledges that these branches

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(1) *Histoire des Sciences de l'Organisation, par M. de Blainville. Introduction,* p. 16.

of knowledge, in as far as they are scientifically constituted, are very modern; and the product solely of the 17th, 18th and 19th centuries. In saying then that they were not known to antiquity we say nothing that any body denies. There are also other sciences, such as meteorology, astronomy, geology, chemistry, which although not so scientifically complete as the preceding ones, still contain positive facts, and invariable principles on which to base a conclusion, and which antiquity did not know.

Having given these explanations, I say that in ancient times none of the sciences which we have used in establishing the sacred cosmogony were known. Was chemistry known? The ancients always kept speaking of the four elements; we meet with them in all the cosmogonies. Now chemistry is a science, the knowledge of which is a necessary preparation for most other sciences. Physiology has need of it, to learn what is the respiratory aliment of animals and plants, and to know the connection between the two great organic kingdoms by means of the elementary kingdom. Geology must recur to it, to establish the identity of the materials of ancient and modern rocks, and deduce there from its most general principles. (1) Was geology known? It requires fossils as the preliminary of its study. The knowledge of fossils supposes anatomical, and physiological data, as also an acquaintance with natural history which the ancients did not possess, and which even were wanting in Buffon, although living in the 18th century. Simple and comparative anatomy, without which it would be vain to attempt a natural classification of the species of the two organic kingdoms, were not known at the time when Moses wrote. In the 11th Chapter of Leviticus, he names about forty animals of different classes; he distinguishes the ruminants from others, but we do not find any natural grouping; and we perceive that the animals have not been studied in themselves or comparatively, with any other view than that of

(1) If Buffon's History of Minerals is so inferior to his other works, it is because he made no use of the science of chemistry. Linnaeus was guilty of the same fault.

salubrity. The book of Job, if not written by Moses, is of very early date. Its author was acquainted with the customs, the manners and knowledge of the ancient world. We find in it the evidence of astronomical and musical studies; we see architecture employed to build palaces, and art used in excavating mines. There is mention in it of Egypt, of the trade with India, of precious vases, of arms and sieges: a certain number of large animals are described in it, but solely in a poetical manner. This book also contains questions on rain, the winds, snow, ice and light; but with all this there is no vestige of our positive sciences. And yet, if they had ever flourished among the ancient people of Asia and of the valley of the Nile, they could not have perished with these people: their numerous applications would have passed into the arts, into commerce and industry: they would have become, as in our days, no longer the property of one nation, but that of all the civilized people of Asia and Africa. We would find them among those various people, either at the same or at different epochs. We would find them in ancient Egypt, where the sacerdotal colleges, which were the academies of that country, were perpetuated without interruption by priestly succession, for there is no trace of any interruption in history, nor is it possible to admit that this institution, the depositary and conserver of all the knowledge of those times, would have entirely and at once disappeared from the soil of Egypt, over which it was spread in so great a multitude of branches. Yet ancient Egypt shews no trace of our sciences, either on her monuments inscribed with hieroglyphics, or in her arts, or in the books of her national or foreign historians, or on the papyri of her necropolis, or in the arts and monuments of her Greek colonies, or in the observations of Thales, Herodotus, Eudoxus, and other Greek philosophers, who sojourned for a long time at different epochs in Egypt, or in the celebrated school of Alexandria, which must have collected all the science of conquered Egypt. Egypt knew astronomy, as the Jews, the Chaldeans, the Chinese, the Hindoos: and yet there remains but little of its astronomy which is unquestionable, but as Desdouits observes, we have of its astrology as much as would fill the 200 volumes of Mercury Trismegistus. We would find our sciences among the Jews, of whose books we possess many, and who, in their long captivities, would have communicated the knowledge of them to other people. We would find them in the ancient books of the Chinese, a people now stationary, but always eminently conservative; or if the Chinese of those times had no relations with other Asiatic nations, we would find these sciences among the Hindoos, most of whose ancient works have been published by the Calcutta Society. So far, however, from this being the case, it becomes daily more and more evident that the little natural knowledge we meet with in the Chinese or Hindoos does not date earlier than our age. Among none of the peoples of antiquity do we find either the applications of our sciences, or our sciences themselves, or the preliminary and instrumental knowledge necessary to their acquisition or to their improvement, such as natural philosophy, chemistry, method, or nomenclature.

Our sciences did not then exist among the ancient post-diluvian people: I will add, neither could they have existed. In the first place, for want of general convictions calculated to elevate and purify the mind, astronomy degenerated into astrology, medicine into incantation, chemistry into alchemy, and natural philosophy into magic. Once entered on this path, the world would have had time to accomplish its destiny before the sciences could have been constituted. It is at least in great part on this account that, despite the ancient civilization of certain pagan nations, as the Hindoos and the Chinese, nowhere at the present day are the exact sciences fully developed except in Christian nations. The sciences would not, indeed, have had this obstacle to surmount among the Jews, whose doctrines were so pure, but there were other difficulties scarcely less insurmountable. The laws of Leviticus permitted the Israelites to eat only of the ruminant animals which had a cloven hoof, of fishes with fins and scales, and of four or five species of insects. All other animals of these classes, as also the reptiles, the amphibians, the crustacea and the mollusks, were forbidden; and consequently were not brought to the markets, where they might have arrested the attention of those who would wish to cultivate the natural sciences. What is of still greater importance to remark, is, that all the prohibited animals were accounted *impure*, and that to touch even their dead bodies, would have been to contract a legal defilement, for the expiation of which certain severe penalties were enacted. It is very evident that these prescriptions of Moses,—otherwise very salubrious in a warm climate, where cleanliness and choice of food are so essential to preservation of health,—opposed an insurmountable obstacle to the cultivation of anatomy and of all the other departments of the science of organization which presuppose anatomy. Let it be remembered that all other Eastern people had similar laws or customs. If it was forbidden to touch a human carcass or other dead body, much more was it not permitted to dissect it. The very intelligible prejudice against human dissections was common to all people; and it is only since it has given way to the necessities of society that anatomy has been able to make any progress.

The study of organic nature by the early postdiluvian nations could not then be prosecuted so successfully that the narrative of the creation could have been deduced therefrom as a logical conclusion. Will it be said that the sciences were constituted by the antediluvian patriarchal families, and that they were lost at the deluge or subsequently, without leaving any other trace of their ancient perfection than the results relative to the creation transmitted by the children of Noe to their posterity and subsequently recorded in Genesis? Those who represent to themselves the first men as occupied in the study of the sciences either must not have reflected on what Moses relates of them, or must have made no account of it. Placing ourselves at first at the point of view supplied by these traditional documents regarding the antediluvians, we shall see that the sublime natural science which some attributed to them, but of which Moses says nothing, was, humanly speaking, incompatible with the character of this primitive society.

Genesis makes known to us the total length of the lives of the patriarchs: it names the founder of the first city, the first man who dwelt in lents and inaugurated the pastoral life, the first who invented the instruments of agriculture and of music;

but it says not a word of those who made collections of animals or plants, or who practised medicine—an art which implies some knowledge of plants and of human organism. This silence is significant, for the wonders of science, if known to the antediluvians, would have struck them more forcibly than the art of those who played on the harp and guitar. The numerous animals introduced by Noe into the ark presented Moses with a favorable occasion of saying something of the zoological science of this patriarch, or of that of his ancestors. I do not attach much importance to this negative proof; but the constitution of these model-men, their alimentary regime, their social state and their manners, supply us with more decisive considerations.

The children of Cain inhabited a city founded by their father, to the East of Eden. The families descended from Seth, and the other children of Adam dwelt in the country of Eden. These two branches of mankind although separated by habitation and manners, were always neighbours, since in the course of time they contracted mutual alliances, which brought on general corruption of manners, and the reign of violence and brutal force mentioned in Genesis. The sacred historian gives us the genealogy of the children of Seth to the deluge. These circumstances suppose that mankind before the deluge formed only small communities, and occupied but a very small part of Asia. Hence after the deluge Moses says that Nimrod was the first who made himself powerful on the earth, by the formation of a kingdom of which Babylon and three others cities were the beginning. He tells us also that the life of the antediluvians was agricultural or pastoral. From these primitive facts it follows that the social conditions of this first age of the world were the least favorable to the cultivation and advancement of the natural sciences. Almost exclusively occupied in tending their flocks or tilling the earth,—divided into families, without forming large national communities,—surrounded on all sides by uninhabited lands, which they were able to cultivate and appropriate without obstacle,—these ancient men had no stimulus to impel them to the study of natural sciences, which, like the arts, are the result of social wants.

The study of plants was at first directed to the healing of disease. Before the deluge, men lived for the most part exempt from sickness, and died by the natural exhaustion of their strength, as we see it also in the history of the post-diluvian patriarchs. The study of plants, with the exception of the alimentary species, was not then a necessity; or if the medical art is derived from this period, its practice must have been extremely limited. Now of all professions that of medicine is the only one necessarily connected with the study of animals and plants. Hence among the great number of naturalists, who, from Aristotle to Blainville, have given a great and appreciable impulse to the study of zoology, we can only count three who were not physicians: Aristotle, Albert the Great, and Buffon.

The vegetables were the first food of man. As long as this exclusive regime lasted, there was neither hunting nor fishing, and consequently no opportunity whatever for the study of animal life: the chase and the fishing-rod are for the zoologist what the quarries, the mines, and the coal-beds are for the geologist and mineralogist. (1) At a later period, when animal flesh formed part of man's food, this custom, limited by regard for health or by manners and prejudices, was confined to a small number of species which zoology cannot yet exceed. We find in Leviticus the distinction between pure and impure animals; but the legislator of the Jews found it already established in the world, and there were no other changes to make than those of which experience had proved the utility, or which were demanded by circumstances and the intention of guarding his people from the superstitious practices of the neighboring nations. It existed before the deluge, since in the narrative of that great event, Noe is ordered to preserve in the

(1) We have a treatise of Paul Jaube (1660) *de piscibus Romanis*; i. e. on the fish sold in the Roman markets: another of Rondelet (1554) on those used in France. Commerce, industry, travels, great public and private enterprises, for public or private advantage, have furnished naturalists with materials, without which science would be impossible.

ark both pure and impure quadrupeds and birds. The impure, and consequently prohibited animals, were the whole animal kingdom with the exception of a small number of species, chosen in three or four classes. It was not then more possible for zoology to establish itself before the deluge than in the ages that followed that event.

The dissection of plants for the purpose of arriving at a knowledge of their functions is subsequent in point of time to animal anatomy; before it would have wanted both a standard and elements of comparison. Animal physiology and comparative anatomy are equally derived from simple anatomy. This latter, at first, had nothing further in view than to attain a knowledge of the human system, for the purpose of healing its maladies. Can we suppose that the want of anatomy was felt by those robust antediluvian constitutions, which endured, without maladies, for many ages? And in the supposition that its want was then felt, how could simple and comparative anatomy, and, consequently, physiology,—animal and vegetable,—and paleontology,—how could these sciences be established and developed at a time when it was not permitted to dissect animals, and still less the remains of man, both being reputed impure either by law or custom, and the last being especially protected by the general opinion which condemned human dissections?

In Europe, where these prohibitions do not exist, the horror of dissections is general. The reptiles and cold blooded animals were long kept in a lower rank than they hold at present, in consequence of the repugnance which naturalists and physicians themselves felt in touching them. It is known, that Linnaeus did not dare touch a frog, and that Ray, under the influence of the same prejudice, had not courage to anatomise and study the reptiles. How much more must not have these repugnances kept men aloof from anatomical studies at a time when their utility was so feebly, if at all, felt and acknowledged.

Two thousand years of observations, made by men whose lives approached the duration of a thousand years, with whom the extent of intellectual ability was in proportion to their physical faculties, would, doubtless have elevated science to a high eminence, had these men lived in circumstances analogous to those of modern society. But time and length of days are not enough. The centenarians of the postdiluvian world did not constitute a single science; and at the present day, when the life of man is so much abridged, the progress of science is neither slow nor intermittent. The Sciences, then, in their development, depend less on the limits of life than on certain other conditions, which were not found in the ancient societies, either before or after the deluge.

We can conceive that the first men should have cultivated astronomy. It was, from an early period, necessary to determine the months, the civil and sacred year,—both divided into months, weeks, and days: to regulate the celebration of festivals in a uniform manner, to guide the steps of the traveller in the desert, or on the ocean, before the discovery of the compass. Patriarchal longevity, the periodicity of the heavenly phenomena, of which a single individual could ascertain the return, the calm nights of the East, the habits of pastoral life,—all were favorable to astronomical observations. This was not the case with chemistry, phytology and the other sciences of organization: to create these something more than eyes were necessary.

Will it be said that we must not rely too much on the history Moses has given of the antediluvian epoch? Shall we reconstruct it by aid of imagination, as did so many of the great postdiluvian nations? Even then we shall find ourselves with the same objections to answer as have been suggested by the Mosaic narrative. The more we shall attribute to it of civilization, necessities, sensualism, intelligence, industry, discovery, and commerce, in a word the more we shall assimilate it with our own epoch, the stronger will become the argument we have advanced. Let us suppose for a moment that our western civilization perished by a deluge or some equally destructive catastrophe, will any one believe that such an occurrence could obliterate all our sciences, and destroy every vestige of their numerous applications to all branches of human industry? Would it destroy all traces of our rail-roads, and electric telegraphs,—our diversified machinery, our chemical preparations of gas-light, our paper and all other manufactures, our steam-boats, libraries, types, barometers and thermometers: our astronomical instruments, our collections and anatomical preparations, our philosophical apparatus, our monumental inscriptions and medals,—in so complete a manner that those who would devote their time to excavate the ruins of Paris, London, Berlin, and other great cities, would find nothing in their ruins which should attest the science and civilization of their former inhabitants? This must be admitted by those who attribute to the primitive societies a scientific development no trace of which can be discovered.

It is then certain that the natural sciences, such as they are to-day in Europe and European colonies, were unknown to antiquity. Now as the cosmogony of Moses contains in a few lines the summary of a long series of facts the knowledge of which could only be attained by human means, after the immense scientific development of the 17th, 18th and 19th centuries; since all the facts recorded in Genesis are in harmony with scientific results, which were neither known nor suspected at the time of Moses and before him, and not until these latter times,—and that the philosophers of all nations and of all epochs had always considered these facts as erroneous, we are forced to acknowledge that this narrative could never have resulted from the knowledge possessed by primitive times.

II.

Had Moses knowledge of these facts by the efforts of his own genius?

In this second supposition, Moses, considered as a philosopher and naturalist, would have been beyond his age, and his contemporaries would not have been able to avail themselves of his knowledge. He would not have been understood, and his scientific works, if any, would have perished because not appreciated. Hence, it might be said, we find no trace of these sciences subsequent to his time.

This is, or rather would be, a silly solution; it is opposed to all the facts of the history of the sciences, as well as to the laws that govern their development.

I.—In studying the history of science from Aristotle to our day, in this long period of 2000 years, we find, that of so many men of genius devoted to its pursuit a very small number, uniting their own observations to those of their predecessors, have succeeded in giving an impulse to science sufficient to carry it even a few degrees beyond the point at which they found it; while the efforts of the great majority of scientific men have been abortive, from a variety of causes not necessary to be enumerated. Among those who have promoted science there is not a single one who did so by his own unaided efforts. Anatomy, created by Galen, became a science in the hands of Vesalius, but owes its perfection to modern times. Vesalius was but a partial anatomist; the higher and more delicate achievements of this science are not his. Comparative anatomy, —of which we find some remarkable germs in Aristotle, Galen, Bélon, &c.,—was not at all developed until the time of Vicq-d'Azir in the last century. Physiology, sketched by Aristotle and but little advanced by Galen, first assumed the form of a science in the immortal work of Haller, based on the experiments of Harvey. Natural History was indeed attempted by Aristotle, but before Buffon it was not developed. Phytology was still slower in appearing. The Greeks and Romans did not look upon it as a special science, and although Theophrastus, a disciple of Aristotle, was acquainted with more than 500 genera of plants, and although Pliny mentions more than a thousand, these writers regarded it in no other light than an accessory to agriculture, horticulture, medicine and the arts. In his treatise on vegetables, Albert the Great was the first to regard them from a philosophic point of view. He observed the degrees of perfection they display, and sought to establish the order of their gradual descent in the natural series, a question which is still discussed by the students of this science. Promoted by Albert and Linnaeus, it continued to advance until Jussieu abandoned the artificial for the natural method in its study. (1)

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(1) In the 17th century, Ray made no objection to the distinction of plants into *herbs* and *trees*, and, what is very remarkable, he based this distinction on the existence of the bud which is, said he, nothing more

In the first part of this work we saw the slow progress made by geology, and its numerous retrogradations. Palcontology owes its origin and development as a science to Pallas, Cuvier and Blainville. Chemistry, so long astray, under the name of alchemy, in search of the philosopher's stone, was created by Lavoisier; but is not yet fully developed. Astronomy, although cultivated from the earliest times, has only become a science since the introduction of the telescope and the calculus.

Order, which is of primary importance in science, consists in proper nomenclature and classification, and is never the work of one man. In the classification of beings there is an artificial and a natural order. The artificial order is based on a single character, the dentition in animals, for example, and for vegetables, the number of stamina; the natural order on the whole of the organic characters. Before arriving at the natural classification of beings, a multitude of artificial classifications are successively admitted and rejected.

Aristotle classified from considerations of habits, habitation, food, locomotion, &c.; Pliny followed the alphabet or unimportant characters. You will find with him divisions like this: Of *birds that have and have not a crest.* Gesner and Albert the Great had an inkling of the serial order and of the principles that were, one day, to establish it: but in the mean time, they adopted artificial divisions, analogous to those of their predecessors. It is very remarkable that Buffon never thought of reading in nature simple existences, and in their state, the particular relations in which God had created them; and consequently he could not feel the necessity of a natural classification. In the quadrupeds, Buffon followed the principle of material utility, which is the most hostile to science. G. Cuvier took for ground the circumstance of blood, and yet Antoine Jussieu had already applied the natural method to the vegetable kingdom, whence it extended itself afterwards to the

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than an annual herb.—In the 18th century, Buffon ridiculed the *Systema Naturæ* of the immortal Linnaeus, who "confounding the most different things, as herbs with trees, placed in the same classes the mulberry and the nettle, the rose and the strawberry, the elm and the carrot, the oak and the shrub."

animals. The terminology was no less slow in developing. There are many efforts in this direction in Aristotle; and the binary nomenclature, which does so much credit to Linnaeus, had already shewed itself in Gesner. It consists in adding a qualifying adjective to a generic noun.

I have only referred to those divisions of science which I have used in this work; but the same observation applies to all others. None has attained a certain degree of development without successive efforts of a more or less considerable number of men of talent. Now, if it be unexampled in the history of science that one man alone ever created and established a single science, how impossible to suppose that Moses could have created and established all, and have brought them to that state of perfection in which we now find them? The examination of the laws which preside over the development of science renders this impossibility still more evident.

II.—Science in its development follows a direction determined by the various wants of society in its different degrees of improvement. It develops, in itself or in its elements, in proportion as society improves and changes, as industry, commerce, art—increase and are perfected, and as public and private enterprises assume greater importance, and international relations become freer and more extended. There is then for science what may be called a time of incubation, during which materials accumulate, although science itself remains stationary. Its progress is less perceptible, more difficult and meritorious, in the earlier social periods than in the later, where its advance is more rapid, more considerable and easier, because its elements are more abundant; and as it experiences less and less the intermittence to which all human works are subject, it constantly profits by the impulse it receives. The ordinary and, so to speak, normal progress of science is accelerated by the great events which take place at long intervals, the effects of which sometimes are of universal extent. The conquests of Alexander prepared the way for the fusion of the various ancient philosophical systems of the Greeks, Egyptians, Jews, Persians and Hindoos. By the Roman conquests in Spain, Gaul, Germany, &c., the sciences of these peoples were brought into contact with each other and mutually modified. At a later period, Christianity,—which is nothing else than true philosophy, raised to its highest degree,—by rectifying all the ideas of the old pagan world on the nature of man, his origin, his destiny, his relation to God, to his fellow men and all inferior beings, placed the human intellect in the conditions most favorable to science, and by presenting to him its divinely à *priori* established doctrine left him in some sort no other task than that of demonstrating it à *posteriori* in every particular which the human intellect could reach. It is to this powerful action of Christianity that we must ascribe the salutary influence of the Roman See, the foundation of schools and universities, the religious orders devoted to learning,—"this army of popes or rather of reason arranged in the name of the papacy which distinguishes the most celebrated epoch of intellectual civilization that the world has seen." (1) To Religion we owe the crusades: they did not indeed succeed in what they attempted, but they produced ulterior scientific results, which cannot be over estimated.

Later and nearer to our own times, and in the interval of two or three centuries, the invention of printing, which multiplies so rapidly books, and that of colored prints, which complete written language and facilitate its comprehension; the use of the mariner's compass in Europe, by means of which the most distant lands can be reached and new avenues by sea from Europe to Asia are opened to us; in fine, the discovery of America, and as a consequence of all these, the publication of travels and of various works, numerous mineral, vegetable, and animal specimens furnished for observation:—for the means of collecting and preserving animals and vegetables was also invented at this epoch;—such are the events which have prepared the ultimate triumphs of science, events which have nothing to compare with them in number or importance among the people of antiquity.

The progress of science is also determined by its own nature.

(1) Blainville, oral lecture at the Sorbonne.

It is a connected and harmonious advance, as are its objects—the natural kingdoms. Certain parts of science, standing in need of being explained by others, await, for further development, the successful cultivation of these latter. Hence in natural history, the classification of animals prerequired the progress of comparative anatomy and physiology: in physiology the respiratory and digestive *appareil*, the phenomena attending the utterance of voice, the faculties of sight and of hearing could not be explained without chemistry, optics, acoustics, &c.—It is as it were a constrained, unforeseen, involuntary advance on the part of man, following which, more or less groping, with oscillations and retrogressions real or apparent, the necessary point in the desired direction is reached by him whose intellect is most deeply impressed with the scientific exigencies of the period when he appears. Sometimes he is a methodizer, like Linnaeus, who arranges the facts accumulated by specialist naturalists to enable men to distinguish and compare natural objects: or an anatomist, like Vicq-d'Azir, who enables us to replace the artificial classification of Linnaeus by a natural one; or a chemist who will supply general naturalists with the knowledge of the various media in which animals and plants live, and the means of explaining the numerous points of agreement by which the different natural kingdoms are connected.

When science has attained a certain degree of development it necessarily divides itself into a corresponding number of specialities. Setting out from Albert the Great, in the thirteenth century, it became, day after day, more difficult to embrace the circle of human knowledge. After Gesner, in the 16th century, we enter on the series of those men, who, despairing of attaining universal science, devote themselves to the study and elucidation of certain subordinate parts: each attends only to a small portion of the great whole without occupying himself with its totality. At this epoch, Bacon, supposing as an evident truth, that one man alone could not constitute science, proposes in his plan of studies to create an Academy where each one might cultivate his specialty, and carry in to completion works already begun,—an excellent idea which has been realized by our Academy of Science. Since the time of Bacon the circle of science has been greatly enlarged; new paths have been opened, others have been extended, special studies have increased in number, and general naturalists are now obliged to accept with confidence the results announced by the cultivators of natural philosophy, by chemists, mineralogists, astronomers, geologists and all cultivators of special studies.

The history of the sciences, the principles that preside at their development, evidently prove that they could not have existed before the deluge, nor in postdiluvian antiquity. Hence the absurdity of supposing that the facts of the cosmogony might have been the logical deductions of some creative scientific mind; for it is manifestly impossible that one man could have been at once, in an eminent degree, natural philosopher, geologist, anatomist, &c.;

Impossible that, embracing all the branches of science, he could have caused them to reach the perfection they have attained in our days;

Impossible that he could have avoided all the errors into which the greatest cultivators of philosophy have fallen, and have been able to dispense with artificial classifications,—these first and provisional outlines of every special science; errors and classifications which cannot prevent science from attaining its end, when this is the result of slow and continuous application and a long series of individual impulses, but which would have retarded its advance from the beginning in the hypothesis under consideration;

Impossible that one man ever could have sufficed to gather plants, and collect animals, spread over various countries, and, making immense collection of them, distinguish, name, compare, and describe them; dissect a sufficient number of animals and plants to establish the science of comparative anatomy and physiology; observe a sufficient number of soils and countries, to lay the ground-work of geology, and make the experiments which the sciences of natural philosophy, chemistry and astronomy presuppose;

Impossible that one and the same social epoch could have furnished all the elements necessary for the establishment and advancement of the various departments of science;

Impossible, therefore, that all these departments could have been developed, as it were, in parallel lines and in the same epoch, without experiencing any of those checks and intermissions so frequent in the history of European science from the time of Aristotle to our days.

III.

May it not be supposed that Moses derived his knowledge from the direct and immediate observations made by the first men?—He is generally supposed to have used ancient documents.

According to the genealogical tables of Genesis he was removed from our first parents only by a few generations. Mathusalem lived with Adam and with Noe: from Noe to Moses, there are four generations. The means of transmission through six generations were numerous and easy, such as oral tradition, canticles, inscriptions, written memoirs, &c. Supposing that Adam and Eve had witnessed creation, they would have transmitted to their posterity a circumstantial account of it, which would necessarily be preserved in the patriarchal families.

This solution is not admissible. Zoology no less than Genesis teaches us that man is the last work of the Creative Power. But were he the first and not the last he could not have witnessed the progress of creation in such a way as to group its totality or describe its details.

Let us however invert this rational, natural and necessary order: let us represent to ourselves creation beginning instead of ending with the human race. In this hypothesis, man, of himself, could have known nothing of what the Sacred Scripture informs us. He would not have known that the luminous fluid had been created before the sun, because, experiencing the sensation of light only after the creation of the sun, he would have referred it exclusively to the sun and not have attributed it to a pre-existent fluid.

He would not have seen the waters that enveloped the terrestrial mass divide between the atmosphere and the basin of the sea; because this separation took place before the appearance of the sun in the heavens; and if he could have observed it, this fact would have presented to him the character of a local rather than of a general and primitive fact.

He would not have known if the waters had flowed off into one great basin of the sea, or into many separate basins. He could only see the coasts of the sea of Asia, and he had no means of ascertaining if there were not other seas independent of that one.

He would not have witnessed the creation of plants, which took place before that of the sun. Moreover, had he beheld the plants spring forth at once from the earth, which before was naked and bare, his inexperience might have attributed it either to a Creative Power inherent in the earth itself, or to its extreme fruitfulness at this epoch. He would not have known but that the plants came from seed formerly fallen on the earth, the germination of which had been hitherto retarded by the waters that had covered the earth.

He would not have known the creation of the sun, of the moon, or of the other heavenly bodies; their first appearance would have seemed the continuation or return of a celestial phenomenon the origin of which preceded his existence.

The same must be said of the creation of animals. He would have thought that the fishes that met his eye for the first time had come from other parts of the sea; the birds and other terrestrial animals from other parts of the same continent or from some neighboring island, to take possession of that part of the earth's surface which had been lately laid-bare.

He would not have known that there was but one species of his own kind, and but two individuals of that species; for he had no means of knowing if there were not many more like himself on distant points of the continent on which he dwelt, or on other continents.

In a word, all the facts of Genesis are general facts, and our first parents could only have witnessed local facts: they could not attest any general creation or organization.

Adam and Eve, whose intellect had not yet been developed by domestic or social life, and who moreover are supposed destitute of all relation with their Creator, would not have been able to make the foregoing observations and reflections; and if Genesis had to tell us only what their eyes and ears could teach them in relation to the creation and organization of existences, its recital, instead of being conformable with the results of science, would doubtless appear to us more replete with fables and fantastic imaginations than all the cosmogonies of pagan antiquity.

IV.

I will not insult the intelligence of the reader by examining the supposition that chance guided the pen of Moses. The only solution, then, of this problem will be found in revelation or divine inspiration. In either supposition the Divine Source of the narrative is acknowledged. GOD HAS SPOKEN TO MAN. He did not leave him, at the beginning of his existence, to the ignorance which would necessarily accompany a pretended state of nature, in which he could not have developed either his body or is soul. He revealed Himself to His principal work. —He conversed with man: He made known to him His works; the order in which they had been accomplished, the rank he himself held among them, and the duties resulting therefrom. Not only did He form the soul of our first parents to His likeness, by an infusion of light and bounty, capable of conducting them to a glorious end; but they learned from Him what this end was, whence they came, and whither they were going. In listening to His voice, they penetrated at one glance all the secrets,—all the springs of their destiny; and their interior light, vivified and confirmed by this great extrinsic light, rested in the peace which was the result of evidence and faith. (1) Tradition has, then, its source in God through the

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(1) The translator subjoins the following passage from the Book of Ecclesiasticus, referred to at pag. 327 of the present work, and quoted in the original at length, as a suitable conclusion to the reasoning of the learned author.

"God created man of the earth; and made him after his own image.

conscience of man from the beginning, and from the same Divine Fount it receives sustenance and renovation, according to the wants created by the inconstancy and the forgetfulness of generations.

And He turned him into it again; and clothed him with strength according to Himself. He gave him the number of his days and time; and gave him power over all things that are upon the earth. He put the fear of him upon all flesh; and he had dominion over beasts and fowls. He created of him a helpmate like to himself; He gave them counsel and a tongue and eyes, and a heart to devise; and He filled them with the knowledge of understanding. He created in them the science of the spirit: He filled their heart with wisdom and shewed them both good and evil. He set His eye upon their hearts to shew them the greatness of His works. That they might praise the holy name and glory in His wondrous acts, that they might declare the glorious things of His works. Moreover He gave them knowledge and the law of life for an inheritance. He made an overlasting covenant with them: and He showed them His justice and judgments. And their eye saw the majesty of His glory; and their ears heard His glorious voice; and He said to them: Beware of all iniquity."—Eccl. XVII. I. II.

(END.)

NOTES.

ON THE DAYS OF CREATION.

Origen, St. Augustine, St. Athanasius, St. Thomas, etc., have been referred to as authorities to show that the interpretation of these days as indeterminate periods is neither heterodox nor objectionable. "Nay, more," says a writer in the '*Annales de la Philosophie Chretienne*,' "in our interpretation we do not go as far as these holy doctors. St. Augustine, urging the objection further than those who reproach geologists with this long series of ages, regards the interval of the natural days as unworthy of the Divine Power; and, passing over all the formal distinctions of Moses, thinks that God created all things at one time and by one sole act."* In rejecting the succession of time, St. Augustine gives us a history of creation which is no longer that of Genesis. And yet, the hypothesis of indeterminate periods leaves the Bishop of Hippo far behind. The boldest opinion is, unquestionably, that which departs most from the spirit of the Mosaic narrative; but this is not so much contained in the distinctions of time, which St. Augustine disregarded, as in the fact it exhibits, that the world was created and ordered by God without the concurrence of secondary causes, that all other beings were created for man, and man for God. Let us examine, from this point of view, the interpretation of the doctor of the Church and that which has been developed in the "*Annales*." In the hypothesis of St. Augustine, all the different groups of beings which form the universe were instantaneously created; which is also the teaching of Moses, only that St. Augustine, contrary to the literal and only true sense of the sacred text, supposes that the beings thus instantaneously created were produced simultaneously.

But this universal creation, produced at once, exhibits, more evidently than a collection of successive instantaneous creations, all beings issuing immediately from the hands of God, before any established order of things, and consequently without the least participation of natural causes, whose action is always successive and more or less slow. In reducing to one single, inappreciable instant the six days of the sacred writer, it adds in some sort to the energy of the creative action, at the same time that it exhibits more strikingly the relations which connect the parts of the universe, and the one pre-

* T. xiii; p. 34.

determined plan on which they had been ordered. St. Augustine, then, appears to have abandoned the days of Moses only to attach himself the more closely to the fundamental idea of the sacred narrative, *the creation of the universe by the will of God alone.* On the other hand, the partizans of the other system, by allowing to each of these days a duration of fifty, one hundred, four hundred thousand years; in a word, by replacing the creation by successive creations, after the manner of Deluc, Ferussac, Cuvier, Ampere, Beaumont, and others, are necessarily led to consider the greater part of these creations as modifications or transformations, accomplished by the concurrence of natural laws, which from the beginning were established to prepare, by means of these long intervals of time, subsequent creations or new modifications of organic or inorganic matter.

The principle of St. Augustine obliged him to see in Genesis the creation of one and the same world. The defenders of the genesiac periods, in order to meet the requirements of the systems they have adopted, are obliged to dissolve each Mosaic creation, to distribute over all points of time and space, by isolating them, the parts of these great groups, these classes, these entire natural kingdoms, which Moses presents as appearing simultaneously — "*let the earth bring forth; let the waters produce*"—so that, in some sort, they render unmeaning these words of the psalmist: "He said, and they were made: He commanded, and they were created"—words which St. Augustine appeals to, and which he accepts in their strictest literal meaning. They see in Genesis the history of six different creations, five of which had been destroyed before the appearance of man. It is, indeed, true that the sciences of organization show that the remains of these supposed worlds belonged to one and the same world, established on one plan, conceived by one Sovereign Intelligence, and called into being by one Creative Will. They demonstrate that the first vegetables and the first animals had the same general conditions of existence, and were governed by the same laws as the plants and animals of the present day. But, if the system of periods be adopted, these sciences are at fault; the union of all parts—a mere abstraction of the mind—was never produced; all these beings never co-existed so as to form a living and harmonious whole.

Whether the one world of Genesis had been produced by one only act or not, would not have changed any of its relations to man, since the cotemporaneousness of all beings would have been rigorously simultaneous; but no relation between man and the worlds of the first five periods would have been possible; the beings belonging to them, the creation of which Moses narrates to us, were not formed for him. The secondary causes which had had time to work and to prepare the earth as a suitable abode for our race, the partizans of the periods condescend to admit as contemporary with the inhabitants of a sixth world, on the creation of which Moses has observed absolute silence, probably because it was too closely connected with man.

Let us add that St. Augustine, in clearly distinguishing, as he does, the act by which God created all things from that by which He preserves them by means of the laws He has established,* necessarily places Moses at the origin of all things, and assigns him an im-

* De Genesi ad litt.; lib. v., c. xi.

pregnable position; while the other system transforms the historian of the creation into a naturalist, whose narrative lies open to the criticism of all naturalists present and future.

This comparison allows us to judge which is the bolder interpretation—that which abandons the letter to attach itself to the general spirit of Genesis, or that which gives up both letter and spirit. I go still further, and say that St. Augustine would have respected the letter of the text and given to the word "day" its natural signification, had he not been embarrased by difficulties which, no longer existing for us, leave us without excuse, if compared with him, and do not permit us to invoke his authority or adopt his principle. He found no philological objection to the literal interpretation. The only difficulty he felt regarded the first three days, an astronomical difficulty which no longer exists, modern science being strictly in accordance with the literal meaning of Genesis. And when, notwithstanding the erroneous ideas which prevailed in his days as admitted truths, we see him passing very lightly over his hypothesis of simultaneous creation, and hear him tell us that we must not too hastily pronounce on the nature of the days of Moses, and find him returning, again and again, to the discussion of the texts which refer to them—always withheld by the same difficulties, and, in spite of these difficulties, hear him propose to himself questions to which he dare not reply: "was the space of hours and times then called 'day' independently of the succession of darkness and light?" *—and in another place: "what are we to understand by these days in which there was no sun; and wherefore were the luminaries of heaven placed to mark days, if days could exist without them? Does the motion of these bodies render the prolongation of time and the distinction of its parts more sensible to men?" † In another work he teaches that "God has created heaven and earth and all that they contain in six days, although He could have made all things in a single moment." ‡ When we reflect on these circumstances, can we doubt but that St. Augustine would have adhered to the literal meaning of the word "day," had he had, on the nature of light, on the movements and condition of our planet in relation to the sun, the ideas which we have since the time of Euler and the discoveries of our celebrated astronomers?

Two phenomena, whose real cause was unknown to him, prevented him from understanding the first three days of creation: 1st. The apparent immobility of the earth and the apparent motion of the sun around it. 2d. The apparent production of light by the sun. He evidently reasoned on the hypothesis that the earth was not in motion, and that the sun was; otherwise he would not have alleged "the difficulty of conceiving and explaining by what revolution anterior to the creation of the sun the succession of the first three days and of the first three nights was possible" §—he would not have distinguished, with reference to the movement by which they were measured, those days from ours; he would not have said, in speaking of the latter, that "they are counted and determined by

* De Gen. ad litt. imperfect; lib.; c. vi.

† Cap. xii.

‡ De Gen. ad litt.: Lib. 1, c. xii.

§ Ibidem.

solar revolutions;"* and, in reference to the former, "that we cannot conceive by means of what motion light produced their evening and morning."† It is, moreover, certain that the light which we now enjoy was not regarded by him as existing independently of the sun, or as identical with that which was created on the first day; otherwise he would not assure us that we can form no idea of that light which existed before the sun. "We see," he says, "that, in ordinary days, evening follows the setting of the sun and morning its rising, but during the first three days there was no sun, the creation of which is assigned to the fourth day. True indeed, that, according to Moses, light had already been created; but the nature of this light is what we can neither imagine nor conceive."‡ On the same ground Origen rejected the literal meaning. He did not bel eve "that a sensible man could see anything but allegory in these three days before the sun, the moon and stars, and the first day, before the firmament itself."§ In his work "*Against Celsus*,"|| to prove that Moses did not speak of ordinary days, Origen relies on the 4th verse of Gen. ii, where it is said, "these are the generations of the heavens and the earth in the day on which God created them;" but the Hebrew *biom*, "in the day," is better translated adverbially, "when," and hence there is no philological difficulty. St. Athanasius, also, is said not to have taken the days of Genesis for ordinary days, and St. Basil leaned, we are told, to the same hypothesis. This is a double error. True it is that St. Basil speaks of this hypothesis, because his subject suggested it, but he does not follow it; he takes the days in the ordinary sense, and appears not to be embarrassed by the difficulties which influenced St. Augustine.(*a*) As to St. Athanasius, the writer in the "*Annales*" has not caught the meaning of the passage to which he refers.(*b*) The learned father did not intend to say that all was created at once, but that the various classes of beings, taken separately, were simultaneously called into existence, and that of the species which compose these classes none were created before the rest. "The stars," says he, "did not appear successively: all were produced by the same act of the creative power. Such was also the origin of quadrupeds, of birds, of plants. All, according to their order, were created at once."(*c*) In his discussion with the Arians he lays down the principle that the general creation was successive, but that each group was simultaneously produced; and in all his works he takes the days in their literal meaning.

In order the better to point out the resemblance and difference between the first days and ours, to see if Moses ought to have called them days, let us distinguish the various parts of the phenomenon which we call day. 1st. Light, a fluid independent of the sun, both

* De Gen. ad litt. imperfect, lib., c. xxvi.

† De civitate Dei; lib. xi, c. vii.

‡ Ibidem.

§ De Principiis; lib iv, v. 16.

|| Contra Celsum; lib. vi.

(*a*) Hexæmeron; hom. ii, n. 8 and hom. vi, n. 2.

(*b*) Orat. 11a contra Arianos, n. 60.

(*c*) Ib.; No. 48-49.

as to its existence and its properties. 2d. The vibrations of this fluid produced by the sun, but also producible by combustion, electricity, etc. 3d. The sensation of light, occassioned by vibration of the luminous fluid, a phenomenon purely relative to organized sensible beings, and which, consequently, cannot exist without them, and in which we can distinguish three orders of sensations—those of evening and morning, and those intermediate to both. 4th. The revolution of the earth on its axis, measuring a duration of twenty-four hours. 5th. The sun, towards which the earth gravitates by another motion, and the presence of which as an instrument of the vibration of light, renders sensible the duration of the diurnal motion of the earth.

1st. Day and night result from the diurnal motion of the earth or its rotation on its axis: by this motion we measure their duration and that of their twilights. The first three days were measured, as are ours, by the motion of the earth on its axis; and consequently had the same duration. The existence of this measure for the first days of the world is not a supposition; it is given to us by Moses himself, for he could not describe full days, or days of twenty-four hours—a phenomenon he expresses after the idiom of his language, by the duration which fills up the interval from evening to morning—without supposing that the measure of which we speak existed already, since there must have been some measure, and there could not have been any other. 2d. Light existed. 3d. We must suppose that it was put in motion by some agent, or by the immediate will of the Creator; since Moses tells us of days, evenings and mornings. The movement of light corresponded to the day; its repose, to night; the commencement of its movement, to morning; its termination, to evening. 4th. This light was not put in motion by the presence of the sun, nor was its repose occasioned by the sun's absence. 5th. The action of the luminous fluid did not occasion the sensation of light, because neither men nor animals existed.

Hence it appears that the differences between the first days and ours are less numerous than the resemblances. They are also less essential, and Moses might disregard these differences and, by analogy, give the name of "day" to these three durations which preceded ordinary days. I say that the differences are not essential; for, whether it be the sun or any other cause which made the ether vibrate, matters not, when the effect is the same. We must, moreover, observe that, had the sun co-existed with light from the beginning, the sensation of light could not have been produced on the earth, because as yet there existed no organized sensible being; even on the fourth day, after the creation of the sun, the vibration of the luminous fluid did not produce any sensation. This phenomenon could not have been produced before the fifth day, when the animals were created; and in the opinion, so little worthy of philosophy, which refuses them a sentient principle, this could not have been produced before the creation of man on the sixth day. Will it be said that these latter days should not be so called because neither animal or man existed? As well might it be said that there are no days even now for those countries that are uninhabited.

If difficulties have appeared, this is to be attributed to the fact that two things very different were confounded—the luminous fluid and the sensation of light. St. Augustine, Origen, Peter Lombard, St. Thomas, Buckland, Chalmers, the author of the dissertation published by Genoude in his translation of Genesis, and others—do not appear to have made this distinction. They all suppose that *brightness*, that the *view* of the sun in the heavens, that the *distinction of sensible objects*, could have existed on earth before the Creator had placed eyes on it. As for the sun, God created to *preside* over the day, as the moon to *preside over the night:* it does not produce the day or the night, but it distinguishes them; renders them sensible to us. Moses gives it the name which suits it—a luminary. When we speak of the day, of the evening, of the morning, it is of the sensation of light, in its progress and decline, that we speak; it is not exact to say, with St. Augustine, that our days derive their evening from the setting of the sun, their morning from its rising. When St. Augustine asks, if the duration even of hours and times was from that time called day, independently of the succession of darkness and of brightness—it is easy to answer, that there was no brightness, no sensation of light for the earth; not because there was no sun—any other agent being capable of supplying its absence—to agitate the luminous fluid, but because there was no being for whom such vibration could produce the sensation of light. On the fourth day the sun puts light in motion, and yet there is no sensation of light; the presence of the sun did not suffice to produce it. On the fifth day the sensation exists for the animals; and on the sixth, man is able to appreciate the duration of this phenomenon which God alone and His angels previously measured.

It is not then impossible, or even difficult, as St. Augustine thought, to conceive the nature of the first three days of the world; the fourth, notwithstanding the creation of the sun, resembled rather the first three days than ours, whatever this holy doctor may say of it. These days differed not so much from ours as he supposes; their analogy to ours authorized Moses to call them days; otherwise, if no men or animals had been created, all things else remaining as they were, it should be said that for him there were no days.

By introducing into a discussion of this kind the testimony of some doctors of the Church, and theologians of the middle ages, without giving the reason for their opinion, or accompanying them with suitable explanations, we would be brought back to the infancy of science; and a retrograde movement would be impressed on biblical exegesis, for the purpose of sustaining an interpretation altogether opposed to the spirit and letter of Genesis, and which we reject also, because it is opposed to the laws of Zoology.

Explanation of the succession of Species in the Deposits, and of their extinction, by natural causes.

The vegetables were created on the greater part of elevated lands; aquatic animals on the different basins of the rivers and of the sea; while a small number of continental elevations presented all the conditions necessary for the existence of land animals, which afterwards were developed and spread themselves abroad according to their species, in proportion as the surface, becoming more and more extended, offered them a larger space wherein to roam.

The islands now inhabited by wild beasts form no objection. They were formerly joined to ancient continents, from which they were separated after having received their population. England was formerly joined to our continent, from which it is now separated by the channel. It is probable that Bering's straits, which separate Asia from North America, did not always exist since these continents began to be inhabited. "We must regard," says Lesson, "the archipelagos of Sunda, the Moluccas, in fine all Polynesia, as remains of the Asiatic continent, which has been rent throughout under the Equator; and corresponding appearances have been observed in the dismemberment of the American continent, under the tropic of Cancer, and even in Europe, more to the north, between the Mediterranean and the Red Sea. The isthmus of Suez corresponds with that of Panama; cape York in the Torres strait is, no doubt a prolongation of the isthmus which united New Guinea and New Holland, and which the waters have sundered," *

The countries of western and southern Europe appear to be those where the most numerous and most complex formations are found; and this has already led us to consider them as having been first

* Complement de Buffon; t. 11. In connection with the above, the translator inserts the following observations on a recent publication of Sir J. Emerson Tennent, from page 144 of Westminister Review, for January, 1862:

"Reasoning on the facts supplied, on the one hand by the marked disaccordance between the fauna and flora of Ceylon and the fauna and flora of southern India, and on the other by the very close conformity between the flora and fauna of Ceylon and the flora and fauna of the Malayan archipelago, Sir E. Tennent has been led to the conclusion that Ceylon is not (as it has been commonly regarded) a fragment of the Indian peninsula, rent from the adjacent mainland at some remote period, but that it is a remnant of a great continent which stretched across what is now the Indian ocean, at a time when northern Asia and a considerable part of the Indian peninsula were beneath the surface of the sea, the Himalaya standing above it as a chain of islands. Of the former existence of such a continent the evidence, from geological data and from the existing distribution of plants and animals, has been gradually accumulating. And it is not a little remarkable that, whilst the hypothesis of its submersion since the diffusion of the human race affords the best solution of the well known fact that the languages of Madagascar are rather Malayo-Polynesian than African, it should be in complete harmony with Singhalese tradition, which affirms that, at an infinitely remote period, Ceylon formed an integral portion of a vast continent, of which the southern extremity fell below the equator, whilst in breadth it extended from Africa to China."

under the waters and the last to emerge. The general flow of the polar waters to the equator, the almost absolute absence of secondary and tertiary formations in the northern parts of Europe, Asia and America, in the Scandinavian peninsula, Norway, Sweden, Finland, the shores of Bering's sea, Greenland, and a great part of North America, appear to attest this fact. On the one hand, the elevated and immense granitic chains of central Asia, their vast table lands, which scarcely present any aquatic formation, and which from the beginning afforded habitable soils; the fact of these mountains covered only with primary deposits or simple alluvions, and which consequently must have emerged at an early period, the absence of land quadrupeds in all our ancient formations of Europe—all appear to point out Asia as the centre of the creation of mammals and the first abode of man. Thus geological facts bring us back to the hypothesis of Linnaeus, that the land animals were created at one single centre whence they subsequently were distributed over the earth. By substituting the point of departure for the hypothesis of successive creations we are easily able to account for the succession of mammal fossils.

If, as all facts concur in establishing, the strata were formed in one originally immense and deep sea, the limits of which are indicated by those of the primary strata on the sides of the great granitic mountains, the variations of this primitive sea in its extent, depth, shores, temperature, partial filling up, and subsequent parceling of its basin, must have produced corresponding variations in its population and in that of the islands, continents, and their rivers. Changes in places bring other changes in the inhabitants of those places. "The circumstances were no longer the same, the races which occupied one point would abandon it for a more suitable one; while other races, who already existed in countries more or less distant, established themselves in those localities which were rendered fitting abodes for them by the changes which had taken place. Thus the change of a deep sea into a bay, then into a lake, then into a marsh, must have induced changes in the species which succeeded each other in the same place. Thus the changes in the relations of continents and seas, in the direction of currents, the position and greater or less abundance of affluents, etc., must needs have produced similar results." *

The vast sea in which our primary and secondary rocks were deposited, was strewed with islands, which, for the most part did not join continents; they produced a vigorous vegetation; they fed insects, bay reptiles, shore and land molusks, but they had no land quadrupeds—these were limited to the distant plateau of the high mountains of Asia, and their bones could not be transported to our formations. Up to the present, no authentic instance of a land mammal fossil earlier than our first tertiary rocks is known. In the beginning, sea animals experienced less frequently those breaks in natural associations, by virtue of which the extinction or displacement of certain species implies the extinction or displacement of others. They were protected by the solitude of the seas and of the isles, where the animals that people them harmonize more entirely when they are not inhabited by the human race, or frequented by

* M. C. Prévost: Note sur le terrain nummulitique de la Sicile, Bulletin de la Soc. Gèol.

carnivorous animals. In our days we have seen the great whales quit the Atlantic and the shores of France, to escape the pursuit of man. The arrival of a porpoise or a dolphin in a bay, drives from it all the fishes which lived there peacefully before.

The temperature, which exerts so great an influence on organic life and the geographical distribution of species, was not every where the same as at the present day. Temperature results from the mutual relations of the atmosphere, the soil and the waters: it is higher and more uniform in the neighborhood of seas and of islands than in the interior country. This relation had already been indicated by Buffon. "It is never so cold," says he, "on the sea coast as in the interior. There are plants which are exposed in open air throughout the winter in London, which we could not preserve at Paris; and Siberia, which is a vast continent where the sea does not penetrate, is, on this account, colder than Sweden which, almost on all sides, is surrounded by the sea."*

The temperature of the great primitive sea was so much higher, as this sea had greater extent and greater depth; and the temperature of the isles and continents was also higher and more humid inasmuch as these lands, being less extensive, approached nearer to the sea. We can, then, understand how, in this great sea, a multitude of animals which we do not find in our small seas, which are no more than remnants of the original sea, and a multitude of plants to which these islands presented superior conditions of temperature and soil may have gradually disappeared and become extinct, when, by the retreat of the waters, such animals and plants were removed to too great distances from the shores and new river mouths. This, also, will explain the difference of the fossil flora at different periods of our strata. Insular plants, which require a moist and uniformly high temperature, would at once predominate in the ancient deposits, because this portion of the general flora existed then in conditions most favorable to its development. Subsequently, these islands, having become continents by the lowering of the level of the seas, would be covered with vast forests; and the continental would in its turn predominate over the insular flora. Such, in fact, are the results ascertained by A. Brongniard. His first period, comprising the primary rocks and the coal strata, and the second, which corresponds with the variegated sand-stone, are characterized by the numerical predominance and great development of the vascular cryptogami (equisetacea, ferns, marsileacea, lycopodiacea); in the third, which extends to the uppermost chalk, it is still the vascular cryptogami and the gymnosperm phanerogami (cycadaceæ, ferns, conifers) which are more numerous; but the fourth, which embraces our tertiary rocks, is distinguished from the preceding by the prevalence of dicotyledon plants (amentaceæ, juglandaceæ, nymphaceæ, acerineæ). Thus vegetation, principally developed in its insular portion up to the variegated sand-stone, loses gradually its dominant character up to the chalk, to show itself principally continental during the third period, as is also the case in our days. Let us not forget that here there is question of a succession of numerical predominance, for all the classes of vegetables are united in the most ancient strata.

The decomposition of the primitive rocks by external agency would still furnish sand, clay; then, with combinations, marl, conglomerates, pudding-stones—which the continental water-courses

* Preuves de la theorie de la terre.

transported into the basin of the sea. The vegetables of the primitive islands, river and sea animals, mollusks, polyps, crustacea, etc., adding their remains to the inorganic materials of the rocks, contributed to form here and there, around the planetary nucleus, those masses or surface soil, very irregular in their local dimensions, but very regular in their order of production. At the same time developing materials augmented irregularly the thickness of the strata: the igneous cause that produced them determined also other inequalities, as well on the continents as in the submarine basins, by breaking a portion of the strata and changing their bearing. These causes—to which we must add, with Buffon and Lamarck, the diminution of the waters by their transformation into solid, calcareous and silicious matter, by animal filtration—produced the emergence of the continents and of the islands, changed the relations of the various parts of the basin of the seas, and altered local temperatures. Sea-depths became bays; bays became shores. Hence the succession of different species on the same points. In proportion as the limits were diminished towards the centre of the basin, the sea animals perished, or sought deeper waters; shore animals, those of estuary and saltish waters, replaced them, following the shores of the waters, and renewed their associations in localities which, for them, were of recent production. These species extend; they are multiplied, together with their points of habitation; the pelagian species, on the contrary, decrease in the same proportion. We must not then be astonished at seeing the shore-species abound in the later secondary, and still more in the tertiary strata; especially when we reflect that the emerged tertiary rocks are essentially shore and estuary formations, produced at a short distance from the coasts.

When the level of the sea lowers, the polyps, whose corals were up to the surface of the water, or were entirely above it, died or disappeared, as they now die or disappear, when the corals rise above the waves. But the polyps afforded shelter, and probably abundant food to the great pelagian mollusks of the family of the ammonites, nautili, belemnites, etc.; these mollusks, and the other animals that fed on the radiata, either migrated or became extinct with them. This was not, however, suddenly effected: there remained always a certain number of individuals and of species which, under altered conditions of existence, underwent specific variations in size and accidental forms. These varieties of species became rarer and rarer, and they present themselves in small number with the new species which the change of circumstances produced; and these changes ever increasing, they finally disappeared. Thus may be explained the mixture of fossils characteristic of different strata at their point of meeting. There were, besides, other causes of these combinations. Continental currents carried down land, river and bay species to the great sea valleys, and sea currents some times transported pelagian species to the neighborhood of shores. Hence other combinations of species belonging to widely separated zones. Moreover, the general distribution of sea species, on the coasts, mouths of rivers, the valleys and plains of the sea, is not marked by very exact limits, and hence the various formations, especially towards their point of contact, must always present the mixture of a certain number of species belonging to different regions. Besides, geological nomenclature admits, for our greater convenience, only a small number of marine habitants;

but nature is not obliged to accommodate itself to our nomenclature or general divisions. For example, in the zones which we call pelagian, the depth of the water is not every where the same, nor, consequently, the temperature. The distance or neighborhood of general currents also establishes other differences. Now, the distribution of the various animal and vegetable pelagian species must bear a relation with these differences of circumstances in each zone. It would, then, be temerity to say that all our ancient pelagian formations were deposited in the same local circumstances, even were we to abstract from the variations in the direction of winds, and in that of the currents, that transported organic substances. If the local circumstances were different, and were, consequently, the habitation of different species, although always belonging to pelagian regions, we should expect to find, in the entire succession of these formations, fossils always varying associated with others which remained unchanged. This observation applies to all formations of different origin.

While admitting, with paleontologists, that aquatic, and especially land species, must have perished by the progressive lowering of temperature, we cannot, however, attribute to this cause the disappearance of the mollusks of the ocean. For, if this local diminution of heat had for the mollusks the effects attributed to it, much more would it have produced the same result in the fresh waters, and consequently in the beings contained in them. The strata of our marine formations envelop, it is true, a great number of genera and species which appear no longer in our actual seas; but this is not the case in our fresh water formations, where we always find lymneæ, planorbs, physæ, anyclæ, helices, unios—scarcely different, as species, from those which at present live in our fresh waters, and certainly generically identical with them. If we find melanopsides in certain fresh water deposits, it is where living species of the kind exist at the present day—in Spain, Greece and, perhaps, in the south of France. This observation is applicable to the living species of our different climates. If, for the marine species, we find remarkable differences between those of our seas and those of the tropics, or of the southern ocean, both as to species and to genus, the same does not hold for the fresh water, or land, species: every where on the surface of the earth, there are helices, planorbs, physæ, lymneæ, paludinæ, cyclostomæ, etc. It is, then, more probable that changes effected in the bed of the ancient sea, or a relative diminution of the depth of its waters on many points, determined or prepared the annihilation of a great number of species, the congeners of which only exist at the present day at the greatest depths. The cypreæ, oliva, strombus, murex, etc., are instances of this observation. Much more must the lowering of the level of the waters have brought about the extinction of a multitude of species which adhered to mineral masses, in places abandoned by the ocean, as the fossil species of the genera ostrea, gryphea, terebatula, patella, and so many others. While these modifications in temperature, in the extent, depth and conformation of the sea basins, successively brought different species on the same points, caused others to disappear, and maintained the succession of different marine fossils in our strata, analogous events, determined by the same causes, produced the same result on the shores of the emerged land.

Land-animals do not begin to live on a given point until vegetables have appeared, and have continued to be propagated there. The vegetable kingdom is the base of the animal kingdom; granivorous and frugiferous animals require plants which yield grains and fruits; herbivorous animals require grasses; and carnivorous animals must be preceded by those that live on vegetables. This natural order, observed at the present day, must have been formerly in force in all the countries whence the sea had retired. Much more; all kinds of vegetables could not grow at the same time; first, because their seeds could not have been carried thither at the same time by the currents, the winds, the birds, and that recently emerged countries, as yet too humid and marshy, would not suit all kinds of species; and secondly, because there are many which only grow in earth formed of organic *detritus*. Moreover, the species which are developed there are not all propagated with equal rapidity and in the same proportion; the conditions of soil and temperature not being equally favorable to them. Vegetation must begin in such places with aquatic plants, and with such as may require little or no soil. After the decomposition of these first species and of their numerous generations, appeared the vegetables which required a less humid and more abundant soil. In all continents which were not centres of creation for the mammals, the series of ancient formations should, then, first present the *debris* of a certain number of plants associated with sea animals, but without mixture with land animals, unless, indeed, we except insects, land mollusks and, perhaps, birds. Fossils, in their position, should reproduce the successive order of occupation, as well for the species as for the class, and still oftener the successive order of predominance of species, or of the numerical *maximum* of their development, and especially of those that live in current waters, or in their neighborhood; for we must never forget that we can only find in the fossil state those species that were numerous and exposed to be carried off by the water courses.

The retirement of the sea gave occasion to other changes. Fresh water or saltish lakes became more numerous, and their inhabitants were increased: rivers extended their basins to the emerged lands; they soon scooped out for themselves deeper beds, assumed a more regular direction and a more uniform course. These circumstances permitted species of the reptile and amphibian classes to establish themselves and multiply successively at their mouths; so that the sediments abandoned at this new epoch contained a greater number of amphibious animals and reptiles than the preceding one.

The vegetables, reptiles, amphibious and other river and lake animals, were, for many ages, in exclusive possession of this new continent; because, between it and the continents more anciently inhabited, there was no communication by which land animals could reach it. In this interval there were changes of secondary importance. The waters of certain lakes may nourish peculiar species; excluded from their basin by the deposits accumulated by the rivers which flowed into them, these waters formed rivers or affluents which, flowing to the sea, transported new species to the series of its deposits. On the other hand, the drying up of many affluents, the sucessive filling up of a number of river mouths, must have thinned certain species of reptiles, and caused the extinction of those that were not capable of following the rivers in their new course toward the sea.

In this way we may explain, without excluding many other explanations, the successive disappearance of the pterodactyls, plesiosauri, icthyosauri, crocodiles, etc. These changes thus progressively diminished the vegetables which require warm and humid exposures, and, on the other hand, augmented the seat of the continental flora. In fine, a new and great lowering of the level of the seas, probably that which caused the chalk and other contemporary formations to emerge, opened paths for land animals, by the junction of the new continent to the islands and primitive continents. Then the mammals, and, after them, man began to emigrate successively from the east to the west, attracted by the mild climate of the southern countries of Europe, and by the virgin forests with which for a long time had been covered those parts of the soil which had been islands. This supposition accords with the annals and traditions of men. The destruction, also, of the great forests commenced at an early period in Asia, and eastern countries, where it contributed to the decay of civilization among the people who inhabited them; and afterwards, by slow degrees, extended itself: it now began to alarm the west.

The land mammals which first reached the new continents were herbivorous; afterwards followed carnivorous animals, which are always sure to appear where there peaceable species :—at last man appeared in these regions. The mammals will be the more numerous in the higher rocks as they may have lived in the great valleys, on the great water-courses, in the gulfs; and less numerous as they may have been able to avoid the neighborhood of rivers, and have lived on table-lands or mountains. This is, in fact, the order of fossils. First we find dolphins, cetacea, shore and bay animals; then dugongs, lamertins, dinotheria, river-animals of almost the same circumstances; then the amphibians of the carnivori and rodentia; then the aquatic pachydermata, such as the paleotheria, anoplotheria, mastodons, elephants, rhinoceri, hippopotami, etc.; and at length the carnivori that feed on the preceding species—the bear, the hyena, the panther, the ounce, the wolf, the jackal, the fox, etc., but the lama, the camel, the giraffe, the squirrel, the marmot, etc., animals of the plain and the mountain, scarcely are found there.

In this general succession of fossils, there will be particular successions of genera and families in the same classes, and particular successions of species in the same genera; there will be for each formation re-appearences—more or less numerous—of the same species in deposits of the same nature. The geological classification of these beings will not be the order of zoology or of creation; but it will express—as much as the circumstances of habitation, animal and vegetable propagation, geological formations, preservation of strata, etc., may permit the naturally successive order of occupation. Whatever be the nature of the circumstances that presided over the occupation of a new continent, we must never suppose that all these vegetable species could have been developed on it at the same time—that animals could have lived there before vegetables—that the carnivori could have dwelt there before the herbivori and the frugiferi—that all these species of animals could have arrived there at the same epoch—and that man who has need of all the natural kingdoms could have preceded them. On all continents which were not centres of creation, it is then impossible that the mammals and man should not appear last in the deposits of the soil,—the mammals necessarily supposing vegetables, and man no less necessarily requiring one and the other.

Once established on a point, man became a cause of extinction for many species of both kingdoms. The *dronte* was destroyed in a few days by the first settlers in the Mauritius, to which place this bird appears to have been peculiar, for it has never been met with elsewhere. Had the wolf been limited to England, it would long since have been destroyed. But without speaking of dangerous species, which man always destroys wherever he can, how many peaceful animals are every-where the victims of the passion for the chase, which is indiscriminating in proportion to man's want of civilization. Since, by means of navigation, he has control of all the continents, of all islands, of all seas,—who can say the number of species,—animal and vegetable—which have perished, in consequence of the changes he every-where effects—the clearing of forests, the reclaiming of marshes, the canalization of rivers and of their affluents? When he established himself in the valleys of France, all the ancient pachydermata that preceded him,—the bones of which are so often found mixed with his,—were obliged to quit them. The elephants, the rhinoceri, the paleotheria, the anoplotheria, the lophiodons, sought elevated regions, where the severer conditions of existence caused the species to languish and gradually disappear. Man knows not always what he does; he asks himself with astonishment what causes could have destroyed such powerful operations, and he lets loose on the globe general revolutions to account for what he himself has done. Those among the mammals that have little means of self-protection, as the edentals, and those that migrate less easily, as the pachydermata, and in general large sized species, perished before others, as this happens before our own eyes in regard to the existing species. Hence, Blainville observes: "Their extinction implies no revolution, no change in the general conditions of life on earth."

We cannot doubt that the progressive development of the human race causes many species often to change place, and at length to settle on one or more points where they may be afterwards easily destroyed by some circumstances, such, for instance, as the severity of the climate, the want of sufficient food, the attacks of hostile and stronger species, the destruction of the forests which sheltered them. Paleontology and history permit us to discover some of their former abodes, and some times enable us to ascertain the measure of their progress and decay. The European bear, formerly found in every part of our continent, as we infer from finding its bones scattered in France, Italy, Austria, England, Belgium, Germany, etc., is now only found on the slopes of the Alps and Pyrennees. The aurochs existed in Gaul and Germany in the time of Cæsar; before that it lived in Lombardy, where its fossil bones have been found. At the present day it has sought refuge towards the North, in the forests of Lithuania. The lions which were seen to roam in the neighborhood of Capetown have retired to the interior country; they have disappeared from Greece and Europe, where they were to be found at the time of the Romans. Two centuries ago, the whale-fishing was carried on in the English channel and Mediterranean; at the present day we follow this animal to Spitzbergen, where we have forced it to take refuge, notwithstanding the severity of the climacteric conditions which it finds there. The hippotamus and crocodile, so abundant in Egypt, in the time of Herodotus, have been driven to the Upper Nile. Many of the inhabitants of North America have never seen, no more than ourselves, a rattle-snake, and yet this reptile was every-where to be found when America was first peopled by Europeans. European species transferred by man to the American forests, even when they were merely herbivorous, have considerably weakened the indigenous species: the development of the ox has almost caused the tapir to disappear.

If, as so many reasons induce us to believe, Europe was peopled by mammals that migrated from Eastern countries, before the species established themselves locally, we should now find, either living or in the fossil state, or at once in both, many species common to the European continent and the East. In fact fossils of the dromedary, now living in Asia, between Constantinople and Astrakan, have been discovered in Siberia. The camel, properly so-called, exists only in Arabia, Egypt and the northern margin of Africa; formerly it dwelt in India and France, as is shown by its bones which are found there.

The aurochs is found now exclusively in Europe, in the forests of Lithuania, but it has left its bones in America. The rein-deer which now is only found in the northern parts of the two ancient continents, is the same that has been found in the fossil state in Scania, France and Italy. Our horse has come to us from Asia: the ox and the sheep are also of oriental origin; but these animals, transported by man to our continent, were not the first of their species that dwelt here; for the ox, the horse and the sheep are found in the fossil state in the tertiary formations of France, Italy, England and Germany: the musk buffalo of Canada is represented by bones of its species on the banks of the Oby, as also on the coast of Tundra, in a still higher latitude. The elephant of India is proved by its remains to have formerly lived in France, and in many other parts of Europe. The *sus larvatus* of Africa is fossil in Germany, in the *faluns* of Anjou, and in the fluvio-marine sands of Montpellier. The African hippopotamus formerly lived in Italy, Sicily and elsewhere in Europe. The close-toothed mastodon dwelt in France, Italy, Piedmont, Bavaria, Peru, and probably, also, in the regions of the lower Himmalaya in Asia. This is what we can affirm from the little we know of the fossil fauna of the East. Moreover, a number of genera, now peculiar to Asia, Africa or America, or to certain countries of these continents were represented, each one by some species, in our European countries, such as the genera pangolinus, orycterope, antilope, lama, tapir, rhinoceros, lamentin, hyena, lion, jaguar, civet-cat, mangousta, morse, etc. The apes of Asia and Africa existed in France: the middle tertiary of Auch yields a species, the *pithecus antiquus*.

To resume: the hypothesis of successive creations was first applied by the school of Werner to the natural kingdoms; it was found subsequently necessary to restrict it, first to classes, then to genera, and afterwards to species. At this lowest limit; and despite its numerous transformations, it still betrays its origin; for it rests, in a lesser or greater degree, on the same false suppositions as the Wernerian artificial classification of formations.

It supposes that these extend over the globe, and that fossilization is a general phenomenon, whereas the formations of each epoch never correspond with all the differently inhabited portions of their respective zones; it supposes that the formations of the first, second and third epochs are *every-where* of the same antiquity, and that different formations of the same rocks are *every-where* of different age.

Moreover it is an opposition with the unity of conception, and of plan in the creation, a rigorously demonstrated fact in zoology, which extends even to species.

But without this hypothesis, the succession of species is better explained by natural causes, the changes occurring on the emerged surface and in the basins of the sea, in consequence of the lowering of the level of the waters; this hypothesis is then inadmissible. The relations hitherto observed between the fossils and the relative antiquity of the rocks that contain them, can only be considered as facts which are neither universal in extent nor of significance for the philosophical history of organized beings. The past may be united with the present by an unbroken chain, all the links of which are not perceptible to us. Some species have forever ceased to exist; others have continued their succession; and the absence of vestiges of so many beings, and the presence of so many others in our various strata, is only the result of circumstances which have first prevented and afterwards favored their deposition under the waters.

COSMOGONY OF MENU.

The reader may find some interest in comparing with the narrative of Moses, the cosmogony least unworthy of such an approximation. *The Book of the Law of Menu* (Manava-d'harma-sastra) is, after the Vedas, the most ancient of the Indian sacred books; and, like the Pentateuch, it begins with a cosmogony; and, like the laws of Moses, the laws of Menu regulated every thing, civil and criminal law, liturgy, priesthood, war, commerce, agriculture and slavery.

"*It was darkness*; imperceptible, without any distinctive quality; neither being capable of being discovered by reason, or of being revealed, the world appeared buried in sleep.

"Then the Lord, *existing of himself*, and who is not comprehensible by the interior senses, rendering this world with the five elements and the other principles perceptible, radiant with the purest light, appeared and dissipated the darkness.

"He whom the mind alone can perceive, who escapes the organs of the senses, who is without visible parts, the soul of all beings, whom none can comprehend, displayed his own splendor.

"Having resolved in his mind to cause the various creatures to emanate from his substance, he first produced the waters in which he deposed a germ.

"This germ became an egg—brilliant as gold, shining like a star with a thousand rays, in which he himself was born, the grand-father of all beings.

"The waters were called *Naras*, because they were the production of *Nara* (the Divine Spirit.) These waters having been the first place of the *movement* (ayana) of *Nara*, he was consequently called *Narayana* (*he who moves over the waters.*)

"By what is,—by the imperceptible, eternal cause, which exists and does not exist, was produced this divine Male (Pouroucha) celebrated in the world by the name *Brahmah.*

"After having remained one year in this egg, the Lord by his thought alone, separated the egg into two parts.

"And of these two parts he formed *heaven and earth*; between them the atmosphere, the eight celestial regions, and the permanent *reservoir of the waters.*

"He emitted from the supreme soul the sentiment which does, and does not exist, and from the sentiment the *Me* (ahancara) monitor and sovereign master:

"And the great intellectual principle, and all that receives the three qualities, and the five organs destined to perceive exterior objects.

"The Supreme Being assigned thus from the beginning to each creature in particular a name, acts, a manner of living, according to the words of the *Veda.*

"The Sovereign Master produced an infinity of gods (devas) essentially active, endowed with a soul, and an invisible troop of genii (sadhyas,) and the sacrifice established from the beginning.

"From the fire, the air and the sun, he emitted, by the completion of the sacrifice, the three eternal *Vedas*, called *Ritch*, *Yadjous and Sama.*

"He created time and the divisions of time, the constellations, the planets, the rivers, the seas, the mountains, the plains, the hilly countries, austere devotion, language, pleasure, desire, anger, and *this creation;* for he wished to give existence to all beings.

"To establish a difference between actions, he distinguished the just from the unjust, and subjected sensible creatures to pleasure and pain, and other antagonistic conditions.

"After having produced this universe and me, (*Menu,*) he whose power is incomprehensible (the *Padma pourara* says: the sovereign divine power, half male and half female,) disappeared once more, absorbed in the supreme soul, replacing time by time. (The *Padma pourara* says: replacing the time of energy by the time of repose.)

"When this God awakes, the universe at once accomplishes its acts: when he sleeps—the mind immersed in profound repose, then the world is dissolved:

"For during his peaceable sleep, the animated beings, provided with the principles of action, quit their functions and consciousness becomes inert.

"And when they are dissolved in the supreme soul, then this soul of all beings sleeps tranquilly in the most perfect repose.

"After having retired into obscurity, it remains there a long time with the organs of sense, ceases to fulfill its functions, and divests itself of its form.

"When again, re-uniting its subtile elementary principles, it enters a vegetable or animal seed, then it resumes its form.

"Thus, by an alternate awaking and repose, the immutable Being causes to revive or to die eternally, all this assemblage of movable and immovable beings."*

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*Translation by *Loiseleur Deslongchamps.*

To consider first the mere form of this narrative, it carries with it the mark of a very high antiquity, although much less than that of the books of Moses. Compare only the first verses. "In the beginning God created heaven and earth. And the earth was void and empty, and darkness was upon the face of the deep, and the spirit of God moved over the waters. And God said: let light be, and light was, and God saw that the light was good: and He divided the light from the darkness. And he called the light Day, and the darkness Night: and the evening and the morning were the first day."* What sublime conciseness, in the one!—in the other what subtile and diluted phraseology! Moses does not dissertate; he does not stop to explain, what God is:—he names Him, and narrates His works; God said: *let light be, and light was!*

Menu explains and paraphrases rather than narrates. "He that the mind alone can perceive, etc." Here you breathe the air of a philosophical era, of a time when reflection combines with tradition. Genesis presents a character otherwise simple and primitive. Moses does not lay aside, for a moment, the pen of a narrator to take up that of a philosopher, who wishes to sound the depths of the Divinity and explain His works.

If from the form we pass to the substance, it is not possible to avoid seeing certain analogies between the Indian and Scriptural traditions. In both, we have only one God, eternal and self-existing. Menu does not speak of *Vischnu* or of *Siva*, whom the celebrated legends called *Pouraras* make divinities equal if not superior to *Brahmah*. *Buddha* is not even once named, either in this narrative of the creation or in any verse of the twelve books of the law. It is, then, monotheism that is ancient, and polytheism that is new in the world. Man did not begin by error, as the *perfectibility* school supposes, but began by truth.

In Menu, as in Moses, the first condition of things is a state of darkness, and the first manifestation of the Divine Power has light for its object. In Menu, as in Moses, the Spirit of God, or a mighty wind, acts on the waters. In Genesis, God creates by His word or will: in the *Manava-d'harma-sastra*, Brahmah forms heaven and earth by his thought alone. In the two cosmogonies, we have simultaneous creations in a general successive creation. Here the analogy ceases, and yet it is more apparent than real. Menu conceives God as distinct from the world, and yet his idea of the creation is already neither complete nor accurate: for the Indian cosmogony exhibits to us the world as pre-existent and co-eternal with Brahmah, who does not *create* it, but merely *organizes* it, after having drawn it from sleep and rendered it perceptible.

In this God who, having completed his work of organization, disappears—absorbed into the Supreme Soul, in which, in turn, are dissolved all animated beings, simple forms which this soul puts on and again puts off—you already see the outline of pantheism, in a less evident and gross form, it is true, than in the philosophy of Kapila, where the desires of the individual produce metamorphases and species, or in Buddhism, where wants create organs, while by compensation moral degradation abolishes members, making the same species ascend and descend by turns in the zoological scale.

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*Gen. I: 1—5.

Besides, ask not of the *Manava-d'harma-sastra* what is man, or what his place in this world: look not on it either for plan of creation or points of contact with science;—there is nothing, absolutely nothing, of all we have admired in Genesis.

The six last verses of the Indian Cosmogony—"when God awakes, etc."—imply a theory degrading to God, contradicted by all facts, and which would appear to have been suggested by these words of Genesis literally understood: "He rested on the seventh day, from all His works which He had made."* The absurd idea of the brilliant egg, developed in the bosom of the waters, in which Brahmah confines himself for a year to prepare the luminous matter of which to form heaven and earth, appears to have arisen from the meaning attributed by the Hindoos to this other verse,—"The Spirit of God moved over the waters,"—the Hebrew word corresponding to *moved* designating the action of a bird who broods. Hence the idea of a hatching, of a luminous and divine egg, in the Indian cosmogony. Have we not seen the *Padma-pourana*, and the philosopher Kapila interpret these concise words of the text: "Male and female He created them," in this manner: "He created the first individual male and female?"

The cosmogony of Menu has, then, preserved precious vestiges, although profoundly altered by philosophic speculations, of a primitive revelation. It would be an additional testimony to the facts recorded in the beginning of the first book of the Pentateuch, if we could see in it anything more than a clumsy imitation of the cosmogony of Genesis. Shall Genesis then, forsooth, be no longer sacred in our eyes, because the laws of Menu have been translated, and because they contain vestiges of the great tradition which was preserved pure by the Hebrew people? Here are men who have turned away their eyes from the true light, to fix them on these pale and weak glimmerings of the east; inquisitive but prejudiced minds, who can scarcely be brought to faith otherwise than by science, and for whom it is time that science should show itself to be what it is—an introduction to and preparation for faith. To such persons are addressed the comparisons and contrasts which are here presented.

*Gen ii: 2.

ERRATA.

Page 45, line 11, for *igneous* read *aqueous*.
" 84, line 19, for *open* read *a pen*.
" 105, line 19, for *grey-stone* read *sand-stone*.
" 175, line 3 in Table, for *Swassic* read *Jurassic*.
" 217, last line, for 1,260 read 1.260.
" 285, line 3, for *co-operating* read *evaporating*.
" 294, line 25, for *it* read *is*.
" 313, line 22, for *more* read *move*.
" 342, line 24, for *more* read *mere*.
" 351, line 21, for *Agean* read *Ægean*.
" 368, line 15, for *than* read *which*.

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