PART 2. PRICE 1s.

RESEARCHES

ON

FOSSIL BONES,

IN WHICH ARE ESTABLISHED

THE CHARACTERS OF

VARIOUS ANIMALS

WHOSE SPECIES HAVE BEEN DESTROYED

BY THE REVOLUTIONS OF

The Globe;

BY

BARON CUVIER

Great Officer of the Legion of Honour, Counsellor of State, and Member of the Royal Council of Public Instruction, One of the Forty of the French Academy, Perpetual Secretary to the Academy of Sciences, Member of the Academies and Royal Societies of London, Berlin, Petersburgh, Stockholm, Edinburgh, Copenhagen, Gottingen, Turin, Bavaria, Modena, The Netherlands, Calcutta, and of the Linnæan Society of London, &c. &c. &c. &c.

FOURTH EDITION,

Revised and Completed

BY ADDITIONAL NOTES,

AND A

SUPPLEMENT LEFT BY THE AUTHOR.

Triomphante des eaux, du trépas, et du temps,
La terre a cru revoir ses premiers habitans.

DELILLE.

IN FOUR VOLUMES.

LONDON:

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AND SOLD BY ALL BOOKSELLERS.

1834.

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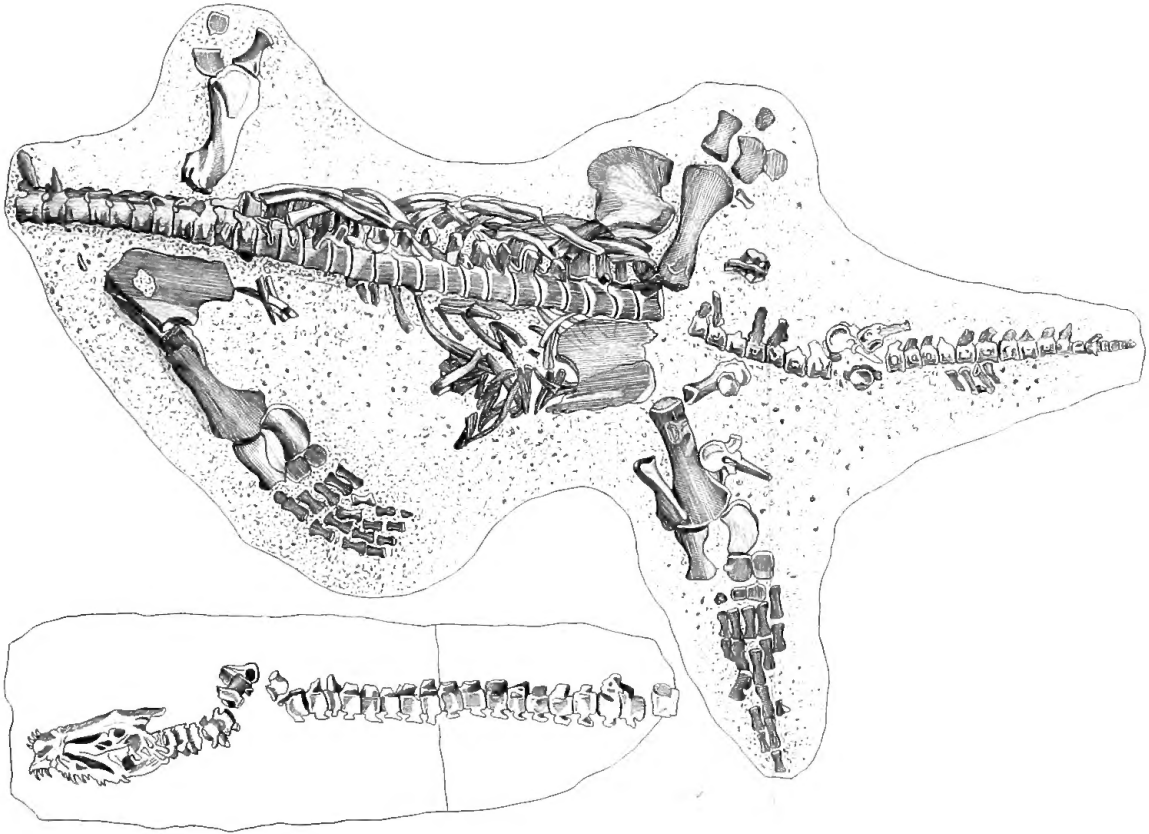

Fossil Skeleton of a Plesiosaurus, discovered at Lyme-Regis.

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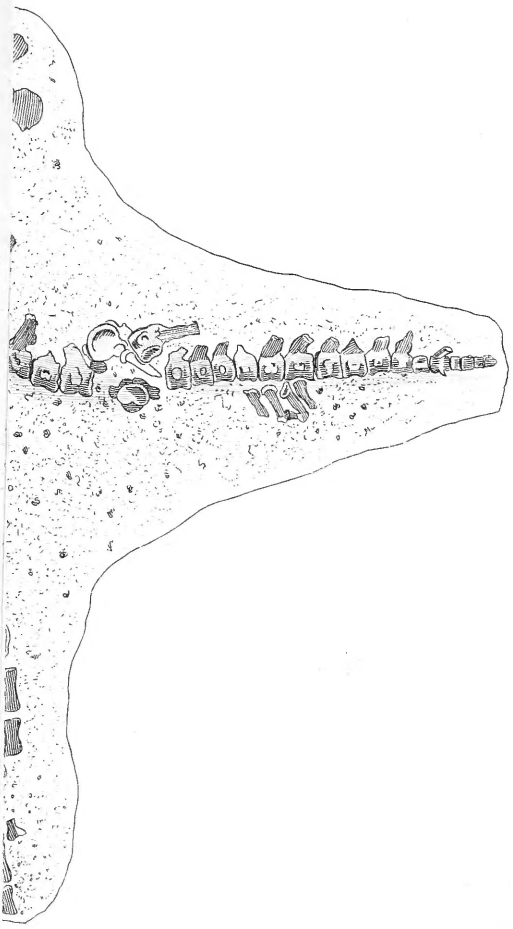

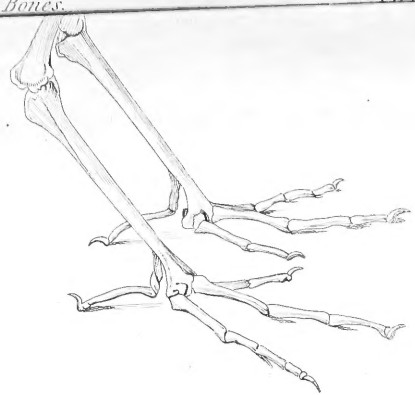

Skeleton of an Ibis from a Mummy found at Thebes in Egypt.

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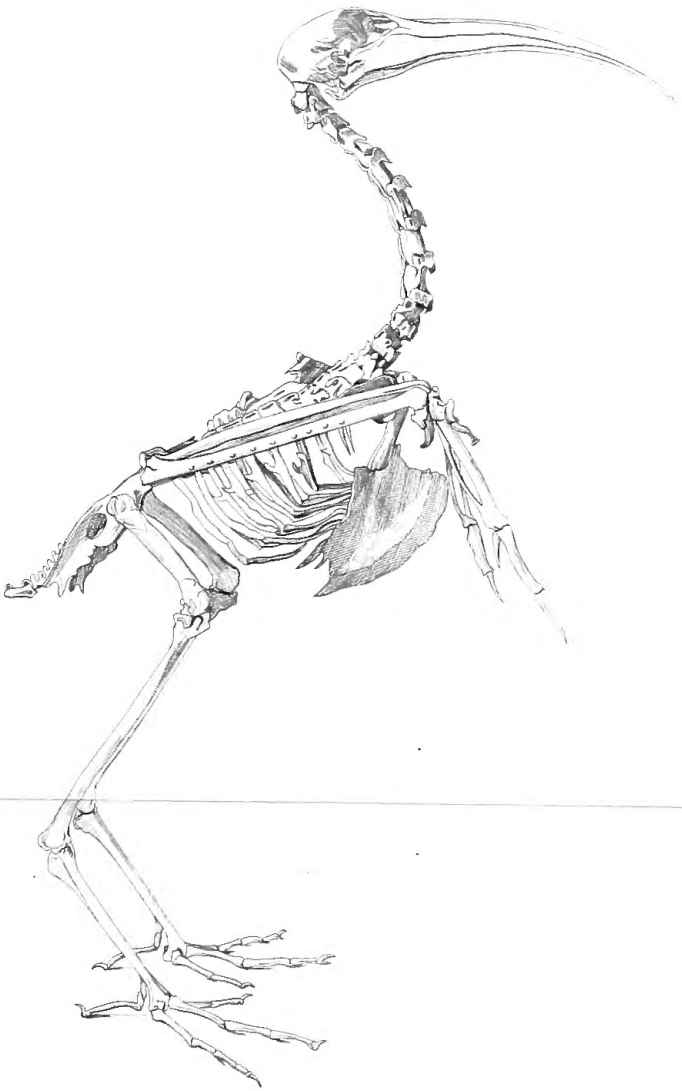

Skeleton of an Ibis from a Mummy found at Thebes in Egypt

London: G Henderson 2 Old Bailey

Demaillet covered the whole globe with water for thousands of years; he caused those waters gradually to retire; all terrestrial animals had at first been marine; man himself was at first a fish; and the author assures his readers that it is not uncommon to find in the ocean fishes which have not only become half men, but which will some day become entire human beings *.

The system of Buffon is only a development of that of Leibnitz, with the sole addition of a comet, which produced from the sun, by a violent shock, the liquefied mass of the earth, together with all the planets: whence result his positive data, for by the actual temperature of the earth we can calculate how long a time has elapsed since it grew cool; and, since the other planets came from the sun at the same time as the earth, we may reckon how many ages must elapse before the larger ones cool, and to what extent the smaller ones have become refrigerated†.

The Latest Systems.

In our times imagination has exercised itself with more freedom than before on this important subject. Some writers have re-produced and greatly extended the ideas of Demaillet; they say that, at first first everything was in a state of liquefaction; that the liquid at first engendered animals of the simplest kind, such as *monads* and others of the infusory and microscopic species; that, in progress of time, and in assuming different habits, the animalia complicated and diversified their species to the extent which we now have in existence. It is these animals who have converted the waters of the ocean gradually into calcareous earth; vegetables, on the origin and changes of which they tell us nothing, have changed the water into clay; but these two earths, by dint of being deprived of the characteristics which life had impressed on them, were resolved, by the last analysis, into flint; and that is the reason why the oldest mountains are the most flinty. All the solid portions of the earth owe their birth, then, to life, and without life the whole globe would be still wholly liquid‡.

Other writers have given the preference to the theory of Kepler. Like this great astronomer, they assign vital powers to the globe; they say that a fluid circulates around it; an assimilation is made as in animate bodies; each of its component parts has life: not only the very elementary atoms have instinct and will, which attract and repel

* Telliamed. Amster. 1748.

† Théorie de la terre, 1749; et Epoques de la Nature, 1775.

‡ See La Physique de Rodig. p. 106. Leips. 1801; and p. 169, vol. ii. of Telliamed, as well as a great number of German works. M. de Lamarck has, with much research and talent, developed this system in his "Hydrogeology and Zoological Philosophy."

by sympathies and antipathies: but every sort of mineral can convert immense masses into its own proper nature, as we convert our aliments into flesh and blood. Mountains are the organs of the respiration of the globe, and the schists the secreting organs; it is by these that sea-water is decomposed to engender volcanic eruptions; the veins in mines are the caries, the abscesses, of the mineral kingdom; and the metals a production of putrefaction and disease; and this accounts for their bad smell*.

Still more recent is a philosophy which substitutes metaphors for reasoning, setting out with a system of absolute identity, or pantheism, produces all phenomena or (what it thinks the same thing) all beings by polarization similar to the two electricities; and calling polarization, all opposition, every obstacle, whether we consider its situation, nature, or functions, it seems to oppose God and the world; in the world the sun and the planets; in each planet solidity and liquidity; and, pursuing this system, changing when needful its figures and allegories, it reaches at last to the minutest details of organized species†.

We must allow that we have selected the most opposite examples, and that all geologists have not carried the boldness of their conceptions as far as those we have cited. But amongst those who have advanced with more caution, and have not sought arguments beyond physics or ordinary chemistry, how much diversity of opinion and contradiction have arisen!

Opposition of all these Systems.

According to one, all is precipitated successively by crystallization: all was deposited as it now is; but the sea which covered all has retired gradually‡.

With another the materials of mountains are incessantly lowered and carried away by rivers to the depths of the ocean, there to become heated beneath enormous pressure, and to form layers which the heat that hardens them will one day elevate with violence§.

A third supposes the liquid divided into a multitude of lakes, amphitheatrically one above another, which, after having deposited our layers of shells, have successively broken down their banks to fill the basin of the ocean‖.

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* M. Patrin has shown much imagination in supporting these fantastic ideas in many articles in "Le Nouveau Dictionnaire d'Histoire Naturelle."

† We particularly find this application of pantheism to geology in the works of M. Steffens and M. Oken.

‡ M. Delamétherie admits crystallization as a principal cause in his Geology.

§ Hutton and Playfair: Illustrations of the Huttonian Theory of the Earth. Edin. 1802.

‖ Lamanon, in many parts of the Journal de Physique, after Michaelis, and many others.

It is the theory of a fourth, that the tides of seven or eight hundred fathoms have, on the contrary, carried off from time to time the bottoms of the sea, and cast them as mountains and hills in the vallies, or on the primitive plains of the continent*.

A fifth has thought that meteoric stones have fallen successively from heaven, which have been the component parts of the earth, and which bear the imprint of their strange origin in the unknown beings whose relics they contain†.

A sixth makes the earth hollow, and places in the centre a diamond, which conveys itself by intervention of comets from one pole to another, drawing with it the centre of gravity and the mass of waters, and thus alternately drowning the two hemispheres ‡.

We could quote twenty other systems, equally contradictory with these. And do not let us be understood as criticising the authors of them; on the contrary, we know that these opinions have generally been elicited from men of genius and understanding, who were not ignorant of facts, to examine which many of them had travelled far and long, and have added many and important truths to the science.

Causes of these Contradictions.

How then can such opposing facts occur in the results of those who have started with the same first principles to resolve the same problem?

Must it not be that the terms of the problem have not *all* been thoroughly considered; which has left it to this day undetermined, though capable of many solutions, all equally plausible when this or that condition is overlooked; all equally unworthy of adoption when a new condition arises, or when attention is arrested by some well-known but neglected fact.

The Nature and Terms of the Problem.

To quit the language of mathematics, we will say that nearly all the authors of these systems, having only regarded certain difficulties which opposed them more forcibly than others, have solved them in a manner more or less plausible, and have thrown aside others as numerous and important. One, for instance, has only contemplated the difficulty of changing the level of the sea; another, that of dissolving all terrestrial substances in one and the same liquid; a third, that of accounting for the existence of animals in the frigid zone, which he supposed could only live in the torrid zone. Exhausting on these

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* Dolomieu, ibid.

† MM. de Marschall: Recherches sur l'Origine et le Developpement de l'Ordre actuel du Monde. Giessen, 1802.

‡ M. Bertrand; Renouvellement Periodique des Continens Terrestres. Hambourg, 1799.

points the whole powers of their imagination, they thought they had effected all in devising a means of answering them. Besides, in neglecting other phenomena, they did not always think of determining precisely the measure and limits of those which they attempted to explain.

This is particularly true in reference to the secondary formations, which form the most important and difficult part of the problem. For a long time naturalists employed themselves very unavailingly in determining the superstrata of their layers, and the relation of these layers with those sorts of animals and plants whose remains they contain.

Are there animals and plants peculiar to certain layers, and which are not met with in others? What is the species of those which first appear, or which come after? Are those two species ever found together? Are there variations in their return; or in other words, do the first again recur, and do the second then disappear? Have these animals all lived in the places where their remains are found, or have some of them been conveyed elsewhere? Do they all exist at present anywhere, or have they been wholly or partly destroyed? Is there a perpetual uniformity between the antiquity of the layers and the resemblance or non-resemblance of the fossils with living beings? Is there a similarity of climate between fossils and those of living beings which most resemble them? Can we determine that the removal of these beings (if there has been any) has been from north to south or from east to west, or by scattering and mixture; and can we distinguish the epochs of those removals by the layers which have these marks impressed on them?

How can we decide on the actual state of the globe if we cannot answer these questions, if we have not sufficient grounds to enable us to determine in the affirmative or negative? Besides, it is but too true that during a long period none of these points have been absolutely cleared up; in fact, it was scarcely deemed expedient to clear them up previous to the formation of a system.

Reason why these Preliminaries have been neglected.

It may be assigned as a cause of this peculiar neglect, that geologists have all been either naturalists of the closet, who had themselves but very superficially examined the structure of mountains, or mineralogists who had not studied in sufficient detail the innumerable varieties of animals, and the infinite complication of their different component parts. The former have only framed systems; the latter have made admirable observations; they have in fact laid down the foundations of the science, but were inadequate to the task of elevating the superstructure.

Progress of Mineral Geology.

In truth, the mineral portion of the great problem of the theory of the earth has been studied with admirable care by Saussure, and brought to a wonderful development by Wërner, and by the numerous and talented disciples of his school.

The former of these celebrated men, scrutinising with indefatigable toil for twenty years the most inaccessible mountainous districts, in a manner attacking the Alps themselves in every direction, in every defile, has laid open to us all the confusion of the primitive formations, and has clearly traced the secondary formations. The latter, availing himself of the numerous excavations made in countries containing the oldest mines, has fixed the laws relating to the succession of layers; he has pointed out their relative antiquity, and traced each through its respective change. It is he, and he only, who has given a date to geology, as far as regards the mineral nature of the layers; but neither Saussure nor Wërner have determined the fossilized organized species in each sort of layer, with that necessary exactness which is so requisite, from the prodigious number of known animals which they contain.

Other men of science, indeed, studied the fossil relics of organized bodies; they collected and published drawings of them by thousands; their works will be valuable collections of materials; but, more engrossed with animals or plants, considered as such, than with the theory of the earth, or, regarding these petrifactions or fossils as curiosities rather than historical documents, or, in truth, contenting themselves with partial explanations on the relative bearing of each relic, they have almost always neglected to seek for the general laws of position, or the relation of fossils with the layers.

Importance of Fossils in Geology.

And yet the idea of such a research was very natural. How was it overlooked that it is to fossils alone that must be attributed the birth of the theory of the earth; that, without them we could never have surmised that there were successive epochs in the formation of the globe, and a series of different operations? Indeed, they alone prove that the globe has not always had the same crust, by the certainty of the fact that they must have existed at the surface before they were buried in the depths where they are now found. It is only by analogy that we extend to primitive formations that conclusion which fossils enable us definitively to ascribe to secondary formations; and if there were only formations without fossils, no one could prove that these formations were not simultaneously produced.

Again, it is to fossils, small as has been our acquaintance with

them, that we owe the little knowledge we have attained respecting the nature of the revolutions of the globe. They have taught us, that the layers which comprise them have been undisturbedly deposited in a liquid; that their alterations have corresponded with those of the liquid; that their exposure was occasioned by the removal of this liquid; that these exposures have taken place more than once. None of these facts could have been decided on without these fossils.

The study of the mineral portion of geology, which is not less necessary, which is even of still greater utility with regard to the mechanical arts, is yet much less instructive with relation to the object of which we are treating.

We are in positive ignorance regarding the causes which can have produced the changes of the substances composing the layers; we do not even know the agents which could have held certain of them in solution; and it is yet a matter of controversy, whether certain of them owe their origin to water or fire. To come at once to the point, we observe that there is a general agreement on one point only; namely, that the sea has changed its situation. And how should we know that if we had no fossils?

Fossils, which have given birth to the theory of the earth, have also furnished it with its principal lights, the only ones which have been generally recognized down to the present period.

It is this idea which has encouraged us to take up the subject; but the field is immense; a single person could only glance over but a very trifling part. A choice was to be made therefore, and we did not hesitate. The class of fossils which forms the object of this work at once determined us, because we saw that it is at the same time more pregnant with precise results, and yet less known and more rich in novel matters of research *.

Paramount importance of the Fossil Bones of Quadrupeds.

It is apparent, that the bones of quadrupeds conduct us, by various reasonings, to more precise results than any other relics of organized bodies.

In the first place, they characterize more clearly the revolutions which have effected them. Shells prove that the sea was once where they are now found; but their change of species could only at the utmost proceed from slight variations in the nature of the liquid or merely in its temperature.

* My work has in fact proved the situation of this subject when I took it up, in spite of the admirable labours of Camper, Pallas, Blumenbach, Merk, Sæmmering, Rusen, Müller, Fischer, Faujas, Home, and other learned men, whose works I have quoted with much care in those chapters of my books to which they relate.

They might have had relation to causes still more accidental. There is nothing to assure us that at the bottom of the sea certain species, even certain genera, after having occupied for a longer or shorter period determinate situations, have not been forced away by others. Here, on the contrary, all is precise; the appearance of the bones of quadrupeds, particularly the whole carcases in the layers, betokens either that the layer itself which contains them was formerly dry land, or that there was terra firma in its immediate vicinity. Their disappearance renders it certain that this layer was inundated, or that this dry land ceased to exist. It is then by these that we learn in a positive manner the important fact of the repeated irruptions of the sea, with which shells and other marine productions could not have made us acquainted; it is by studying them profoundly that we may hope to ascertain the numbers and periods of these irruptions.

Secondly, the nature of the revolutions which have altered the surface of the globe must have exercised a more entire action over terrestrial quadrupeds than marine animals. As these revolutions have in a great measure consisted in changes of the bed of the sea, and the waters must have destroyed all the quadrupeds which they reached, if the irruption were general, the whole class must have perished; or, if only operating on certain continents, it must have destroyed at least the species peculiar to these continents, without exercising the same influence upon marine animals. On the contrary, millions of aquatic individuals might have been left on dry land, or buried under new layers, or thrown with violence on the shore, and their race be still preserved in some places more tranquil, where it might again be propagated after the disturbance of the waters had ceased.

Thirdly, this action, as more complete, is more easily seized on; it is more easy to demonstrate its effects, because, the number of quadrupeds being limited, the greater part of their species, at least of the larger kind, being known, we have still further means afforded us of ascertaining whether the fossil bones belong to one of them, or if they formed a part of the species now extinct. As we are, on the contrary, very far from knowing all the marine testacea and sea fish; (and are probably ignorant yet of the greater part which are in the depths of the ocean), it is impossible to know with certainty if a species found fossilized be or be not extinct. Thus we observe learmed men obstinately bent on giving the name of pelagian shells, that is, shells of the deep sea, to belemnites, to cornua-ammonis, and other shelly relics, which have as yet only been observed in ancient layers; meaning by that, that if they have not been yet found in a living state, it is because they inhabit depths beyond the reach of our nets.

Certainly naturalists have not yet traversed every continent, and do not even know all the quadrupeds which inhabit the countries over which they have travelled. New species of this class are from time to time discovered; and those who have not attentively examined all the circumstances of these discoveries, might believe also that the unknown quadrupeds whose bones are found in our layers have remained concealed to the present time in some islands not yet discovered, or in some of the vast deserts which occupy the middle of Asia, Africa, the two Americas, and New Holland.

Little probability of finding new Species of great Quadrupeds.

However, if we examine what species of quadrupeds have been recently found, and in what circumstances they have been discovered, we shall see that there is but little hope of ever finding those that we have only seen as fossils.

Islands of moderate extent, situated at a distance from extensive continents have very few quadrupeds, and those very small; when they have large ones, it is because they have been brought from elsewhere. Bougainville and Cook found only dogs in the South Sea Islands; and the largest species of the West-India Islands was the agouti.

In fact, large territories such as Asia, Africa, the two Americas, and New Holland, have large quadrupeds, and generally species peculiar to each of them; so that wherever it has been found that the situation of these lands has kept them isolated from the rest of the world, a class of quadrupeds has been there found entirely different from any elsewhere existing. Thus, when the Spaniards first overran South America, they did not find one of the quadrupeds common to Europe, Asia, or Africa. The puma, the jaguar, the tapir, the cabiai, the lama, the vicuna, sloths, armadilloes, opossums, and all the species of monkeys, were to them entirely strange, and beings of which they had no idea. The same phenomenon occurred in our time, when the first survey of the coast of New Holland and the adjacent islands took place. The different kangaroos, phascolomys, dasyurus, and perameles, the flying phalangers, the ornithorynchi, and echidnæ, have been found to astonish naturalists by their strange conformations, which broke through all rules and overthrew all systems.

If then there remained any extensive continent to discover, we might hope to find new species, amongst which, some might be found more or less resembling those of which the bowels of the earth have presented us with the relics; but it is sufficient to cast a glance over the mass of the world, and see the numerous directions in which navi-

gators have ploughed the ocean, to judge that there cannot be any other large tract of land, unless it be at the North Pole, where the ice would not admit of any duration of existence.

Thus we find that it is from the interior of the large divisions of the world that we can expect unknown quadrupeds.

But, on a little reflection, we shall soon see that this expectation is hardly more likely to be realized here than in the islands.

The European traveller does not easily effect his passage through vast extent of countries, desert, or only supporting a ferocious population, and this is more particularly the case in Africa; but nothing prevents animals from overrunning these countries in every direction and approaching the coasts. Although great mountainous chains may intervene between the coasts and the deserts of the interior, they would be broken in some places to allow of the passage of the rivers; and, in these burning deserts, quadrupeds give the preference to the banks of the rivers. The population of these coasts ascend these rivers and soon acquire a knowledge, either from experience, or by commerce and tradition, of the more remote population, and of all the remarkable species which live near the sources of the streams.

At no period have the civilized nations, who have frequented the coasts of a great country, failed in acquiring a knowledge of the largest animals, or those whose formation is peculiar and striking.

Facts bear out this reasoning. Although the ancients did not pass the Imaus or the Ganges, in Asia, and had not got beyond Mount Atlas, in Africa, they yet knew all the large animals of these parts of the world. and, if they did not distinguish all these species, it was not because they could not have seen or heard speak of them, but because the resemblance of the species would not allow of their discriminating their peculiar characteristics. The only great exception which may be brought against me is the tapir of Malacca, recently sent from India by two young naturalists, pupils of mine, MM. Duvaucel and Diard, and which in fact is one of the most brilliant discoveries with which modern times have enriched natural history.

The ancients were acquainted with the elephant, and the history of this quadruped is more exact in Aristotle than in Buffon.

They were not even ignorant of the distinguishing marks between the elephants of Africa and those of Asia* (*a*).

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* See in my Researches the chapter on elephants.

(*a*) ☞ In the Zoological Magazine, January 1st, 1833, p. 20, there is a full description, with a very fair plate, of the one-horned species of India, the *Rhinoceros Indicus* of Cuvier. From this magazine, which, we lament, was not sufficiently supported to be upheld for a longer period than six months, we extract the following account:—

They knew the double-horned rhinoceros, now no longer living in modern Europe. Domitian exhibited one at Rome, and had it engraved on medals. Pausanias describes it with much exactness.

As the Rhinoceros Indicus is the only species of one-horned animals which has in modern times been brought alive to Europe, it has been most commonly figured. A sketch was taken from the animal sent to Portugal in 1513, which was engraved by Albert Durer. This sketch was afterwards embellished by the celebrated painter of Nuremberg, and at a still later period was put into the possession of Sir Hans Sloane with an inscription attached to it, of which the following appears in the Philosophical Transactions for 1744, a literal translation: "In 1513, May 1, there was brought to our king at Lisbon such a living beast from the East Indies that is called *Rhinocerate*; therefore, on account of its wonderfulness, I thought myself obliged to send you a representation of it. It hath the colour of a toad, and is close covered over with thick scales. It is in size like an elephant, but lower, and is the elephant's deadly enemy; it hath on the fort-part of its nose a strong sharp horn; and when this beast comes near the elephant to fight with him, he always first whets his horn upon the stones, and runs at the elephant with his head between his fore-legs; then rips up the elephant where he hath the thinnest skin, and so gores him. The elephant is terribly afraid of the Rhinocerate, for he gores always wherever he meets an elephant, for he is well armed, and is very alert and nimble. This beast is called Rhinocero in Greek and Latin, but in India Gomba."

The animal sent to England in 1739 is described by Dr. Parsons as very broad and thick. His head is very large, and the hinder parts next his ears considerably too high for the rest of his face, which is flat, and sinks down suddenly forward towards the middle, rising again to the horn, but in a less degree. The horn stands on the nose of the animal as on a hill. In Sir Hans Sloane's museum, the bones of the head of one of these animals clearly show that the part on which the horn is fixed rises to a blunt cone, to answer to the cavity in the basis of the horn, which is hard and solid, having no marrow or core like other quadrupeds. From the fore-part of the horn to the upper lip is the nose; on this part there are a number of wrinkles running across the front of it, and advancing towards the eyes. The nostrils are in the same direction as the mouth, and not above an inch from it. The under lip resembles that of an ox, and the upper that of a horse, with this difference, the rhinoceros can stretch it out about six inches to a point, and double it round a stick; so that in its action it is more like the proboscis of the elephant.

According to some naturalists, the tongue is said to be rough enough to rub a man's flesh from his bones; but that of our present animal is soft, whether it may grow rough as the beast grows older must yet remain undetermined.

His eyes are dull and half closed, like those of a hog, and situated near the nose. His ears broad and thin, with a round root, with wrinkles about it. His neck is short, and has two folds round it, the fore one being broken underneath, whence is suspended a hollow flap deep enough to contain a man's fist. His shoulders are thick and heavy, and each has a fold downward that crosses the fore-leg, and doubles under the belly behind the fore-leg.

His body is very thick, and juts out at the sides like that of a cow with calf. His belly sinks almost to the ground. From the highest point in his back, the fold of the loins runs down on each side between the last ribs and the hips, and is lost before it comes to the belly; but above the place of its being lost another rises and runs backward round the hind legs, a little above the joint. This is called the crural fold.

The legs of the rhinoceros are thick and strong; they bend back at the knee. Round the joint of each leg there is a fold, which is only perceptible when the animal lies down.

The tail is not more than seventeen or eighteen inches long, and not very thick. It has a great roughness round it, and a twist or stricture towards the extremity, which is flat. On the sides of this flat extremity of the tail are a few long black hairs. On the left side of the tail; the hairs grow almost up to its root, whereas on the right side they grow no higher than the flat part. There is no other hair on this animal than a very

The unicorn rhinoceros, though very remote from Rome, was equally well known there. Pompey exhibited one. Strabo has accurately described another at Alexandria*.

The rhinoceros of Sumatra, described by Mr. Bell, and that of Java, discovered and sent over by Messrs. Duvaucel and Diard, do not appear to live on the continent. Therefore it is not astonishing that the ancients had no knowledge of them, and perhaps if they had they would not have distinguished them.

The hippopotamus has not been so well described as the preceding species; but we find very exact delineations of it on the monuments left by the Romans, which represent things relative to Egypt, such as the statue of Nilus, the mosaic of Palestrina, and a great many medals. In fact, the Romans saw them often, they were exhibited by Scaurus, Augustus, Antoninus, Commodus, Heliogabalus, Philip, and Carinus†.

The two species of camels, that of Bactria, and that of Arabia, are

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small quantity on the posterior edge of the upper parts of the ears. This animal has a wonderful acuteness in its hearing; the slightest noise disturbs him, whether eating or sleeping; and, under the greatest engagements nature imposes upon him, he stops every thing suddenly, and lifts up his head with great attention till the noise is over.

The skin of the rhinoceros is thick and impenetrable. In several parts of the body it is covered over with hard incrustations, particularly on the shoulders and buttocks. Between the folds the skin is soft and smooth, and of a pale flesh colour.

The folds of this quadruped are necessary to render the body flexible. The skin is so inflexible and impenetrable in most parts, that without folds they could not bend. But by the wisdom of Providence, these folds are placed in such parts of the body as to facilitate the performance of any voluntary motion the animal may be disposed to make.

The rhinoceros utters a note similar to the grunt of a boar, but somewhat shriller when it is enraged. One hundred and twenty-four pounds of food, and a proportionate quantity of drink, is consumed by this animal in a day. The animal of which Dr. Parsons speaks consumed every day three pounds of sugar and seven pounds of rice, with about a truss of hay per week, besides greens of different kinds.

From the time of his being taken to the time of his landing in England, his expenses were said to amount to one thousand pounds. The rhinoceros commonly lives in solitude, moves slowly, ploughing the earth with his horn, and casting huge stones behind him. When he runs, his tail is extended like that of a bull. The rhinoceros is greatly tormented by the stings of numerous insects, and, as a means of defence, they roll themselves in the mire, which hardening in the sun, forms a sort of cuirass to the naked skin. The flesh of the rhinoceros is similar in its flavour to pork, and better than that of the elephant. The horn is much esteemed by the Asiatics, they make drinking cups of them; they are sometimes sculptured with considerable taste. The hide is employed to make whips. An interesting memoir, by M. Frederick Cuvier, has appeared in the splendid work published by him conjointly with M. Geoffroy St. Hilaire, on the animals in the menagerie in the Garden of Plants at Paris. It relates to the rhinoceros lately living in that establishment.

It was from this memoir that the figure of the rhinoceros was taken. We are happy to add, that for those geologists who directed their attention to fossil animals, that there is at present a very interesting specimen of this genus of large animals in the Surrey Zoological Gardens.—ENG. ED.

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* See in my work the chapter on the rhinoceros.

† See in my Researches the chapter on the hippopotamus.

already well described and characterized by Aristotle*. The ancients knew the giraffe or camel-leopard; they even had a living one at Rome in the circus under the dictatorship of Julius Cæsar, in the year of Rome 708. Gordian III. had ten at one time, which were killed at the secular games of Philip†, which must astonish the moderns, who have only seen one in the fifteenth century‡.

If we read attentively the descriptions of the hippopotamus, given by Herodotus and Aristotle, and which are said to be borrowed from Hecatæus of Miletus, we shall find that they must have been composed of two different animals, of which one perhaps was the real hippopotamus, and the other certainly the gnu, a quadruped of which our naturalists have made no mention till the end of the eighteenth century. It was the same animal of which so many fabled narratives were told under the name of catoblepas or catablepon§.

The Ethiopian wild boar of Agatharchides, which had horns, was the same as our Ethiopian wild boar, whose enormous weapons of defence have almost as much claim to the name of horns as the tusks of the elephant‖.

The bubalus and nagor are described by Pliny¶; the gazelle, by Ælian**; the oryx, by Oppian††; the axis was known in the time of Ctesias‡‡; the algazel and the corinna are perfectly depicted on Egyptian monuments§§.

Ælian well describes the yak or *bos grunniens*, under the name of the ox, whose tail serves for a fly-flapper‖‖.

The buffalo has not been domesticated amongst the ancients; but the ox of the Indies, of which Ælian¶¶ speaks, and which had horns large enough to hold three amphoræ, was a variety of the buffalo, called *arni*.

And even this wild ox, with depressed horns, which Aristotle places in Arachosia***, must be the common buffalo.

The ancients knew the oxen without horns†††; the oxen of Africa,

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* His. Anim. lib. ii, c. 1.

† Jul. Capitol. Gord. III, cap. 23.

‡ That which the soldan of Egypt sent to Lorenzo de Medicis, and which is painted in the frescoes of Poggio Cajano.

§ See Pliny, lib. viii, cap. 32, and Elian, lib. vii. c. 5.

‖ Ælian, Anim. v. 27.

¶ Pliny, lib. viii, cap. 15, and lib. xi, c. 37.

** Ælian, Anim. l. xiv. c. 14.

†† Op. Cyneg. ii, v. 445, et seq.

‡‡ Pliny, lib. viii, c. 21.

§§ See the great work on Egypt, Antiq. iv, pl. 49 and 66.

‖‖ Ælian, Anim. xv, 14.

¶¶ Id. iii, 34.

*** Arist. Hist. An. lib. ii, cap. 5.

††† Ælian, ii, 53.

whose horns, attached to the skin only, are shaken with it*; the oxen of India as swift in flight as horses †; those no larger than a goat‡; sheep with a large tail§; and those of India as large as asses‖.

Although the ancient accounts of the aurochs, the rein-deer and the elk, are mixed with fable, they still prove that they had some knowledge of them; but that the knowledge, founded on the accounts of ignorant persons, had not been submitted to a critical judgment¶. These animals dwell in the country assigned to them by the ancients, and have only disappeared in countries too much cultivated for their habits of life; the aurochs and the elks still live in the forests of Lithuania, which formerly joined the forest of Hercynia. There are aurochs in the north of Greece, as in the time of Pausanias. The rein-deer inhabits the north, in the cold regions which it has always inhabited; there it changes colour, not according to its will, but to the seasons. It was by a series of inexcuseable mistakes that it was thought they would be found in the Pyrenees in the fourteenth century**. The white bear was seen in Egypt during the reign of the Ptolemies ††.

Lions and panthers were common at Rome in the games; they were exhibited by hundreds; there were even tigers; the striped hyena, and the crocodile of the Nile, were there produced. There are in the artificial mosaics preserved at Rome excellent representations of the rarest of these species; amongst others, the striped hyena accurately depicted on a fragment preserved in the museum in the Vatican; and when I was in Rome (in 1809) they discovered in a garden beside the arch of Gallienus, a mosaic pavement of natural stones arranged in the Florentine manner, representing four Bengal tigers, admirably done.

The museum of the Vatican contains a basalt crocodile, very nearly accurate‡‡; we cannot doubt but that the *hippotigris* was the zebra, which, however, is only found in the southern parts of Africa§§.

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† Ælian, ii, 20. † Id. xv, 24. ‡ Id. ibid.
§ Id. Anim. iii. 5. ‖ Id. iv. 32.

¶ See in my Researches the chapters on deer and oxen.

** Buffon having read in Du Fouilloux a passage quoted from Gaston-Phebus, Count de Foix, in which that prince describes the rein-deer hunt, imagined that that animal existed in the Pyrenees at that period; and the printed editions of Gaston are so faulty, that it was with difficulty ascertained what the author means to say; but having reverted to the original manuscript, which is preserved in the king's library, I have found that it was in Xueden and Nourwergue (Sweden and Norway), that he says he saw and partook of the chase of rein-deer.

†† Athenée, lib. v.

‡‡ There is no error except that there is a nail too many at the back of the foot. Augustus exhibited thirty-six. Dion. lib. xv.

§§ Caracalla killed one in the circus. Dion. lib. lxxvii. Cinf. Gisb. Cuperi de Elipt. in nummis obviis, ex. ii. cap. 7.

It would be easy to show that nearly all the most remarkable species of apes have been accurately defined by the ancients under the names of pitheci, sphynxes, satyrs, cebi, cynocephali, cercopitheci*.

They knew and described even the smaller descriptions of glires, when they had any peculiarity of conformation or remarkable property†. But the smaller species do not concern us; it is enough to have shown that all the larger kinds, distinguished by some marked characteristic, which we have now any knowledge of in Europe, Asia, and Africa, were already known to the ancients; whence we may safely draw the conclusion, that if they do not describe the smaller, or if they do not discriminate between those which closely resembled each other, as the gazelles and others, they were prevented by carelessness or want of method, rather than by opposition from the climate. We shall also determine, that if eighteen or twenty ages, and the circumnavigation of Africa and the Indies, have added nothing in this species to what the ancients already knew, that there is no likelihood that ages to come will bring much additional information to our posterity.

But perhaps an inverse argument may be used against us, and it will be said, that not only the ancients, as we have just proved, have known as many animals as ourselves, but they have described many which we now have not; that we are too hasty in regarding these animals as fabulous; that we should again search for them before we decide in exhausting the history of the existing creation; that indeed, amongst these pretendedly fabulous animals, we shall detect, when we know them better, the originals of our remains of unknown species. Some may even surmise that those different monsters, the essential ornaments of the heroic age amongst nearly all people, are precisely those which it has been necessary to destroy, to admit of the progress and establishment of civilization. Thus Theseus and Bellerophon, who bravely defeated these noxious animals, must have been far more fortunate than the existing race, but have not yet contrived to exterminate any one species, but only to drive them back.

It is easy to reply to this objection, by examining the descriptions of these unknown beings, and searching into their origin.

The most numerous have a source purely mythological, and of that their descriptions bear the undeniable impress; for we see in nearly all only portions of known animals, united by an unrestrained fancy,

* See Lichtenstein, Comment. de Simiarium quotquot veteribus innotuerint formis. Hamburg, 1791.

† The jerboa is engraved on the medals of Cyrene, and pointed out by Aristotle as the *rat with two feet*.

and in opposition to every law of nature. Those invented or put together by the Greeks are certainly graceful in their composition; like those arabesques which ornament the remains of some ancient edifices, and which the fertile pencil of Raphael has multiplied: forms are there united, totally repugnant to reason, offering to the eye agreeable proportions; these are the light productions of happy dreams; perhaps emblems of the oriental taste, in which they pretended to veil beneath mystic imagery the refined suggestions of metaphysics and morals. Let us excuse those who endeavour to employ their time in unravelling the wisdom concealed in the Sphynx of Thebes, the Pegasus of Thessaly, the Minotaur of Crete, or the Chimera of Epirus; but let us hope that no one would seriously seek for them in nature; as well might we expect to find the animals of Daniel, or the beasts of the Apocalypse. Let us not attempt to seek for the mythological animals of the Persians, offspring of a still more heated imagination; the *martichore*, or destroyer of men, which has the head of a man on the body of a lion, terminated by a scorpion's tail*; the *griffin*, or treasure-keeper, half eagle half lion†; the *cartazonon*‡, or wild ass, whose head is armed with a long horn.

Ctesias, who has described these as existing animals, has passed with many for an inventor of fables, whilst he only attributed a reality to emblematical figures. These fantastic sculptures have been found in the ruins of Persepolis§. What is their meaning? Most probably we shall never learn, but they certainly do not represent real creatures.

Agatharchides, another fabricator of animals, probably drew from an analogous source. The monuments of Egypt show us still numerous combinations of the parts of different species; the gods are there often represented with a human body and an animal's head; we see animals with human heads, which have produced the cynocephali, the sphynxes, and the satyrs of ancient naturalists. The custom of depicting in the same painting men of different heights, the king or the conqueror gigantic, the conquered or people three or four times smaller, may have given birth to the story of the pigmies. It is in some recess of one of these monuments that Agatharchides must have seen his carnivorous bull, whose mouth, cleft to his ears, spared no other

* Plin. viii, 31; Arist. lib. ii, cap. 11; Phot. Bibl. art. 72; Ctes. Indic; Ælian, Anim. iv, 21.

† Ælian, Anim. iv, 27.

‡ Id. xvi. 20; Photius Bibl. art. 72; Ctes. Indic.

§ See Corneille Lebrun, Voyage en Muscovy, en Perse, et aux Indes, t. ii; and the German work of M. Heeren on the Commerce of the Ancients.

animal*; but surely naturalists will not assert that there can be such; for nature never unites either cloven feet or horns with cutting teeth.

There were most probably other figures equally strange, either in those monuments which were not able to withstand the ravages of time, or in those temples of Ethiopia and Arabia which the Mahomedans and Abyssinians, in the excess of their religious zeal, have destroyed. Those of India swarm with them; but the combinations are too extravagant to deceive any one: monsters with a hundred arms, and twenty different heads, are too monstrous to find belief.

It is not the Japanese and Chinese only who have not the imaginary animals which they represent as real, and even exhibit in their religious books; the Mexicans have them also: it is the custom of all people, either at the time when their idolatry has not become sufficiently refined, or when the meaning of these emblematical combinations have been lost. But who will pretend to find in nature these offsprings of ignorance and superstition?

Certain travellers, however, anxious to establish a character of renown, have asserted that they have seen these fantastic animals, or that, for want of due attention, and deceived by a slight resemblance, they have taken real creatures for them. Large apes have appeared real cynocephali: baboons, as men with tails; and thus St. Augustin said that he had seen a satyr.

Some real animals, scarcely seen and badly described, may have caused these monstrous ideas, slightly founded on reality. Thus we cannot doubt the existence of the hyena, though this animal has not a neck supported by one single bone†, and that he does not change sex every year, as Pliny‡ says; thus perhaps the carnivorous bull is only a rhinoceros with his two horns. M. de Weltheim asserts, that the auriferous ants of Herodotus are *corsacs*.

One of the most famous amongst the animals of the ancients is the *unicorn*. Naturalists were fully bent, even down to our times, on

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* Photius Bibl. art. 250; Agatharchid. Excerpt. Hist. cap. xxxix; Ælian, xvii, 35; Plin. viii, 21.

† I have seen, in the cabinet of the late M. Adrian Camper, a hyena's skeleton, in which many of the vertebræ of the neck were soldered together. It is probable that it is some similar individual which has caused this character to be given to all hyenas. This animal must be more subject to this accident than any other, in consequence of the prodigious force of its neck, and the frequent use it makes of it. When the hyena has seized any thing, it is easier to draw it along than to tear from it what it holds: this is why the Arabs have selected it as the emblem of insuperable obstinacy.

‡ It does not change the sex; but has at the perinæum an orifice which has given rise to the opinion of its being an hermaphrodite.

finding it, or at least in seeking arguments in favour of its existence. Three animals are frequently mentioned by the ancients as having only one horn in front. The *oryx of Africa,* which has at the same time cloven feet, the hair reversed*, is of great size, equal to the ox†, or even the rhinoceros‡, and which it is agreed approaches sheep or goats in form§; the *ass of the Indies,* which is solid footed; and the *monoceros,* properly so called, whose feet are sometimes compared with those of a lion‖, sometimes with those of an elephant¶, and consequently cloven-footed. The horse** and the unicorn oxen have a mutual relation certainly to the ass of the Indies††, for the ox is mentioned as even solid-footed. I ask, if these animals existed as distinct species, should we not at least have their horns in our collections? And what single horns have we but those of the rhinoceros and the narwal?

How, after this, can we refer to the coarse figures traced by savages on the rocks‡‡? Ignorant of perspective, and wishing to present in profile the horned antelope, they could only give it *one* horn, and thus originated the oryx. The oryx of the Egyptian monuments are most probably but the productions of a similarly crude style, which the religion of the country imposed on the artist. Many of the profiles of quadrupeds have only one leg before and one behind; why then should they show two horns? It is possible that individual animals might be taken in the chase, whom accident had despoiled of one horn, as it often happens to chamois and the Scythian antelope (saiga); and that would suffice to confirm the error which these pictures originally produced. It is thus, probably, that we find anew the unicorn in the mountains of Thibet.

All the ancients, besides, have not reduced the oryx to a single horn; Oppian§§ expressly gives it several; and Ælian mentions some of the oryx who had four‖‖‖. Now if this animal were ruminating and cleft-footed, it certainly had the frontal bone divided in two, and could not, according to the accurate remark of Camper, have had a horn on the suture.

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* Arist. Anim. ii, 1. iii, 1; Plin. xl, 46.
† Herod. iv, 192.
‡ Oppian Cyneg. ii, vers. 551.
§ Plin. viii, 53.
‖ Philostorge, iii, 11.
¶ Plin. viii, 21.
** Onesicrite, ap. Strab. lib. xv; Ælian, Anim. xiii, 42.
†† Plin. viii, 31.
‡‡ Barrow, Voyage to the Cape.
§§ Oppian Cyneg. lib. ii, v, 468 and 471.
‖‖‖ De An. lib. xv, cap. 14.

But, we may be asked, what two-horned animal could give the idea of the oryx, and present the features which are given of its conformation, even in depriving it of its unity of horn? I reply with Pallas, it is the horned antelope, improperly called the *pasan* by Buffon. It inhabits the deserts of Africa, and would have reached the confines of Egypt; it is that which the hieroglyphics seem to represent; its figure is nearly that of the stag; its height equals that of the ox; the hair of its back is directed towards the head; its horns are formidable weapons, sharp as darts, hard as iron; its hair is whitish, its countenance has marks and black streaks; and this is all that naturalists have described of it; and, as to the motives of the priests of Egypt, who spread abroad fables concerning it, and adopted it in their hieroglyphics, there is no occasion for their having a foundation in reality. Suppose then that an oryx with only one horn has been seen; that they have taken it for a perfect being, a type of its whole species; suppose that Aristotle, who adopted this error, has been copied by others; it is all possible, and even natural, but proves nothing in favour of the existence of an unicorn species.

As to the ass of the Indies, we have only to read of the anti-poisonous properties attributed to its horn by the ancients, and we shall see that they are precisely similar to those which the orientals of the present day assign to the horn of the rhinoceros. When the horn was first introduced amongst the Greeks, they could not have known the animal which had borne it. Indeed, Aristotle makes no mention of the rhinoceros, and Agatharchides is the first who has described it. In the same manner, the ancients possessed ivory long before they became acquainted with the elephant. Perhaps some traveller may have named the rhinoceros *the ass of the Indies*, with as much justice as the Romans had named the elephant *the bull of Lucania*. All that has been said of the strength, height, and ferocity of the wild ass, agrees very well with the rhinoceros. Moreover, those who best know the rhinoceros, finding in former authors the denomination of *ass of the Indies*, have taken it, without reflexion, for that of a peculiar animal; and, in fact, from the name, we should conclude that this animal was solid-footed. There is a full description of an ass of the Indies by Ctesias*, but we have seen above that it was taken from the bas-reliefs of Persepolis; it should not pass for anything in the actual history of the animal.

When there was also a description still less exact, which mentioned an animal with a single horn with many lines, a third species was made out, with the name of *monoceros*. These sort of twofold

* Ælian, Anim. iv. 52; Photius, Bibl. p. 154.

accounts are the more common with ancient naturalists, because almost all those whose works remain to us were simple compilers; but even Aristotle himself has frequently mixed facts borrowed from others with those which he himself has observed; so that in fact the art of criticism was as little known then by naturalists as by historians, which is saying a great deal.

After all these reasonings, all these digressions, it results, that all the great animals that are known in the old continent were known to the ancients; and that the animals described by the ancients, and not now known, were fabulous; it also results, that very little time elapsed before all the great animals of the three first known parts of the globe were known by the people who frequented the coasts.

We may thence conclude, that we have not even any large species to discover in America. If there were any, there exists no cause why we should not have been acquainted with them; and in fact, for a hundred and fifty years, none have been discovered. The tapir, the jaguar, the puma, the cabiai, the lama, the vigogne, the red wolf, the buffalo, or American bison, the ant-eaters, sloths, and armadilloes, are already in Margrave and in Hernandes, as well as Buffon. We may say that they are there better described, for Buffon has mingled the history of the ant-eaters, misunderstood the jaguar and the red wolf, and confounded the bison of America with the aurochs of Poland. In fact, Pennant is the first naturalist who has properly distinguished the little musk ox, but it had long been pointed out by travellers. The cleft-footed horse of Molina is not described by the first Spanish voyagers; but its existence is more than doubtful, and Molina's authority is too dubious to be adopted. It would be possible to characterise better than at present the stags of America and the Indies; but with them, as with the ancients respecting the various antelopes, a good method of description was wanting, (and not opportunities of seeing them,) that they might be better known. We may then say, that the mouflon of the Blue Mountains is now the only quadruped of America of any size, the discovery of which is entirely modern; and perhaps it is only a Siberian goat that has crossed the ice.

How then can we believe that the enormous mastodons, the gigantic megatheria, whose remains have been found under the earth in the two Americas, can still exist on that continent? How could they have escaped those wandering people who incessantly over-run the country, in every corner of it, and who themselves acknowledge that they no longer exist, since they have imagined a fable about their destruction, saying that they were killed by the Great Spirit, to prevent them from destroying the human race? But we may see that this

fable was occasioned by the discovery of the bones, like that of the inhabitants of Siberia and their mammoth, which they pretend lives under ground like moles; and like all those of the ancients about the tombs of the giants, which they placed wherever they found the bones of elephants.

Thus we may believe, that if, as we shall prove hereafter, any of the great species of quadrupeds now embedded in regularly stony layers, are not found similar to the living species that we are acquainted with,—it is not the effect of chance, nor because these species, of which we have only fossil bones, are hidden in deserts, and have escaped all travellers to the present time; we ought, on the contrary, to regard this phenomenon as tending to general causes; and the study of it as one of the most proper to lead us to the origin and nature of these causes.

The Fossil Bones of Quadrupeds are difficult to determine.

But if this study is more satisfactory in its results than that of the fossil remains of other animals, it is also beset with infinitely greater difficulties. The fossil shells generally present themselves entire, and with all the characteristics which admit of their being analogously arranged in collections or works of naturalists; fish even present their skeletons more or less entire; we generally trace the original form of their bodies, and frequently their generic and specific characteristics, which are drawn from their solid parts. In quadrupeds, on the contrary, although we should meet with the whole skeleton, we should have great difficulty in applying to it the characteristics for the most part derived from the hair, colour, and other marks, which disappear before the incrustation; and it is uncommonly rare to find a fossil skeleton at all perfect; bones isolated and confusedly intermingled, most frequently broken and reduced to fragments; this is all with which our layers furnish us in this class, and is the sole resource of the naturalist. Thus we may say that the majority of observers, frightened at these difficulties, have passed lightly over the fossil bones of quadrupeds; have classed them very vaguely, after superficial resemblances: or have not even hazarded the giving a name to them; so that this part of the fossil history, the most important and instructive of all, is of all others the least cultivated *.

* I do not pretend by this remark, as well as those already made, to detract from the merit of the observations of Messrs. Camper, Pallas, Blumenbach, Sœmmering, Merk, Faugas, Rosen Müller, Home, &c.; but their estimable labours, which have been very useful to me, and which I have cited everywhere, are only partial, and many of these labours even published after the first editions of this Discourse.

Principle of this determination.

Fortunately, comparative anatomy possesses a principle which, properly developed, was capable of clearing up all embarrassment: it was that of the natural relation of forms in organized beings, by means of which each sort of creature may, by rigorous scrutiny, be known by each fragmant of each of its parts.

Every organized being forms a whole, an unique, and perfect system, the parts of which mutually correspond, and concur in the same definitive action by a reciprocal re-action. None of these parts can change without the whole changing; and consequently each of them, separately considered, points out and marks all the others.

Thus, as I have before remarked, if the intestines of an animal are so organized as only to digest flesh, and that fresh, it follows that its jaws must be constructed to devour a prey, its claws to seize and tear it, its teeth to cut and divide it, the whole structure of its organs of motion such as to pursue and catch it, its perceptive organs to discern it at a distance; nature must even have placed in its brain the necessary instinct, to know how to conceal itself and lay snares for its victims. Such will be the general conditions of the carnivorous kingdom; every animal of this species will infallibly unite these qualities; for its race could not exist without them. But under these general conditions there are particular ones, relative to the size, species, and haunts of the prey, for which each animal is inclined; and each of these particular conditions result from modifications of the detail in the formations which they derive from the general conditions; thus, not only the class, but the order, the genus, and even the species, are detected in the formation of each part.

For, that the jaw may be enabled to seize, it must have a certain shaped prominence for the articulation, a certain relation between the position of the resisting power and that of the strength employed with the fulcrum: a certain volume in the temporal muscle, requiring an equivalent extent in the hollow which receives it, and a certain convexity of the zygomatic arch under which it passes: this zygomatic arch must also possess a certain strength, to give strength to the masseter muscle.

That an animal may carry off his prey, a certain strength is requisite in the muscles which raise the head; whence results a determinate formation in the vertebræ or the muscles attached, and in the occiput where they are inserted.

That the teeth may cut the flesh, they must be sharp; and they must be so more or less, according as they will have, more or less ex-

clusively, flesh to cut. Their roots should be the more solid, as they have more and larger bones to break. All these circumstances will in like manner influence the developement of all those parts which serve to move the jaw.

That the claws may seize the prey, they must have a certain mobility in the talons, a certain strength in the nails, whence will result determinate formations in all the claws, and the necessary distribution of muscles and tendons; it will be necessary that the fore-arm have a certain facility of turning, whence again will result determinate formation in the bones which compose it; but the bone of the fore-arm, articulating in the shoulder-bone, cannot change its structure, without this latter also change. The shoulder-blade will have a certain degree of strength in those animals which employ their legs to seize with, and they will thence obtain peculiar structure. The play of all these parts will require certain properties in all the muscles, and the impressions of these muscles so proportioned will more fully determine the structure of the bones.

It may be seen that we could draw equally just conclusions for the hinder quarters, which contribute to the rapidity of the general movements; as to the formation of the body, the shape of the vertebræ, which influence the ease and flexibility of the motions; as to the form of nasal bones, of the socket of the eye, of the ear, whose mutual relation to the perfection of the sense of smelling, seeing, and hearing, are so palpable. In a word, the formation of the tooth bespeaks the structure of the articulation of the jaw, that of the scapula, that of the claws, just as the equation of a curve involves all its properties; and in taking each property separately, as the basis of a particular equation, we should find again both the ordinary equation and all the other certain properties: so the claw, the scapula, the articulation of the jaw, the thigh bone, and all the other bones separately considered, require the certain tooth, or the tooth requires them reciprocally; and beginning with any one, he who possessed a knowledge of the laws of organic economy, would detect the whole animal.

This principle is sufficiently self-evident, in the usual acceptation, not to require a farther demonstration; but when we come to apply it, there are many cases in which our theoretic knowledge of the mutual relations of the structure would not be sufficient, if it were not supported by observation.

We see, for instance, very plainly that hoofed animals must all be herbivorous, since they have no means of seizing upon their prey; we see also that, having no other use for their fore-feet than to support their bodies, they have no occasion for so powerfully-framed a shoulder;

whence we may account for the absence of the clavicle and the acromion, and the straightness of the scapula; not having any occasion to turn the fore-leg, their radius will be solidly united to the cubitus, or at least articulated by a hinge-joint, and not by ball and socket, with the shoulder; their herbaceous diet will require teeth with a broad surface, to crush seeds and herbs; this breadth must be irregular, and for this reason the enamelled parts must alternate with the osseous parts; this sort of surface compelling horizontal motion, for grinding the food to pieces, the articulation of the jaw cannot form a hinge so close as in carnivorous animals; it must be flattened, and correspond with the facing of the temporal bones, more or less flattened; the temporal cavity, which will only contain a very small muscle, will be small and shallow, &c. All these are necessary deductions one from another, according to their greater or lesser universality; and so that some are essential and exclusively belonging to hoofed animals, and others, although equally necessary to those animals, are not peculiar to them, but are to be found in other animals, where the other general rules of structure admit of these also.

If we descend to the orders or subdivisions of the class of hoofed animals, and examine what modifications the general condition undergo, or rather, what peculiar conditions are united to them, according to the character proper to each of these orders, the reasons of these secondary conditions begin to appear less palpable. We soon perceive, in general terms, the necessity of a digestive system more complicated in the species where the dental system is more imperfect; thus we might say that these should rather be ruminating animals, where such and such an order of the teeth is wanting; we may deduce from it a certain form of the œsophagus, and corresponding formation of the vertebræ, of the teeth, &c. But I doubt whether any one would have guessed, if observation had not suggested it, that ruminating animals would all have cloven feet, and that they alone would have them: I doubt whether any one would have guessed that those only would have horns on the forehead that belong to this class; that those amongst them who have sharp eye-teeth are for the greatest part deficient in horns, &c.

However, since these coincidences are constant, they must have a satisfactory cause; but as we do not know it, we ought to supply the defect of the theory by observation; it serves us to establish suppositious laws, which become almost as certain as the laws of reasoning, when they rest on often-repeated observations; so that now, any one who sees the track of a cleft-foot may conclude that the animal who left it is ruminant; and this assertion is as sure as any other in physics or morality. This foot-mark alone gives to the observer both the

formation of the teeth, the shape of the jaws, the structure of the vertebræ, and the form of all bones of the legs, thighs, shoulders, and even the frame of the animal which has passed. It is a more certain mark than all those of Zadig.

Whatever secret reasonings there may be in these relations, it is observation which has elicited them, independently of general philosophy.

In fact, when we make an assemblage of these facts, we remark not only a specific consistency, if we may use such a term, between a certain formation of a certain organ, and a certain formation of a different organ; but we perceive also a classified consistency, and a correspondent gradation in the developement of these two organs, which evince, almost as well as an effective reasoning, their mutual influence.

For example, the dental system of hoofed animals, not ruminant, is usually more perfect than that of cleft-footed animals, or those which ruminate, because the former have either incisors or canine teeth, and generally both in both jaws; and the structure of their foot is more complicated, because they have more toes, or nails which less enclose the phalanges, or more separate bones of the metacarpus and metatarsus, or the bones of the tarsus more numerous, or a more distinct prominence of the tibia, or in fact, because they unite all these points. It is impossible to account for these correspondences; but what proves that they are not the effect of chance, is, that whenever a cleft-footed animal shows, in the arrangement of its teeth, any tendency to a similarity with the animals of which we are speaking, it also evinces a similar tendency in the formation of its feet. Thus camels, which have canine teeth, and even two or four incisors in the upper jaw, have a bone more in the tarsus, because their scaphoid is not united with the cuboid, and very small nails corresponding with the phalanges which have nails. The chevrotians, whose canine teeth are much developed, bear a distinct mark along the tibia, whilst other cleft-footed animals have only, instead of the fibula articulated, a small bone along the tibia. There is then a constant harmony between two organs apparently very distinct from each other; and the gradations of their formation correspond without alteration, even in cases where we can assign no cause for the similarity.

But, in thus adopting the method of observation as an additional means when theory forsakes us, we arrive at astonishing results. The least prominence of the bone—the smallest apophysis—has a determined character relative to the class, the order, the genus, and even the species to which it belongs; so that whenever we have only the extremity of a well-preserved bone, we may, by scrutinizing it, and ap-

plying analogical skill and close comparison, determine all these things as certainly as if we had the whole animal. I have often in this way experimented on portions of known animals, before I entirely applied the test to fossils; but it has always had such infallible success, that I have no longer any doubt on the certainty of the results which it afforded.

It is true, that I have been in possession of every assistance which I required; and my situation and assiduous search of nearly thirty years* have procured me skeletons of every genus and kind of quadrupeds, and even of many species in certain genera, and many individuals in certain species. With such means, I have had much ease in multiplying my comparisons, and verifying, in all their details, the applications that I made of my laws.

We cannot now dwell longer on this method, and are compelled to refer to the larger comparative anatomy, which we shall soon produce, and which will contain all these rules. However, an intelligent reader will be still able to derive a vast many from the work on fossil bones, if he will take the trouble to follow all the applications there laid down. He will see, that it is by this method alone that we have been guided, and have always found it sufficient to classify each bone with its species, when it was a living species; to its genera, when it was of an unknown species; to its order, when it was of a new genus; and finally, to its class, when it belonged to an order not yet established; and also to assign it, in these last three cases, the proper characteristics, to distinguish it from the orders, genera, or species most resembling it. Naturalists before us did no more for entire animals. Thus we have determined and classed the remains of more than one hundred and fifty mammiferous and oviparous quadrupeds.

The general Results of these Researches.

Considered relatively to the species, more than ninety of these animals are certainly unknown to present naturalists; eleven or twelve have so exact a resemblance to known species, that there can scarcely be a doubt of their identity; others present, with the known species, many points of similarity; but the comparison has not been made with sufficient accuracy to remove all scruples.

Considered with regard to genera, amongst the ninety unknown species, there are nearly sixty which belong to new genera; the other species belong to known genera.

It is not unprofitable to consider these animals with relation to the class and orders to which they belong.

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* 1825.

Of the hundred and fifty species, about a fourth are oviparous quadrupeds, and all the others are mammiferous. Amongst these, more than half belong to non-ruminating hoofed animals.

It would be premature to establish on these researches any conclusion relative to the theory of the earth; because they have not a necessary relation to the members of the genera or species which may be imbedded in our layers. Thus much has been gathered from those bones of the larger species, which more readily strike the workmen; whilst those of the smaller are usually neglected, unless chance brings them into the hands of a naturalist, or some striking circumstance, such as their abounding in certain places, should draw the attention of the common observer.

Relations of the Species with the Strata.

What is more important, and is even the most essential object of all my toil, and establishes the actual relation with the theory of the earth, is to know in what layers we find a particular species, and if there be any general and relative laws either as regards zoological subdivisions, or to the greater or lesser resemblance of the species with those of the present day.

The recognized laws in this respect are very remarkable and very clear.

First, it is certain that oviparous quadrupeds appear much more frequently than viviparous; that they are ever more abundant, larger, and more various in the ancient layers than at the actual surface of the globe.

The ichthyosauri, the plesiosauri, many tortoises, and crocodiles, are beneath the chalk in the formations commonly called those of Jura. The monitors of Thuringia would be still more ancient, according to the opinion of the school of Werner, if the copper slate which includes them, amidst so many sorts of fishes supposed to be of fresh water origin, be amongst the most ancient beds of secondary formation. The immense crocodiles and great tortoises of Maestricht are even in the chalky layer; but these are marine animals. This first appearance of the fossil bones seems then to prove that there were dry lands and fresh waters before the formation of the chalk; but neither at that epoch, nor whilst the chalk was forming, nor even long afterwards, was it incrusted with the relics of terrestrial mammifera; at least the small number of those alleged to have been found form only an exception perfectly immaterial.

We begin to find the bones of marine mammifera, that is, of lamantins and seals, in the thick shelly limestone which is above the chalk

in the neighbourhood of Paris; but there is no bone of a terrestrial mammiferous animal.

In spite of the most indefatigable researches, I have found it impossible to discover any distinct trace of this class prior to the layers deposited on the coarser limestone: lignites and molasses certainly have them; but I much doubt whether these earths are, as is believed, anterior to the limestone; the places where they have furnished bones are too limited and too few, therefore we may suppose there has been some irregularity or some recurrence in their formation. On the contrary, when we reach the deposites immediately above the limestones, the bones of terrestrial animals appear in great numbers.

Thus, as it is rational to believe that shells and fishes did not exist at the period of the formation of the primordial layers, so may we also believe that the oviparous quadrupeds began with fishes and the first production of secondary formations; but that terrestrial quadrupeds did not appear, at least in considerable numbers, until a long time afterwards, and when the thick limestone which now contains the greatest portion of our genera of shells, although different in species, had been deposited.

We must remark, that these coarse limestone strata, which we make use of in Paris for building, are the last banks which denote a long and peaceful flowing of the sea over our own continents. After them we find layers filled with shells and other marine productions; but these consist of shifting layers, sands, marls, sand-stones, and soft clays, which rather denote changes more or less sudden than a quiet settling; and, if there be any stony or regular banks of any size beneath or above these moving layers, they generally betray marks of having been deposited from fresh water.

Nearly all the known bones of viviparous quadrupeds are then either in these deposites of fresh water, or in the alluvial deposites; and consequently, there is reason to believe that these quadrupeds had not begun to exist, or at least to leave their relics in the layers that we are able to fathom, till after the last retreat but one of the sea, and during that state of things which had preceded its last irruption.

But there is also an order in the arrangement of these bones amongst themselves; and this order bespeaks a very remarkable succession in their species.

First, all the unknown genera, the palæotheria, the anoplotheria, &c., on the relative situation of which we have certain ideas, belong to the oldest of the layers in question; to those which rest immediately above the coarse limestone. It is these, principally, which fill the regular banks, deposited by soft waters or certain shifting beds,

very anciently formed, and generally composed of sand and round flints, and which were probably the first alluvial deposites of the ancient world. We find with them certain lost species of known kinds, but in small numbers, and some oviparous quadrupeds and fresh-water fishes. The beds which contain them are always more or less covered over by the shifting beds, filled with shells and other marine productions.

The most celebrated of these unknown species, which belong to the known kinds, or to kinds very much resembling those that are known, such as the fossil elephant, the rhinoceros, the hippopotamus, and the mastodons, are not found amongst the more ancient kinds. It is only in the shifting layers that they are discovered, sometimes with sea-shells, sometimes with the shells of fresh water, but never in the regular stony beds. All that is found with these species is either unknown as they are, or at least doubtful.

In fact, the bones of the species which appear the same as ours only present themselves in the last deposites of alluvions formed on the banks of rivers, or on the beds of old ponds or dried marshes, or in the depths of turf layers, or in the clefts and hollows of certain rocks, or, finally, at a short distance from the surface, in places where they may have been imbedded by casualties or by the hand of man; and their superficial position makes these bones, the most recent of any, almost always in the worst state of preservation. It must not, however, be supposed that this classifying of different relative situations is as clear as that of the species, or that it can have a demonstrative character equally distinct; there are manifest causes why it cannot be so.

First, all my arrangements of species have been made on the bones themselves, or on good figures; it was necessary, on the other hand, that I should have observed myself all the places where these bones have been discovered. Very often I have been compelled to have recourse to vague and ambiguous resemblances, made by persons who did not know what peculiar observations were necessary; and more frequently still, I have not found any hints at all.

Secondly, there must be in this respect infinitely more doubt than with regard to the bones themselves. The same deposite may appear recent in places where it is superficial, and ancient in those where it is covered over by banks which have succeeded it. Ancient layers may have been transported by partial inundations, and have covered recent bones; they may have been buried beneath them, and have enveloped and mingled with the productions of the ancient seas which they before contained: ancient bones may have been washed by the waters, and

then taken up by recent alluvial deposites: and recent bones may have fallen into the clefts and caverns of the ancient rocks, and then have been enveloped by stalactites or other incrustations. It would be necessary, in every case, to analyse and justly determine on all these circumstances which might veil from the sight the real origin of fossils; and persons who have collected bones have very seldom doubted of this necessity; whence it follows, that the real nature of their geological position have nearly always been neglected or misunderstood.

Thirdly, there are some doubtful species, which would more or less alter the certainty of these results, just as long as clear distinctions with regard to them were not made out; thus horses and buffaloes, which are found with elephants, have not yet peculiar and specific characters; and geologists, who will not adopt my different epochs for fossil bones, will still be able to draw from them, for many years, an argument useful and convenient, as it is from my book that they will derive it.

But although it may be said that these epochs are capable of some objections with persons who but slightly consider some particular case, I am no less persuaded that those who will adopt the whole of these phenomena will not be checked by these small and partial difficulties, and will acknowledge with me, that there has been one and probably two successions in the class of quadrupeds before that which now peoples the surface of our continents.

I here expect another objection; one has been made already.

The Extinct Species are not varieties of Living Species.

Why, I am asked, should not the present race be modifications of those ancient races which we find among fossils, modifications which would have been produced by local circumstances and change of climate, and brought to this great difference by a long series of years?

This objection must appear very cogent with those who believe in the undefined possibility of the change of forms in organized bodies, and who think that with ages and habits every species may change, one into another, or result from a single one amongst them.

We may answer them in their own way; that, if the species has gradually changed, we must find traces of these gradual modifications; that between the palæotheria and the present species we should have discovered some intermediate formation; but to the present time none of these have appeared.

Why have not the bowels of the earth preserved the monuments of so remarkable a genealogy, unless it be that the species of former ages

were as constant as our own; or at least because the catastrophe that destroyed them had not left them time to give evidence of the changes?

As to the naturalists who allow that the varieties are confined within certain limits fixed by nature, it is necessary, in order to answer them, that we should examine what may be the extent of these limits—a curious research, very interesting in itself in many respects, and yet one which has hitherto excited but very little attention.

This inquiry calls for the definition of a *species*, which may serve as the foundation for the use which is made of the term. A species then includes *the individuals which descend from one another, or from common parents, and those which resemble them as strongly as they resemble one another.* Thus we only call the *varieties* of a species those races, more or less different, which may have proceeded from them by generation. Our observations on the distinctions between ancestors and descendants are consequently our only rational rule; for every other would enter into hypothesis without proofs.

But in thus considering the *variety*, we observe that the differences which constitute it depend on determinate circumstances, and that their extent increases with the weight of these circumstances.

Thus the most superficial characteristics are the most changeable; colour depends much on light; the thickness of the *hair* on the heat; the size on the great supply of food. But in a wild animal, even these varieties are very much limited by its habits, for it will not willingly leave the place where it finds, in a quantity suited to its wants, all that is necessary for the support of its species, and then only to those where it may find them as equally well supplied. Thus, although the wolf and the fox are found from the torrid to the icy zone, we rarely find in this vast space very little other difference than a little more or less beauty in their fur. I have compared the skulls of foxes of the north and those of Egypt with those of France, and have only found individual differences.

Those savage animals which are confined to more limited spaces vary still less, particularly those which are carnivorous. A thicker mane makes the only difference between the hyena of Persia and those of Morocco.

Herbivorous wild animals feel rather more sensibly the influence of climate, because it more affects their food, which differs in abundance and quality at various times. Thus elephants will be greater in one forest than in another; they will have tusks larger in those places where the nourishment is more congenial to the formation of the

material of ivory; it is the same with rein-deer and stags, according to their woods; but let us take the two most dissimilar elephants, and we shall not discover the least differences in the number or articulations of their bones, in the structure of their teeth, &c.

Besides, the herbivorous species, in a wild state, appear more limited in their dispersion than carnivorous animals, because the species of the food unites with the temperature to confine them.

Nature takes care to prevent any alteration of the species which might result from their mixture, by the mutual aversion which she has implanted within them. All the plans and the power of man are called forth to effect these unions, even in the species most alike; and when the productions are fruitful, which is very rare, the fertility does not last beyond a few generations, and would not probably take place without a continuation of the cares which excited them. Thus, we do not find in the wood intermediate individuals between the hare and the rabbit, between the stag and the fallow deer, between the marten and the pole-cat.

But the sovereignty of man alters this order; it developes all the variations of which each species is capable, and derives from the production what the species, left to themselves, would never have done.

Here the degree of variation is still proportioned to the influence of their cause—which is slavery. It does not rank very high in the domestic species; as for instance, a cat. Hair of a finer texture, brighter colours, size greater or less, is all that it proves, but the skeleton of an Angora cat has no decided or perpetual difference from that of a wild cat.

From domesticated herbivorous animals, which we transport to every kind of climate, which we accustom to every sort of food, and to which we assign labour and nourishment without rule, we obtain greater varieties, but still they are only superficial. A greater or less height—horns longer or shorter, or even entirely wanting—a lump of fat more or less developed on their shoulders—form the difference of oxen; and these differences are for a long time kept up, even in those breeds exported from the country in which they were produced, when proper care is taken to prevent crossing.

Of this kind are the numerous varieties of sheep which are valuable for their wool chiefly, because that is the object which has obtained the greatest attention of mankind. It is still rather less, although distinctly marked in horses.

In general the forms of the bones vary but little; their structure, their articulation, the form of their large grinders never vary.

The small marks of tusks in the domestic pig, and the juncture of the hoofs in some of this race, are the extreme difference that we have produced in the herbivorous domestic kind.

The most marked effects of the influence of man is evinced on the animal over which he has obtained the most complete conquest—the dog. This species is so much devoted to man, that even the very individuals seem to have sacrificed themselves to us, with their interests and their feelings. Conveyed by man to all parts of the universe, subjected to every cause capable of influencing their development, and joined in their union according to the taste of their masters, dogs vary so much in colour; in the thickness of their hair, which is sometimes lost; in their breed; in height, which differs as one to five in lineary dimensions, which makes more than an hundred fold in the mass; in the form of the ears, the nose, and the tail;—as to the relative length of their legs; as to the progressive developement of the brain in the domestic variety, whence even results the shape of the head; sometimes slender, with a sharp nose, and broad forehead; sometimes with a short nose and round forehead; as these differences are observable in a mastiff and a water spaniel in a greyhound and a pug; that these effects become more strongly marked than in those of any wild species of a similar natural genus. In fact, and this is the maximum of the difference known at the present time in the animal kingdom, that there are breeds of dogs which have an additional toe on the hind leg, with correspondent bones of the tarsus, as there are in the human race some families having six fingers on each hand.

But in all these varieties the relations of the bones remain the same, and the shape of the teeth never undergoes any palpable change; although there are some individuals which have an extra and false grinder, sometimes on one side, and sometimes on the other *.

There are then, in animals, characteristics which defy all influence, whether natural or human, and there is nothing which proves to us that time will effect any more than climate and a state of domestication. I know that some naturalists rely much on the thousands of ages which they can accumulate with a stroke of the pen; but in such matters we can only judge of what length of time would produce, by multiplying in thought what the least time will effect. I have endeavoured to collect the most ancient documents of the forms of animals, and there are no countries which furnish us with older and

* See my brother's (M. Frederic Cuvier's) Memoir on the varieties of dogs, inserted in his 'Annales du Museum d'Histoire Naturelle.' This work was done at my request from the skeletons of all varieties of dogs, expressly prepared.

more abundant specimens than Egypt. It affords us not only the representations of animals, but their bodies themselves embalmed in the catacombs.

I have attentively examined the drawings of animals and birds engraved on the numerous columns brought from Egypt to Rome. All these figures have (taken as a whole, which must be the way in which artists consider them,) a perfect resemblance to those of the same species still existing.

Every one may examine the copies made by Kirker and Zoega; they have given drawings of them, easily recognized, although not precisely similar to the originals. We may easily distinguish the ibis, the vulture, the owl, the falcon, the Egyptian goose, the lapwing, the landrail, the aspic, the cerustes, the Egyptian hare with its long ears, and even the hippopotamus; and in these numerous monuments, engraved in the great work on Egypt, we sometimes have the rarest animals—the algazel, for instance, which was not seen in Europe till within these few years*.

My learned colleague, M. Geoffroy Saint Hilaire, strongly impressed with the importance of this research, collected with great care, in the tombs and temples of Upper and Lower Egpyt, all the mummies of animals which he could obtain. He brought both cats, ibises, birds of prey, dogs, monkeys, crocodiles, and an ox's head embalmed; and we cannot find any more differences between these and those of the present day, than between human mummies and human skeletons of the present time. Some difference has been found between the mummies of ibis and the bird so called by naturalists of the present day; but I have removed all difficulties in an essay on this bird subjoined to this Discourse, in which I have shewn that it is at the present time precisely as it was in the time of the Pharaohs. I am aware that I only refer to animals of two or three thousand years, but these are the earliest periods to which we are enabled to revert.

There is nothing then in known facts, which can support in the least the opinion that the new genera which I have discovered or established amongst fossils, as well as those detected by other naturalists, the *palæotheria*, the anoplotheria, the megalonyces, the mastodontes, the pterodactyli, the ichthyosauri, &c., could have been the sources of any animals now existing, which would only differ by the influence of time or climate; and although it should be true (which I am far from be-

* The first representation of it from nature is in 'La Description de la Menagerie, by my brother; it is accurately represented in the great work on Egypt. Descr. d' l'Egypte, Ant. t. iv. pl. xlix.

lieving) that elephants, rhinoceroses, elks and fossil bears, differ no more from those of the present time, than the race of dogs differ from each other—we cannot thence determine the identity of the species, because the race of dogs has been subjected to the influence of domestication, to which these other animals have not nor could not have been compelled or induced to submit.

Besides, when I assert that the rocky beds contain the bones of various genera, and the shifting or alluvial strata those of many species which no longer exist, I do not mean to allege that a new creation was necessary to produce the species now existing; I only maintain that they did not exist in the places where we now see them, and that they must have been deposited there by some other means.

For instance, let us suppose that a great irruption of the sea covers, with a mass of sand, or other accumulation, the continent of New Holland; it would bury the carcases of the *kangaroos*, *phascolomys*, dasyuras, perameles, flying phalanger, echidna, and ornithorynchus, and would entirely destroy the species of all these genera, since none of them now exist in any other country.

Suppose that the same revolution were to leave dry the multiplied small straits which separate New Holland from the continent of Asia, it would open a way for the elephant, rhinoceros, buffalo, horse, camel, tiger, and all other Asiatic quadrupeds, which would come and people a land in which they were before unknown.

If a naturalist, after having well studied the living species, were to lay open the soil on which they live, he would find the remains of very different animals.

What New Holland would become, were this supposition realized, Europe, Siberia, and a great portion of America really are; and it may one day be discovered in the examination of other countries, and even of New Holland itself, that they have all experienced similar revolutions—I should say nearly all mutual exchanges of productions; for, to carry the supposition still farther, after this transport of Asiatic animals into New Holland, let us allow that a second revolution destroyed Asia, their original country; those who should discover them in New Holland, their second country, would be as much embarrassed to find out whence they came, as we now are to discover the origin of those which are found in our own countries.

I now proceed to apply this reasoning to the human species.

There are no Fossil Human Bones.

It is a fact, that as yet no human bones have been discovered amongst fossil remains; this is an additional proof that the fossil races were not

varieties of the species, since they could not have been subjected to human influence.

I beg to be clearly understood, when I say that human bones have never been found amongst fossils, to mean fossils properly so called, or, in other words, in the regular layers of the surface of the earth; for in turf bogs, in alluvial deposites, as well as in burial grounds, we can as easily disinter human bones, as bones of horses or other common animals: they may also be found in the clefts of rocks and in grottos, where the stalactites will have congealed over them; but in the beds which contain the ancient races, amongst the palæotheria, and even amongst elephants and rhinoceroses, not a particle of human bone has ever been discovered. Many of the workmen in the gypsum quarries, near Paris, think that the bones with which they abound are human; but as I have seen many thousands of these bones, I may be allowed to assert that they have never produced a single bone that ever formed a part of the human frame. I have examined at Pavia the piles of bones collected from the isle of Cerigo by Spallanzani, and, in defiance of the assertion of this celebrated observer, I affirm, in like manner, that there is not one which can be proved to be human, Scheuchzer's *homo diluvii testis* has been placed since my first edition with its real genus, that of the salamanders; and in an examination which I have been since enabled to make at Haarlem, through the kindness of M. Van Marum, who allowed me to uncover the parts concealed in the stone, I have substantiated satisfactorily what I before asserted. We see amongst the bones found at Cronstadt, the fragment of a jaw, and some articles of human manufacture; but we know that the ground was dug up without care, and that no observation was made of the various depths at which each relic was discovered. Besides, in every instance, the fragments said to be human have been found on examination to be those of some animal, whether they have been examined themselves, or by figures of them.

Very lately a pretended discovery was made at Marseilles, in a quarry, for a long time neglected *; but they only proved to be marine productions *(tuyaux marins)* †. The real human bones were carcases fallen into clefts of the rock, or left in ancient galleries of mines, or become incrusted; and I extend this assertion even to the human skeletons discovered at Guadeloupe ‡ in a rock formed of a collection of madrepores cast up by the sea and united by water strongly imbued

* See le Journal de Marseilles et des Bouches du Rhone, des 27 Sep. 25 Oct. and 1er Nov. 1820.

† I am convinced of this by the drawings sent by M. Cottard, Professor at the College of Marseilles.

‡ Vide Plate.

with a calcareous matter *. The human bones found near Koestriz, and pointed out by M. de Schlotheim, were said to have been extracted from very ancient beds; but this respectable naturalist is desirous of making known how much the assertion is still a matter of doubt †. It is the same with articles of human manufacture. The fragments of iron found at Montmartre are points of the tools which the workmen employ in blasting, and which sometimes break in the stone ‡.

A report has been spread for several months of certain human frag-

* These skeletons, more or less mutilated, are found near Pont du Moule, at the north-west coast of the high land of Guadeloupe, in a kind of slope resting on the steep bank of the island, which the water in a great measure covers at high tide, and which is only a tufa formed and daily increased by the very small particles of shells and corals which the sea wears away from the rocks, the whole mass of which coheres very firmly in those parts which are most frequently left dry. We find, with the aid of a magnifying glass, that many of these fragments have the same red tint as a portion of the corals contained in the reefs of the island. These sorts of formation are common in all the Archipelago of the Antilles, and are called by the negroes *maçonne-bon-dieu*. Their accumulation is the more rapid in proportion as the sea is more violent. They have extended the plain of the Cayes to San Domingo, whose situation is somewhat similar to that of the Plage du Moule, and sometimes fragments of vessels of human workmanship are found at a depth of twenty feet from the surface. A thousand conjectures have been made, and events have even been imagined to account for these skeletons of Guadeloupe; but, after all these circumstances, M. Moreau de Jonnés, corresponding member of the Academy of Science, who has visited the place, and to whom I am indebted for all this detail, is of opinion that they are only the carcases of persons who have been shipwrecked. They were discovered in 1805, by M. Manual Cortes y Campomanes, at that time a staff-officer in the service of that colony. General Ernouf, the governor, had one extracted with much care. It wanted the head and nearly all the upper extremities; it was left at Guadeloupe, with hopes of getting one more complete, in order to send the two to Paris; but when the island was taken by the English, admiral Cochrane, having found this skeleton at head quarters, sent it to the English Admiralty, who presented it to the British Museum. It is now in that collection, and M. Kœnig, keeper of the mineralogical department, described it in the Philosophical Transactions of 1814, and I saw it there in 1818. M. Kœnig remarks, that the stone in which it is imbedded has not been cut, but seems to have been simply inserted as a distinct kernel in the surrounding mass. The skeleton is so superficial that its presence must have been visible from the projection of some of the bones. They still contain *some of the animal matter, and the whole of their phosphate of lime.* The rock, entirely composed of parcels of coral and compact limestone, is easily dissolved in nitric acid. M. Kœnig has detected fragments of the *millepora miniacea* of some madrepores and shells, which he compares to the *helix acuta* and *turbo pica*. More recently, General Denzelot has extracted another of these skeletons, now in the cabinet of the king, of which we give an engraving.

It is a body with bent knees. A portion of the upper jaw is still left, the left half of the lower, nearly all one side of the trunk and pelvis, and a great part of the upper and lower left extremities. The rock is certainly travertine, in which are imbedded shells of the neighbouring sea and land shells, which still exist in the island, and which are known as the *bulimus Guadalupensis* of Ferrussac.

† See Le Traite des Pètrifactions of M. de Schlotheim, Gotha, 1820, p.57; and his letter in the Isis, of 1820, 8th No., Suppl. No. 6,

‡ It is perhaps necessary to make some mention of the fragments of sand stone, of which some talk has been made these several years (from 1824), in which a man and horse were said to have been found petrified. The very fact of its being a man and horse, with the flesh and skin, which must have been visible, was sufficient to inform the whole world that it was a *lusus naturæ*, and not a real petrifaction.

ments, having been discovered in caverns in our southern provinces; but it suffices to say, that, though they have been found, in such a situation, yet they must be admitted into our general law*.

Yet human bones preserve equally well with those of animals under similar circumstances. There is no difference between the human mummies found in Egypt, and those of quadrupeds I collected in the excavations made some years since in the old church of Saint Geneviève, some human bones interred beneath the first race, which may have belonged to some prince of the family of Clovis, and which have still preserved their forms very accurately †. We do not find in ancient fields of battle that the skeletons of men are more altered than those of horses, if we allow for the difference of size; and we find among the fossils animals as small as rats still very perfectly preserved.

All these tend to confirm the assertion, that the human race did not exist in the countries where fossil bones are found, at the epoch of the revolutions which buried these bones; for there cannot be assigned any reason why mankind should have escaped such overwhelming catastrophes, nor why human remains should not now be discovered as well as those of other animals; but I do not wish to conclude that man did not exist previously to this epoch. He might have inhabited some confined tract of country, whence he re-peopled the world after these terrible events; perhaps the places in which he dwelt have been entirely swallowed up, and his bones buried at the bottom of the present seas, with the exception of the small number of individuals who have propagated the species. However it may be, the establishment of man in the country where we have said that the fossil remains of land animals are found, that is, in the greatest part of Europe, Asia, and America, is necessarily posterior, not only to the revolutions which have covered these bones, but even to those which have laid open the strata which envelope them, and which are the last which the globe has been subjected to; whence it is clear that we can neither draw from the bones themselves, nor from the more or less considerable masses of rock or earth which cover them, any argument in favour of the antiquity of the human species in these different countries.

Physical Proofs of the Newness of the Present State of the Continents.

On the contrary, in closely examining what has taken place on the surface of the globe, since it was left dry for the last time, whence continents have assumed their present form, at least in the highest

* An attentive examination of the situation of these bones, afterwards made, has, in effect, proved that they were not fossils.

† Fourcroy has given an analysis. Ann. du Museum, tome x. p. 1.

parts, we clearly see that the last revolution, and consequently the establishment of present society, cannot be very ancient. It is one of those results, though most clearly proved, is the least regarded in sound geology; a result the most valuable, as it unites, in an unbroken chain, natural and civil history.

In measuring the effects produced in a certain time by actual causes, and in comparing them with those which they have produced since the commencement of their operations, we can determine nearly the very moment whence their action may be dated, which is necessarily the same as that when our continents received their present form, or that of the last sudden retreat of the waters.

It is in fact from this retreat that we must begin to calculate the wearing away of our steep eminences, and the formation of hilly remains at their bases; that our present rivers began to flow and to deposit their alluvial spoils; that our present vegetation began to extend itself and to produce mould; that our present cliffs began to be worn away by the sea, and that our present downs began to be accumulated by the wind. Also from this epoch must we calculate that colonies of the human race commenced or re-commenced to spread themselves abroad, and to form establishments in places which nature had assigned to them. I do not speak of volcanoes, not only because of their irregular irruptions, but because nothing proves that they could have existed beneath the sea, and therefore they are of no service in proving what lapse of time has occurred since the last retreat of it.

Lands Gained by the Perpetual Deposit of Alluvial Matter by Rivers.

MM. Deluc and Dolomieu have most attentively examined the progress of the lands formed by the deposites of the rivers; and, although at issue on a great number of points relating to the theory of the earth, they agree to this: that these alluvial accumulations increase very rapidly, and must have augmented much more quickly at first, when mountains afforded more materials for streams, and yet their extent is but very limited.

The memoir of Dolomieu on Egypt* tends to prove, that, in the time of Homer, the tongue of land on which Alexander built his city was not then in existence; that they were able to navigate from the island of Pharos into the gulf since called lake Mareotis; and that this gulf was then from fifteen to twenty leagues long, as stated by Menelaus. The nine centuries then between Homer and Strabo were sufficient to bring matters to the state described by the latter, and to

* Journal de Physique, tome xlii, p. 40, &c.

reduce this gulf to the form of a lake six leagues long. It is still even true, that since that period things have undergone a still greater change. The sands thrown up by the sea and the wind have formed between the isle of Pharos and the ancient city a tongue of land of two hundred fathoms in breadth, on which the modern city has been built. It has blocked up the nearest mouth of the Nile, and diminished the lake Mareotis to nearly nothing. During this period the alluvial deposites of the Nile have been left on the banks, and very much increased their extent.

The ancients were acquainted with these alterations. Herodotus says, that the priests of Egypt looked on their country as the gift of the river Nile. It is only a short time, he says, that in a manner the Delta has appeared*. Aristotle observes, that Homer speaks of Thebes as if it were the only city of Egypt, and makes no mention of Memphis†. The Canopian and Pelusian mouths of the Nile were formerly the principal ones; and the coast extended in a direct line from one to the other; it appears so in the charts of Ptolemy; since his time, however, the water has been cast into the Bolbitian and Phatnitic mouths; and at these entrances the most extensive formations of accumulated alluvial deposites have been made, which have given a semicircular contour to the coast. The cities of Rosetta and Damietta, built on the sea shores at these mouths, less than a thousand years since, are now two leagues distant from it. According to Demaillet, it would only have required twenty-six years to form a cape half a league in length in front of Rosetta‡.

The height of the soil of Egypt is produced at the same time as the extension of its surface, and the bottom of the bed of the river is elevated in proportion to the adjacent plains, whence the inundation of every succeeding century much exceeds the height of the marks it left of its preceeding ones. According to Herodotus, a lapse of nine hundred years was enough to establish a difference in the level of seven or eight cubits (ten or twelve feet)§. At Elephantia, the inundation now reaches seven feet higher than during the reign of Septimus Severus, at the beginning of the third century. At Cairo, before it is deemed sufficient for the purpose of irrigating the lands, it must attain a height of three feet and a half more than was requisite in the ninth century. The ancient monuments of this country are all more or less enveloped in the soil. The mud left by the river even

* Herod. Euterpe, v. and xv. † Arist. Méteor. lib. i. cap. xiv.
‡ Demaillet, Descr. de l'Egypte, p. 102 and 103.
§ Herod. Euterpe, xiii.

covers the small artificial hills, on which the ancient cities were founded, to a depth of several feet*.

The Delta of the Rhône is no less remarkable for its accumulations. Astruc details them in his history of Languedoc; and, by a careful comparison of the descriptions of Mela, Strabo, and Pliny with the state of the places as they were at the commencement of the eighteenth century, he proves, by the aid of many writers of the middle ages, that the arms of the Rhône have extended themselves three leagues during eighteen centuries; that the alluvial accumulations of a similar kind have been formed to the west of the Rhône; and that many places, situated six or eight centuries back on the bank of the sea shore or large pools, are now many miles inland.

Any person may observe in Holland and Italy how rapidly the Rhine, the Pô, and the Arno, now that they are confined within dykes, raise their beds; how their mouths approach into the sea by forming long promontories at their sides; and can judge by these facts how few centuries these waves have employed in depositing the flat plains which they at present traverse.

Many cities, which at well-known periods of history were flourishing sea-ports, are now several leagues inland; many have even been ruined in consequence of this change of situation. Venice can scarcely preserve the *lagunes* which separate her from the continent; and, in spite of every exertion, she will one day become united to the main land†.

We learn from Strabo, that, in the time of Augustus, Ravenna was amongst lagoons, as Venice now is; and now Ravenna is a league from the shore. Spina had been founded by the Greeks on the sea shore; yet in Strabo's time it was ninety stadia from it, and is now destroyed. Adria in Lombardy, which had conferred its title on the sea, of which it formed (during a period of more than twenty centuries) the principal port, is now six leagues distant from it. Foris has even reckoned it probable, that, at a period still more remote, the Euganian mountains might have been islands.

My learned brother of the Institute, M. de Prony, inspector-general

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* The the Observations on the Valley of Egypt, and on the regular increase of the soil which covers it, by M. Girard, in the great work on Egypt, and Mod. Mem. v. 2, p. 343. On which we may remark, that Dolomieu, Shaw, and other good authors, estimate these accumulations much higher than M. Girard. It is to be regretted that the thickness of these layers have not been examined, either on the primitive soil or the natural rock.

† See the Memoir of M. Forfait on the lagoons of Venice, with Mem. de la Classe Phys. de l'Inst. vol. v, p. 213.

of the bridges and roads, has communicated to me his valuable researches explanatory of these changes in the shores of the Adriatic.

Extract from the Researches of M. De Prony, on the Hydraulic System of Italy.

(*"An Account of the Displacement of that Portion of the Banks of the Adriatic Sea occupied by the Mouths of the Po."*)

"That part of the coast of the Adriatic comprised within the southern extremities of the lake or lagoons of Comachio and those of Venice has undergone since early times many changes, attested by many veracious authors, and borne out by the present state of the soil in the districts on the coast; but it is impossible to detail with precision the successive progress of these changes, and particularly the exact measures, previously to the twelfth century of our era.

"We are however sure that the city of Atria, now Adria, was formerly situated on the sea coast; and this gives us a decided and known point of the primitive shore, whence the shortest distance to the present shore, taken from the mouth of the Adige, is 25,000 metres*, (15½ miles and upwards). The inhabitants of the city have formed very exaggerated notions, in many instances, on the antiquity of this city; but it cannot be denied that it is one of the most ancient in Italy: it gave name to the sea which washed its walls. By some excavations made there and in the vicinity, a stratum mixed with relics of Etruscan pottery has been discovered, in which there is no mixture of Roman workmanship; the Etruscan and Roman are found mingled in an upper stratum, above which the vestiges of a theatre have been found. Both layers are very much below the present soil. I have seen in Adria curious collections, in which the relics that they contain are arranged separately. The prince viceroy, to whom I observed how interesting it would be to history and geology if a research were made into all the excavations of Adria, as well in the primitive soil as in the successive alluvial deposites, seemed much struck with my suggestions but I am not aware if they have been carried into effect.

"On leaving Atria, which was seated at the bottom of a small gulf, we find, in following the line of coast to the south, a branch of the Athesis (Adige), and the Fossa Philistina, of which the remaining trace corresponds with what might have been the re-union of the

* We shall find that the farther extremity of the alluvial promontory formed by the Po, has advanced into the sea farther by ten thousand metres (6¼ miles nearly) than the mouth of the Adige.

the Mincio and Tartaro, if the Po still flowed southward of Ferraro. Afterwards we come to the Delta Venetum, which appears to have occupied the site of the lake or lagoon of Commachio. This Delta was traversed by seven branches of the Eridanus, or Vadis Padus, Podincus or Po, as it was variously called, which had on its left bank, at the various ramifications of these mouths, the city of Trigopolis (Trigoboli), whose site could not be very distant from Ferraro. The seven lakes of the Delta were called Septem Maria, and Hatria is sometimes called Urbs Septem Marium, or the city of the seven seas or lakes.

"Pursuing the line of coast more north from Hatria, we reach the principal embouchure or mouth of the Athesis, called also Fossa Philistina, and Æstuarium Altini, an island sea, separated from the ocean by a chain of islets, in the midst of which is a small archipelago of other islands, called Rialtum, on which cluster Venice now stands. The Æstuarium Altini is the lagoon of Venice, which only communicates with the sea by five passages; the small islands which have been united to form a continuous dyke.

"Eastward of the lagoons, and northward of the city of Este, are the Euganian mountains, forming in the midst of a vast alluvial plain a singular and isolated group of conical hills, near which the ancients fixed the spot of the celebrated fall of Phaëton. Some writers assert that this fable originated from the vast masses of inflamed materials cast by the volcanic eruptions into the mouths of the Po. It is certain that a great quantity of volcanic productions are found in the vicinity of Padua and Verona.

"The earliest information which I have attained respecting the situation of coast of the Adriatic, at the mouths of the Po, has, from the twelfth century, some exactness. At this period all the waters of the Po flowed southward of Ferrara into the Po di Volano and the Po di Primaro, ramifications which then flowed over what is now occupied by the lagoon of Commachio. The two mouths with which the Po afterwards made an irruption northward of Ferrara, were called respectively the river of Corbola, Longola, or Mazorno; and the river of Toi. The former, which was most northward, the Tartaro or Canal Bianco, near the sea; the latter was increased at Ariano by a branch of the Po, called the river Goro.

"The coast of the sea was possibly inclined from south to north, a a distance of ten or twelve thousand metres (between six and eight English miles) from the meridian of Adria; it then passed the western angle of Mesola; and Loreo, north of Mesola, was only distant about two thousand metres (more than a mile).

"About the middle of the twelfth century, the great waters of the Po passed across the dykes which restrained them on the left side of the coast, near the small city of Ficarolo, situated nineteen thousand metres (nearly twelve miles) north-west of Ferrara, and, spreading themselves over the northern territory of Ferrara and the Polesine of Rovigo, flowed into the two above-mentioned canals of Mazzorno and Toi. It is well known that the labour of man has had much to do in effecting this diversion of the waters of the Po; and historians who have mentioned this remarkable fact only differ in the detail. The tendency of the river to follow the new tracks made for it becoming daily more and more powerful, the two branches of the Volano and the Primaro rapidly decreased, and were in less than a century reduced nearly to the state in which they now are, and the main channel of the river was formed between the mouth of the Adige and the place now called Porto di Goro. The two canals becoming inadequate, new ones were dug; and, at the beginning of the seventeenth century, its principal mouth, called Bocco Tramontana, having approached too nearly to the mouth of the Adige, it greatly alarmed the Venetians, who, in 1604, dug the new bed called Taglio de Porto Viro, or Po delle Fornaci, by means of which the Bocco Maestra was diverted from the Adige towards the south.

During the four hundred years which elapsed from the end of the twelfth to the end of the sixteenth century, the alluvial deposites of the Po gained considerably on the sea. The northern mouth which flowed in past the situation of the canal of Mazzorno, and formed the Ramo Tramontana, was, in 1600, twenty thousand metres (twelve miles) from the meridian of Adria; and the southern mouth, which had taken the place of the canal of Toi, was at the same period seventeen thousand metres (ten miles) from that meridian; thus the coast had become enlarged nine or ten thousand metres (five or six miles) to the north, and six or seven thousand metres (between three and four miles) to the south. Between the two mouths of which I have spoken was part of the coast, which receded a little, called Sacca di Goro.

"It was during the same interval, between the thirteenth and seventeenth centuries, that the great works of the embarkments of the Po were made, and a considerable portion of the western declivities of the Alps was cleared away and cultivated.

"The canal called Taglio di Porto Viro determines the progress of the alluvial deposites in the great promontory formed by the mouth of the Po. In proportion as their entrances into the sea are distant,

the annual quantity of deposites increase in an alarming degree, as well from the diminution of the inclination of the waters (the necessary consequence of the extent of the bed of the river) as from the confinement of these waters within dykes, and by the facilities which the recently cultivated sloping lands afforded of carrying the soil of the mountains into the plains. Thus the bay of Sacca di Goro was choked up, and the two promontories formed by the two first mouths united into one, the present extremity of which is thirty-two or thirty-three thousand metres (nineteen to twenty miles) from the meridian of Adria. Thus, in two centuries, the mouths of the Po have gained fourteen thousand metres (nearly nine miles) on the sea.

"Of this hasty sketch these are the results:—

"1st. That at an early period, the precise date of which cannot be ascertained, the Adriatic Sea washed the walls of Adria.

"2ndly. That in the twelfth century, before a passage had been opened at Ficarolo, for the waters of the Po, on the left bank, the sea shore was removed nine or ten thousand metres (six miles) from Adria.

"3dly. That the extremities of the promontories formed by the two principal mouths of the Po, were, in 1600, before the formation of the canal of Taglio di Porto Viro, at a mean distance of eighteen thousand five hundred metres (twelve miles) from Adria; which, since the year 1200, gives an extent of alluvial deposite of twenty-five metres (twenty-seven yards one foot and a fraction, English admeasurement*).

"4thly. That the extremity of the single promontory, formed by the present mouths, is thirty-two or thirty-three thousand metres (nineteen to twenty miles) from the meridian of Adria; whence we may conclude the mean progress of the alluvial deposites to be about seventy metres (upwards of seventy-six yards) per annum for the last two centuries, which is a rapidity greater than that of preceding ages.

"De Prony."

M. de Prony having been employed by the government to examine what remedies could be applied to the devastations occasioned by the floods of the Po, ascertained that this river, since the time when dykes inclosed it, had elevated its bed so greatly, that the surface of its waters is now higher than the roofs of the houses of Ferrara; at the same time, its alluvial deposites have advanced to the sea with so much rapidity, that, on a comparison between the ancient charts and the

* The *metre* was a measure adopted during the French revolution of about 39½ inches, English measure.—*Translator.*

present state, we find that the shore has gained more than six thousand fathoms since 1604, which is an average of one hundred and fifty or one hundred and eighty, and in some places, two hundred feet per annum. The Adige and Po are now more elevated than all the land which lies between them; and it is only by opening again new channels in the low lands which they formerly deposited, that we can avert the disasters with which they now threaten us.

The same causes have produced the same effects along the branches of the Rhine and the Meuse; and thus the richest districts of Holland have perpetually before them the frightful sight of their waters suspended above their soil, at a height of twenty or thirty feet.

M. Wiebeking, director of the bridges and roads in the kingdom of Bavaria, has written a memoir on this progress of things, so important to be well understood by the people and the government, in which he shows that this property of elevating their beds belongs more or less to all rivers.

The accumulations along the coasts of the North Sea are not less quickly formed than in Italy. We can easily trace them in Friesland and in Groningen, where the first dykes were constructed by the Spanish governor, Gaspar Robles, in 1570. A century afterwards land had been formed in some places three quarters of a league beyond these dykes; and the city of Groningen itself, partly built on the ancient soil, on a limestone which does not belong to the present sea, and in which we find the same shells as in our coarse limestone in the neighbourhood of Paris, is only six leagues from the sea. Having visited these places, I can myself testify other well-known facts, the greater portion of which M. Deluc has already ably explained*. The same phenomenon may be observed, and with the same exactitude, along the coasts of East Friesland, and the countries of Bremen and Holstein, because the parts are known where the new lands were enclosed for the first time, and thence we can measure what has since been gained.

This alluvial plain, so very fertile, formed by the rivers and the sea, is in this country a gift the more valuable, as the ancient soil, covered with heath and turf-bogs *(tourbières)* is incapable of being made to produce vegetation; the alluvial deposites alone supply the means of subsistence to the inhabited cities established along this coast since the middle age, and which would not have reached their present opulent state without the rich lands which the rivers produced for them, and which they are continually augmenting.

If the extent which Herodotus assigns to the sea of Azof, which he

* In various parts of the two last volumes of his Letters to the Queen of England.

makes nearly equal to that of the Euxine * was expressed in less ambiguous terms, and if we clearly knew what he meant by the Gerrhus †, we should find there also strong proofs of the changes produced by the rivers, and the rapidity with which they are effected; for the alluvial deposites of the river could alone ‡ during this epoch, that is, for two thousand two or three hundred years, have reduced the sea of Azof to its present size, have closed the course of the Gerrhus, or that branch of the Dnieper which would have united with the Hypacyris, and with that river have thrown its waters into the gulph Carcinites or Olu-Deignitz, and have reduced the Hypacyris itself to nearly nothing §. We should have proof no less powerful if it were ascertained that the Oxus or Sihoun, which now disembogues itself into the lake Aral, fell once into the Caspian sea; but we have close at hand proofs sufficiently convincing without being compelled to have recourse to any in the least ambiguous, or to make the geographical ignorance of the ancients any grounds for our physical proposition ‖.

Progress of the Downs.

We have already spoken of the downs or those sand heaps which the sea throws on flat shores when its bottom is sandy. Wherever the industry of man has failed in confining them, these downs advance inland as irresistibly as the alluvial deposites of rivers advance towards the sea; they drive before them pools formed by the rain-water of the

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* Melpom. lxxxvi. † Ibid. lvi.

‡ This supposed diminution of the Black Sea and the sea of Azof has been attributed to the breaking up of the Bosphorus, which happened at the pretended epoch of the deluge of Deucalion; and yet, to establish the fact, recourse is had to the successive diminutions of the extent assigned to these seas in Herodotus, Strabo, &c. But, it is quite plain, that, if this diminution had arisen from the rupture of the Bosphorus, it must have been completed long before the time of Herodotus, and even the period called that of Deucalion.

§ See Rennel's Geography of Herodotus, p. 56, &c., and a part of M. Dureau de Lamalle's work, called 'The Physical Geography of the Black Sea,' &c. At present there is only the very small river of Kamennoipost, which can represent the Gerrhus of Hypacyris of Herodotus.

M. Dureau, p. 170, attributes to Herodotus the making the Borysthenes and Hypanis discharge their waters into the Palus Mœotis; but Herodotus only says (Melp. liii.) that these two rivers flow together on to the same lake, that is, Liman, as at present. He does not carry the Gerrhus and Hypacyris further.

‖ For instance, M. Dureau de Lamalle, in his 'Physical Geography of the Black Sea' quotes Aristotle (Meteor. lib. I. c. 13) as "telling us that in his time there were many ancients, periods and peripli, proving that there was a canal leading from the Caspian Sea to the Palus Mœotis." But Aristotle says in the passage in question, (ed. de Duval, i. p. 545) "From the Paropamisus, amongst other rivers, descend the Bactrus, the Choaspes, and Araxes, whence the Tanais, a branch of it, takes its rise into the Palus Mœotis." Who cannot see that this blunder, founded neither on periods nor peripli, was only the wild ideas of Alexander's soldiery, who took the Jaxartes or Tanais of the Transoxian for the Don or Tanais of Scythia? Arrian and Pliny distinguish them; but this was not the case in Aristotle's time. How then can geological arguments be derived from such geographers?

lands in their vicinity, whose progress towards the sea they intercept, and their advance in many places is made with alarming rapidity. Forests, buildings, and cultivated fields, are overwhelmed by them. Those of the Bay of Biscay* have already covered a number of villages mentioned in the accounts of the middle ages, and, at this time in the single department of Landes, they are threatening to advance with inevitable destruction. One of these villages, that of Mimisan, has struggled against them for twenty years, and a down more than sixty feet high is perceptibly approaching it.

In 1802 the pools overflowed five fine farms in the village of St. Julien.† They have long since covered an ancient Roman road leading from Bourdeaux to Bayonne, and which could be seen forty years ago when the waters were low‡. The Adour, which was known to have formerly passed Old Boucaut, and flowed into the sea at Cape Breton, is now turned from it more than a thousand fathoms.

The late M. Bremontier, inspector of bridges and roads, who made great researches on downs, calculated their progress at sixty feet annualy, and in some places at seventy-two. According to his calculations, they will reach Bourdeaux in two thousand years; and from their present size rather more than four thousand years must have elapsed since their accumulation commenced§. The overwhelming of the cultivated lands of Egypt by the sterile sands of Libya, which the west wind casts on them, is a phenomenon similar to that of the downs. These sands have buried a number of cities and villages, whose ruins may still be seen, and that since the conquest of the country by the Mahometans, as the tops of mosques and the pinnacles of minarets are to be seen projecting through the sand,‖ Advancing so rapidly they would doubtlessly have filled the narrow defiles of the valley if so many ages had elapsed since they began to be cast there.¶ There would be nothing left between the Libyan chain and the Nile. It is then a chronometer, the measure of which it would be as easy as interesting to obtain.

Turf-bogs and Slips.

The turf-bogs, so generally produced in the north of Europe by the accumulation of the remains of sphagna and other aquatic mosses, also give us a measure of time. They increase in proportion determined

* See the Report of the Downs of the Bay of Biscay by M. Tassin, Mont de Marsan, an. X.

† Memoirs of M. Bremontier, of the fixing of Downs. ‡ Tassin loc. Cit.

§ See Bremontier's Memoir. ‖ Denon—Voyage en Egypte.

¶ We may here refer to all travellers who have traversed the western parts of Egypt.

with regard to each place; they thus envelope the small mounds of earth on which they are formed. Many of these mounds have been covered within the memory of man. In other places the turf-bog descends along the valleys; it advances like the glaciers, but the glaciers melt at the base, whilst the turf-bog is impeded by nothing. By sounding it down to the solid soil, we judge of its antiquity; and we find with turf-bogs as with downs, that they cannot have commenced at an indefinite and very remote epoch. It is the same with slips, which are made with vast rapidity at the base of steep rocks, and which are still very far from having covered them. But, as no precise measurements have yet been applied to these two operations, we shall not expatiate on them farther,*

We see that wherever Nature addresses us, she always uses the same language—everywhere informs us that the present state of things has not commenced at a very remote period; and what is not a little singular, we hear everywhere echoes of the voice of Nature, whether we consult the authentic traditions of nations, or examine their moral and political condition, and the intellectual developement which they had reached at the moment whence their authentic remains take date.

The History of Nations Confirms the Newness of the Continents.

Although, at the first glance, the traditions of some ancient nations, who extend their origin for so many thousand of years, may seem to contradict very powerfully the newness of the present world, yet, when we examine these traditions more carefully, we are not long in concluding that they are not founded in history; on the contrary, we are soon convinced that the real history, and all that it has transmitted to us of positive proofs of the early establishment of nations, confirms what the natural records had declared.

The chronology of none of the nations of the west can be traced unbroken farther back than three thousand years. None of them can produce before this epoch, nor even for two or three centuries afterwards,

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* These phenomena are well discussed in the Letters of M. Deluc to the Queen of England, where he treats of the turf-mosses of Westphalia; and in his letters to Lametherie, inserted in the Journal de Physique of 1791, &c., as well as those addressed by him to M. Blumenbach, 1798. We may add the interesting details given in his Geologic Voyage, vol. i., on the isles of the west coast of the duchy of Sleswic, and the manner of their union, either with themselves or with the continent, by alluvial deposites and turf-bogs; as well as respecting the irruptions which have from time to time destroyed or separated some of their parts.

As to the slips, Mr. Jameson, in a note to his English translation of this Discourse, cites a remarkable instance taken from the steep rocks near Edinburgh, called Salisbury Crags. Although of a trifling height, the abrupt and vertical face is not yet concealed by the mass of debris accumulated at their feet, and which yet annually increases.

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