ART. XXXI.—*The Quaternian or Diluvian Period, considered in its relation to the present Epoch*; by F. J. PICTET.

[From the Bibliothèque Universelle (Archives) de Genève, vol. viii, p. 255.]

WHEN in 1844, the first volume (1st edition,) of my elementary treatise on palæontology was printed, I was struck with the impossibility of fixing a precise limit between the Diluvian epoch and the present or modern period. These two periods, it is true, have been considered as distinct in all treatises upon geology; but when I attempted to point out their palæontologic characters, I soon perceived that the zoologic population had not in reality been modified in passing from one to the other, and that they are evidently the uninterrupted continuation of one and the same state of things. This truth appeared to me so evident that I merely indicated the principal arguments which supported it,† without entering into details, and I considered it sufficient, to call the attention of geologists and palæontologists to this point. This has had its influence, and recently, since questions of this nature have taken a new importance by the discoveries relating to human fossils, many geologists have admitted the above conclusions as demonstrated. I would especially mention Mr. Scipio Gras,‡ who is engaged in an important work on the diluvium of the valleys of the Rhone and the Rhine, and also Mr. Lartet,§ who has recently sustained the same opinion in a memoir upon the geological antiquity of the human race in western Europe.

There are however some opponents to these views, especially Mr. Kœchlin Schlumberger,|| who replying to Mr. Scipio Gras, has called my opinion *a little radical* and has sought to overthrow

* The Stereoscope, p. 91, London, 1856.

† *Traité élémentaire de paléontologie*, note B, 1st edition, tome i, p. 359.

‡ *Bulletin de la Société géologique de France*, 2d Series, tome xv, p. 167.

§ *Bibl. Univ. (Archives)*, tome viii, p. 193. July, 1860.

|| *Bulletin de la Société géologique de France*, 2d Series, tome xvi, p. 88. Nov 21, 1859.

it. I therefore think it necessary at this time to furnish new proofs and to set forth more clearly those evidences which have decided my own mind, and which I have no doubt will convince the most incredulous.

This question may be considered from two points of view, the geological and the palæontological. I shall only approach the question in the latter aspect, for which my studies have better fitted me, but I ought to remark that we have no example of serious disagreement between palæontology and geology when they are employed to distinguish the several periods of the history of the globe. There is no one of these periods which is not clearly distinguished by the character of its fauna, and no case can be cited where stratigraphy has required a division which palæontology has not confirmed. If we survey the whole series we never find any two consecutive stages in which the zoological population has been identical.

If this is so, the geologists and the palæontologists will be unanimous for uniting these two epochs into one, and for applying to them a common name. I think if I am able to prove, from the standpoint of palæontology, that the two periods are only one, this result ought to be as fully admitted as in analogous cases for anterior epochs.

I know that this opinion is not without question, and that some geologists, whose learning and judgment I highly respect, think that in the condition of the globe and the forces which have existed since the termination of the tertiary period there are sufficient reasons for distinguishing completely the tertiary period from the modern epoch. I shall not discuss this question for which I do not think myself qualified. I will only say that however this may be, it will be impossible for me to assimilate the separation of two periods whose fauna are continued identical from one to the other, to the well determined limits which distinguish geologically and palæontologically all the anterior periods admitted as divisions of the history of the globe. I have elsewhere intimated that these same geologists are singularly embarrassed in regard to the precise point where they ought to establish the division, and that the long series of Quaternary deposits, following the glacial period, which certainly neither commenced nor ends suddenly, will give them very great difficulties.

My object in this communication is simply to demonstrate that between the Diluvian period and the modern epoch there has not been any modification of the fauna having the least relation to the changes which characterize and distinguish other palæontological faunæ. For this purpose I shall consider two distinct points. I shall demonstrate first that *all* actual or modern faunæ have existed from the origin of the Diluvian period. I shall

inquire afterwards what differences exist between the Diluvian fauna and the present fauna and shall show that they consist only in the disappearance of a limited number of the larger species.

I ought however before proceeding to details to notice an objection. Of late years questions relating to the origin of species have been reviewed with renewed ardor, and some persons think that the solution of these questions may have an influence upon the demonstration of the question with which I am now engaged. On the contrary I think the subject with which I am concerned is entirely an independent question. Whether we admit with Lamarck or with Mr. Darwin a gradual transformation of beings, or think there is a general law of nature introducing, at certain epochs, new organic forms, or accept the idea of successive creations, we shall in either case be obliged to refer to the same facts in the history of the globe. At the end of a certain number of years or centuries the zoological population of a country is changed and the species are replaced by others. The surface of the globe has been successively occupied by a series of faunæ perfectly distinct; each of these fauna corresponds to a period which it characterizes. Whatever theory may be entertained in regard to the cause of the change, the change itself is not questioned. But all we need to do here, is to show that these organic differences characterize the successive periods, and that there is no such difference between the Diluvian period and the present epoch.

I ought, as I have said, to demonstrate in the first place that all the present faunæ have existed from the commencement of the diluvian period, as well as the last species, of which I shall speak farther on. For this purpose I have recently arranged a complete catalogue of the fauna of European mammifers, and I have inquired which have not been found in the fossil state, and what are those the bones of which have been found buried in the Quaternian or Diluvian beds, with the fossil elephant, *Elephas primigenius* or with the Cavern Bear, *Ursus spelæus*.

Reasoning upon comparable and sufficiently certain facts, I have excluded from this list:

1st, Marine mammifers in view of the difficulty of determining the age of marine Quaternian deposits.

2d, Mammifers of remote regions whose bones are not likely to be found in the more explored and better known diluvian deposits of Central Europe. Thus I have not considered as important either the monkey of Gibraltar, or the small species on the confines of Asiatic Russia, or those which have been recently discovered in Sicily or in Turkey. I have confined myself to those actually living in places where the Quaternian deposits are well known. Besides this, the excellent work of Eichwald

proves the existence of the same state of things in Russia as in England, Belgium, France, Germany or Switzerland.

The following are the principal facts obtained from an analysis of my catalogue, viz :

Almost all the common species of *Cheiroptera* have been found in the Quaternary deposits. I have found, especially those here cited: *Vespertilio*:—*V. noctula*, *V. pipistrellus*, *V. serotinus*, the common bat, the lop eared bat, *Vesp. auritus*, the *fer à cheval*, the *V. discolor*, and the *V. mystacinus*. Is it not extremely probable, not to say evident, that the rare species more recently discovered which are wanting upon this list, are wanting because we have not known how to distinguish their bones or because they have not yet been found? What geologist will venture to affirm that, the varieties *V. Leisleri*, *V. Kuhlii*, &c., which only appeared before the species named above, appertain to a more recent fauna.

The same results are furnished by the *Insectivora*.

In these same Quaternary deposits are cited the hedge-hog, the mole and three or four species of the shrew-mouse.

This is all our fauna, for, on account of the reasons mentioned above, I am not able to give any importance to the two species of *Mygale* ('*desmans*'), one from the Pyrenees and the other from Russia, which have not yet been found in the fossil state.

The group *Rodentia* is of difficult determination and we may naturally expect to find some vacancies, but there are none, however, of any importance. We may cite the squirrel, the marmot, the dormouse, the mouse, the hamster (*Crisetus*), the water-rat, the ordinary meadow-mouse, the beaver, the hare, and the rabbit. The only striking vacancy will be that of the porcupine, but Mr. Arcas has fortunately found this also in the caverns of Sicily. There are wanting to our list only some small species of the mouse, the garden dormouse, the muscardin, &c., in regard to which we may make the same reflection, as was suggested by the *Cheiroptera*. The jerboa, lagomys, &c., are found as fossils in Russia.

The *Carnivora* being in general larger than those animals which represent the preceding groups and being at the same time more easily recognized scarcely present any vacuity.

There have been found the lion, cat, wolf, domestic dog, fox, genet, white bear, brown bear, badger, glutton, martin, beech martin, polecat, ermine, weasel and the otter. There is lacking to this list only the lynx, and it is important to know whether the *Felis engiholensis* of Schmerling, from the caverns of Belgium is not identical with it. I have not supposed that any person could see an indication of a subsequent creation in the absence of some species from excentric regions as the fox of the north, the polecat of Poland, or the *P. boccamela* of the Mediterranean islands.

The only *Pachyderms* of the present fauna yet found in our Quaternary deposits are three, the wild boar, the horse and the ass.

Among *Ruminants* have been enumerated all our present deer, the deer properly so-called, the reindeer, the moose deer, and the roe-buck. The fallow deer is not comprised in this last, but, as is well known, it is not native in Central Europe. There are enumerated also the wild oxen, (the *urus* and the bison), the chamois, and the goat. The sheep had not been discovered until the last few years, which had probably been more recently imported; however, Mr. Arcas has found in the caverns of Sicily a closely related species, the *mufflon*. Finally, to this series of animals, modern discoveries authorize us to add *man*. All this, as I have said elsewhere,* appears to demonstrate that man has coëxisted with this diluvian fauna and that his history dates probably from the same epoch.

The facts here mentioned are remarkably conclusive, for they prove that all the present fauna of European mammals have been found as fossils in the Quaternary deposits, except some small species difficult to be determined, the bones of which if preserved, have not yet been recovered. It appears to me evident that these rare exceptions are without value as objections, and that we may boldly declare that: *From the commencement of the Diluvian period to the present day, no species of mammals has been added to the fauna which then lived in Europe.*

What we have said of mammals may also be affirmed of birds and reptiles; but upon this part of the subject I shall not enter into details, for these classes are less known and do not furnish results so certain. The examination of a treatise on palæontology is sufficient to show that the existing species are already indicated in the Diluvian deposits.

The terrestrial and fluviatile mollusks are in the same category. Thus with the bones of the *Elephas primigenius* are frequently found buried all our species of *Helix*, *Bulimus*, &c., and they show us that for the invertebrata as well as for the vertebrata, all the existing fauna date from the origin of the Diluvian period.

The preceding facts suffice to show that there has been no renewal of the fauna between the Diluvian period and the Modern epoch. We must now consider in what consists the apparent difference which has led most geologists into error. It has been caused by the gradual disappearance of a certain number of species. At the commencement of the Diluvian period the fauna was richer and more complete than it is at present. There lived in Europe at that time not only our present animals but a certain number of species which are now extinct. These latter have gradually disappeared from causes probably in part similar to

* *Bibl. Univ.* (new series), tome vii, p. 364. March, 1860.

those which destroyed one species of ox mentioned by Julius Cæsar, and which destroyed most likely the last representatives of the ure-ox (aurochs) and the elk. The fauna of the eastern continent has been successively impoverished, and as the population and cultivation of the soil increased only a part of the species which once dwelt there remain living.

It is not possible, in the present state of palæontology to prepare a complete and precise catalogue of these extinct species; but it is sufficient for our purpose to sketch the principal features of such a catalogue.

I am embarrassed in regard to the Alluvial deposits of Auvergne, which appear to present characters somewhat exceptional. It is not perfectly demonstrated that the fauna which they enclose has all been contemporaneous with the Quaternary deposits of the greater part of Europe. There are found many species as yet imperfectly known which appear to be extinct and which have not been recovered elsewhere. Such is the *Erinaceus major*, many of the dogs, some polecats, at least three species of deer, the wild goats of Roset, &c. It will probably be necessary to add to them hereafter; but new investigations appear indispensable to make the proper additions with certainty. I have experienced some doubt in regard to many races or species of true Quaternary deposits, indicated as different from those now living, but which have been characterized without doubt by their form and not by appreciable organic characters. It appears to me quite natural that species at the commencement of the Diluvian epoch, finding abundant nourishment in a country where great forests and immense virgin territories replaced our present culture, and being able there to develop in freedom should have frequently had a form a little superior to their existing representatives, which, surrounded by hunters, restrained on every side, lead a more difficult and precarious life. I do not think it possible to give a specific value to slight differences of stature, if all the other characters are identical, and therefore I consider as doubtful many of those species inserted in the catalogues of palæontology. Such are the *Talpa fossilis*, the *Meles Morreni*, the *Lutra antiqua*, the *Sciurus priscus*, the *Arctomys primigenia*, the *Myoxus fossilis*, the *Sus priscus*, &c. Some of these are probably identical with living species. By new researches we shall find that some of these are truly extinct.

But aside from these difficulties and doubts a certain number of species have certainly disappeared which I will briefly enumerate.

In the family of bears I consider as lost the great Cavern Bear (*Ursus spelæus*). Their bones characterize well the deposits called Diluvian, or the formations more ancient than the last period of our globe. The *Ursus priscus* is more doubtful

and is probably identical with our black bear. The *Hyenas* appear to have been represented in the ancient epochs by three species which have now disappeared; the hyena of caverns (*H. spelæa*), analogous to the spotted hyena of the Cape of Good Hope, the *Hyena Monspessulana*, of Christol, more similar to the striped hyena, and the *Hyena intermedia*, Marcel de Serres.

In the family of the *felinidæ*, we should add to the wild-cat, the lynx (?) and lion which have disappeared from Europe in the historic period, another species related to the leopard, (*Felis antiqua*).

The numerous order of *Rodents* appear to contain some extinct species more different from the living than those which I have cited above in speaking of differences of form. These are the *Spermophilus superciliosus* of Kaup; the Castor (*Tragotherium*) Cuvier, Fischer de Waldheim; the *Lepus priscus* Cuvier, from the breccias of the Mediterranean, and some species of *Lagomys*, &c.

The *Elephant* is one of the most remarkable of the genera among those which have made a part of the ancient fauna of our period. Their bones are, with those of the bear, the most characteristic of these Diluvian strata, since they are abundantly scattered over an immense surface of country. The species best known is the mammoth (*Elephas primigenius*). Of other bones may be mentioned those of the African elephant (*E. Africanus*). The existence of some other species (such as the *E. meridionalis* Nesti), is contested by some anatomists and admitted by others.

The great *Rhinoceros* with valved nostrils (*R. tichorhinus*) less widely diffused than the elephant, and probably also one or two species of the same genus, are striking examples of those races which have disappeared.

It is the same with the *Hippopotami* of which it is thought we may admit the prior existence of many species now extinct (*H. major*, *H. minor*, *H. Pentlandi*, and the hippopotamus of the valley of the river Sômmes).

The horse of Pézenas appears to be another species different from the one mentioned above as related to the existing horse.

The genus *Cervus* has been numerous from the commencement of the diluvian epoch, for to the species now living, and which, as I have said, existed then, is to be added the beautiful giant stag of the peat bogs of Ireland (*Cervus euryceros*), the great deer of the Sômmes (*Cervus dama giganteus*) the *Cervus martialis*, Gravais, and many species from caverns described by Marcel de Serres.

Among the other species of *ruminants* lost from our fauna, it is necessary to mention the *Antelope Christoli*, M. de Serres, the *Dicotyles*, Gervais, and *Ibex Cebennarum*, Gervais.

I will not add the *Bos primigenius* because it was seen alive by Julius Cæsar.

I have not found among birds or reptiles any species to add with certainty to this list.

We shall find only a few in this category among the terrestrial invertebrata. The marine deposits on the borders of the Mediterranean contain some mollusks of lost species, but their numbers are small compared with species still living.

We thus see, as I have said, that the fauna originating at the period which succeeded the Tertiary epoch has been successively deprived of many remarkable species. This gradual disappearance may have proceeded from many natural causes. First the climate, cooling very much as the formation of great glaciers proves (Glacial period), would not be favorable to any one of them, especially to the great pachyderms, the congeners of which characterize in our day the torrid zone. Still more as I have said elsewhere,* admitting the presence of man from the origin of the latter period, we may, with much probability attribute to him the destruction of a part of the species. If we examine the list which I have given we shall see that, aside from the great pachyderms, it is principally composed of carnivorous animals which man is interested to destroy, and of herbivora which should serve for his nourishment.

Mr. Lartet, in the memoir which I have cited, has furnished a new argument in favor of this hypothesis. He has found marks of the instruments of man upon the bones of many species of this epoch, and in particular upon those of the ox and the goat; these marks being generally deep cuts designed to cause the rupture of the bone, sometimes more superficial wounds as if the object had been to elevate the skin about the base of the horns. This destruction of species is merely like that which daily transpires before our eyes. If new circumstances should cause the laws in regard to the chase to be abolished, and if the great land-owners did not protect some species, it would not be long before all our present deer would be classed among extinct species. They have already disappeared from many countries, and among others from the valley of the Rhone, where the stag and the roe-buck were abundant at the end of the last century.

A curious fact has been cited which seems to confirm what I have said, it is the very limited number of species of small size, or little connected with the wants of man, among those which have disappeared.

Such is the opinion which has been formed in regard to the causes of this extinction. I repeat therefore that these causes can

* *Bibl. Univ.* (new series), tome vii, p. 371, March, 1860.

have no relation to those which acted during the previous periods, for in the renovation of the fauna there has always been a replacing of some species by others.

Here, on the contrary, we merely find extinctions which can no more furnish a basis for distinguishing two periods than could the destruction of the *Bos primigenius* or that of the Dodo.

To complete our knowledge of the history of the Diluvio-modern period, it would be very interesting to ascertain the date of the extinction of each species. Some investigations of this kind have been recently undertaken, principally in England; but observers generally content themselves with stating the relation of bones to the Quaternary epoch without other details. It is important always where it is possible to determine accurately the position and the geological relations of the stratum which encloses them, and sometimes even to indicate whether they are found in the upper or the lower part of the stratum. It is important to examine with great care the bones in the deposits of the glacial epoch, for it is very probable that many species have extended even to that period. By such studies well directed we may obtain more accurate knowledge of this series of extinctions, and I doubt not we shall be more and more convinced that they have been gradual and successive.