THE FOSSIL MAMMALS OF NORTH AMERICA.[1]

THIS important contribution to our knowledge of the extinct mammals of the United States is the joint production of Profs. W. B. Scott and H. F. Osborn, of the Geological Museum at Princeton College, to whom we are already indebted for much valuable work on the subject. The present memoir is of more than ordinary importance, since the authors have endeavoured to complete our knowledge of forms already more or less fully described, rather than to add fresh burdens to the memory by recording a host of so-called new species and genera founded upon specimens which are not sufficiently characteristic to prove their distinctness from forms already described. Indeed, they have taken the opposite course, and endeavoured to show how the number of such species and genera may be reduced; not shrinking, as the manner of some is, from relegating when necessary some of the terms proposed by themselves to the rank of synonyms. This line of work, we are assured, is the one now urgently called for, as it is almost certain that the number of names which have been already proposed must, if properly defined and correlated, really include by far the greater proportion of the animals of the better known formations.

The work is divided into four parts; the first and second being by Prof. Scott, the third and fourth by Prof. Osborn. Part I. treats of the geological and faunal relationships of the Uinta beds; Part II. includes those mammals referable to the groups known as Creodonts, Rodents, and Artiodactyle Ungulates; Part III. is devoted to the Perissodactyle Ungulates; while the concluding Part is an endeavour to trace the gradual modification of the foot-structure of the Ungulates from the generalized older forms to the specialized types found at the present day.

In the first part we are told that in the Upper Green River valley in Colorado there are three well-marked groups of Tertiary strata overlying the Upper Cretaceous Laramie beds, and named, in ascending order, the Wasatch, Green River, and Bridger Eocene groups; the earliest Puerco Eocene being apparently missing between the Laramie and the Wasatch beds. The Bridger, or Middle Eocene, which is further divisible into three minor groups, is characterized as a whole by the presence of the now well-known Dinocerata, so fully described by Profs. Marsh and Cope. The geology of the Uinta beds and their relation to the Bridger group appear to be somewhat obscure; but it seems that while part of these beds may be contemporaneous with the Bridger, the greater portion is decidedly newer, and consequently that the entire group should be classed as Upper Eocene, and regarded as forming the transition to the Miocene beds of the White River. These Uinta beds are readily distinguished from the Bridger group by the absence of the remains of Dinocerata; and their fauna of Perissodactyle Ungulates is described as being intermediate between that of the Bridger Eocene and the White River Miocene. The genera of mammals which the authors record from these beds include (1) *Mesonyx* and (2) *Miacis* among the Carnivorous types, (3) the Rodent *Plesiarctomys*, (4) the Lemuroid *Hyopsodus*, in the Artiodactyle Ungulates (5) *Protoreodon*, and (6) *Leptotragulus*, and in the Perissodactyles (7) *Diplacodon*, (8) *Isectolophus*, (9) *Triplopus*, (10) *Pachynolophus*,[2] and (11) *Amynodon*. Of these genera, Nos. 5, 6, and 7 are peculiar to the Uinta beds, while all the others are represented in the underlying Bridger group.

Of the forms described in Parts II. and III., we shall merely notice a few of those which are of more especial interest. The first of these is the Rodent genus *Plesiarctomys*, first described by Bravard upon the evidence of very fragmentary remains from the European Tertiaries, but now fully known through the specimens described in this memoir. Dr. Scott regards this form as one of, if not actually the oldest of the known Rodents, and as therefore entitled to especial interest from an evolutionary point of view. He finds that the molar teeth (Fig. 1) are of the tritubercular type so characteristic of the earlier

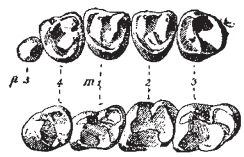

FIG. 1.—The left upper and lower cheek-teeth of *Plesiarctomys sciuroides*.

Eocene mammals of all orders (see NATURE, vol. xli. p. 465), and therefore concludes that the Rodents were probably derived from the same generalized group of mammals which has given origin to the existing Carnivora and Ungulata. *Plesiarctomys* itself should apparently be placed among the existing Sciuromorpha (squirrels and marmots), although in certain generalized features of the skull it shows signs of affinity with the Hystricomorpha (porcupines).

Another form of considerable interest is the genus *Leptotragulus*, a small Ungulate at first regarded as allied to the existing chevrotains (Tragulina), but which proves to be the earliest definitely known ancestral type of the camels and llamas (Tylopoda). This genus is indeed now regarded as the direct ancestor of *Poëbrotherium* of the overlying White River Miocene, the latter being an early cameloid type not larger than a fox; and thus affords another example of the rule that all groups of mammals increase in the size of their representatives with the advance of time. Other observations induce the author to suggest that these early Cameloid types may themselves have originally branched off from the little *Dichobunus* of the Eocene of Europe and probably also of America—a small chevrotain-like Ungulate, with bunodont molars carrying five cusps on their crowns. If this full phylogeny be substantiated by later researches it will be of extreme interest.

The Artiodactyle Ungulate described as *Protoreodon* is another annectant genus of more than ordinary interest. Thus while it conforms to the Miocene Oreodonts in the structure of the feet, and in the peculiar feature that the first lower premolar assumes the form and functions of a canine, its upper molar teeth differ in that they have five instead of four cusps on the crown, and thus accord with those of the generalized hog-like Ungulates known as *Anthracotherium* and *Hyopotamus*. This is a very important fact pointing very strongly to the derivation of the Oreodonts from an early stock more or less closely allied to the known *Anthracotheriidæ*.

With the Perissodactyla we come to the work of Prof. Osborn, and some important observations are made, in the introductory portion of Part III., regarding the synonymy of some of the earlier forms of the ancestors of the horse. It is there stated that Prof. Marsh's genus *Eohippus* is identical with Owen's *Hyracotherium* of the London Clay, from which *Pliolophus* appears to be likewise inseparable. The distinctive feature of this genus is that the fourth premolar in both jaws is unlike the first molar, the fourth upper premolar having but a single inner cusp. *Orohippus*, however, which has been hitherto identified with *Hyracotherium*, is shown to be distinct, the fourth premolar being as complex as the true molars; this genus is, however, identical with the European *Pachynolophus*. *Epihippus*, in which both the third and fourth premolars become like the molars, forms the next step in the ancestry of the horse, leading on to the well-known European genera

[1] "The Mammalia of the Uinta Formation." By W. B. Scott and H. F. Osborn. Transactions of the American Philosophical Society, Ser. 2, Vol. XVI., Part III. Pp. 111, plates 5, and woodcuts. (Philadelphia, 1889.)

[2] Incorrectly *Orotherium* in the text.

Anchilophus and *Anchitherium*. An interesting section is devoted to the rhinoceros-like animals described under the names of *Amynodon* and *Metamynodon*, the latter occurring in the White River Miocene. These genera are regarded as representing a distinct family, distinguished from the living rhinoceroses, among other features, by the resemblance of the last upper molar to the two preceding teeth. We are scarcely disposed to regard this and the other features mentioned as of sufficient importance to justify the formation of a distinct family, but this is purely a matter of opinion. *Amynodon* has been generally regarded as the ancestor of the modern rhinoceroses, but Prof. Osborn points out several objections to this view, and also shows that *Metamynodon* is clearly a separate branch from *Amynodon*, departing still more widely from the modern rhinoceroses. It is suggested, however, that the real ancestor of the latter will prove to be more or less closely allied to *Amynodon*.

Of the other Perissodactyles described in the third part, it will suffice to mention that *Isectolophus* is regarded

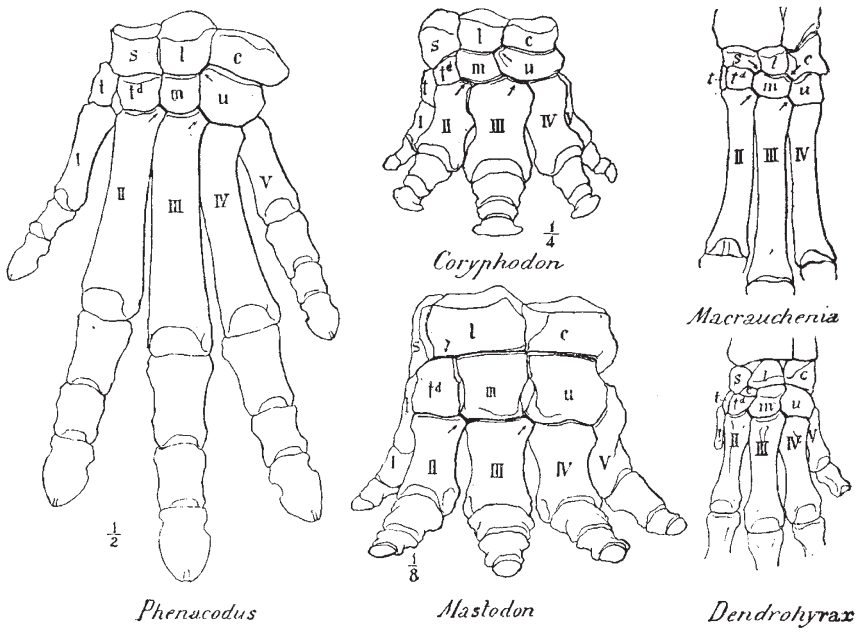

FIG. 2.—The left fore-foot of various Ungulates, to show the more generalized condition, in which the scaphoid (*s*), lunar (*l*), and cuneiform (*c*), are respectively placed directly over the trapezoid (*td*), magnum (*m*), and unciform (*u*). In *Mastodon* the lunar has extended over the trapezoid. *t* = trapezium.

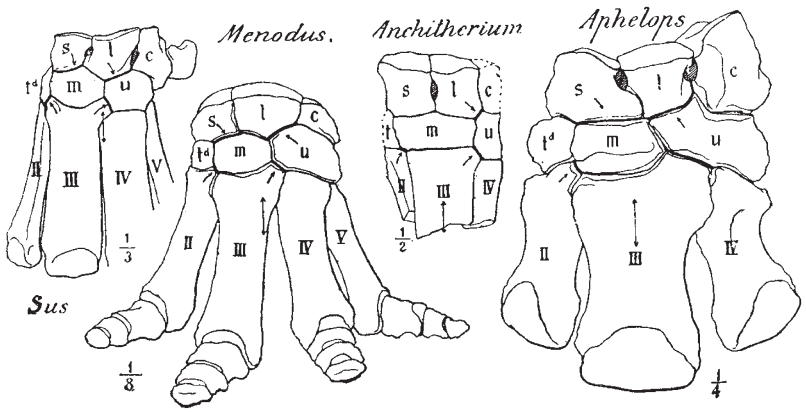

FIG. 3.—The left fore-foot of more specialized Ungulates, showing the displacement and mutual interlocking of the carpal bones. Letters as in Fig. 2. The vertical arrows indicate the median line of the foot, and the oblique ones the direction of displacement.

as an ancestral type of the tapirs, in which the fourth, and probably the third, upper premolar approximated to the type of the molars. The author considers that an imperfectly known tapiroid from the White River Miocene will prove to have three upper premolars of a molariform type, and would thus lead on closely to the true tapirs, in which all the premolars are molariform.

These observations show that in each of the three existing families of Perissodactyles there is a gradual advance in the complexity of the premolars, till in all the living types they become as complex as the molars.

In the concluding part, relating to the advance from a plantigrade and pentadactylate type of foot in the Ungulate to the digitigrade type with a reduced number of digits, Prof. Osborn lays great stress on the effects of strain and impact as leading to the gradual displacement and thence abortion of the lateral elements in the wrist, ankle, hand, and foot, supporting his conclusions with several diagrammatic figures, of which we reproduce two. The author observes that the feet of the modern Ungulates are connected with the simple type of foot found in the Ungulates of the Puerco Eocene by the

genus *Phenacodus*, and that without this annectant form it would have been almost impossible to say that the Puerco mammals were Ungulates at all, since their feet are more like those of the plantigrade Carnivores. The details of how the foot of the generalized primitive type has become gradually modified into the numerous modifications exhibited by the Ungulates of the present day, are far too technical and complicated to be even touched upon in these pages, and we must therefore refer the reader desirous of entering upon this difficult branch of study to the memoir itself. We may, however, mention that the primitive type of foot (Fig. 2) is characterized by the component bones of the two horizontal rows of the wrist and ankle being placed vertically one above another, over the axes of the digits they respectively support; while in the specialized types (Fig. 3) these bones mutually overlap and interlock, so as to totally obliterate the original vertical lines of division coinciding with the intervals between the individual digits. The nearest approach to the primitive type now remaining, is found in the elephant and the hyrax; but the elephant and its ally the mastodon (Fig. 2) are peculiar in that the lunar bone of the wrist has become extended towards the outer side so as to rest upon the trapezoid.

In conclusion, we may observe that a memoir like the present marks a distinct advance in our knowledge, not only of the mammals of the Upper Eocene of North America, but also in respect to several points in connection with the phylogeny of the Ungulates, and of the relationship of the extinct Old World representatives of that order to those of the new. We offer our congratulations to the authors, and look forward to seeing equally good work on the mammals of other horizons of the Tertiaries of the United States. R. L.

EARTHWORMS.

THE Colonial Office can hardly render a greater assistance to science, than by publishing such reports from our distant possessions as that contained in the October number of the *Kew Bulletin*, from Mr. Alvan Millson, Assistant Colonial Secretary at Lagos, who has also acted as a Special Commissioner to the interior, and who has made good use of his opportunities in observing Nature in those remote parts.

The report in question is contained in a despatch from Sir Alfred Maloney to Lord Knutsford, dated June 11, 1890, and we propose to give a short account of its contents.

In Yoruba Land, after passing the fringe of forest, which skirts the lagoons to the eastward of Lagos for some 50 miles inland, a vast tract of open country is reached, extending as far as the valley of the Niger and the Houssa States beyond. The only difference between these grass lands and the forest fringing the lagoons appears to be that "for many generations the farmers of Yoruba have with axe and fire destroyed the growing trees, and robbed the soil of its original covering, leaving nothing but a rank growth of tall and tangled grass to take its place." This is apparently unfavourable to the growth of deep-rooting trees, but shows a truly surprising surface-fertility, when subjected to cultivation; and as the Yoruba people are cut off from the coast by the tribes inhabiting the forest belt, and are entirely dependent on the soil for food and clothing, it has to support a considerable population.

The soil appears to consist of a sandy loam derived from the igneous rocks, ironstone or quartz conglomerate, which form the bed rock, the soil increasing in fertility where the harder strata give place to more friable micaceous rocks, but even where the soil is not over a foot in depth, the fertility is truly astonishing. Crops in Yoruba are not only of unusual excellence, but the surface soil shows a marvellous recuperative power, even when compared with that of favoured lands in other portions of the tropics.

In this district, after a very simple tillage with the hoe only, the following rotation of crops is raised. In the first year a crop of yams and Indian corn is planted, and a second crop of maize and beans in the autumn; the same in the second year; while in the third year both crops are maize and beans. No manure of any kind is used, nor any tool more powerful than the hoe; and then for two or three years the land lies fallow, after which it is ready for a similar rotation, and so on. A crop of Guinea corn, cotton, indigo, tobacco, and sweet potatoes is also in some places gathered.

In spite of the exhaustive system of cultivation pursued, the crops show no sign of falling off, and such is the inexhaustible fertility of this belt, that maize sells for 4½*d.* and sweet potatoes at 1*d.* per 70 pound load, and other products in proportion, even in large towns like Ibadau, said to have 150,000 inhabitants.

Mr. Millson considers that the fertility cannot be caused by termites, as described by Drummond in "Tropical Africa," as the ant-hills of the Yoruba land are exceptionally small and widely scattered; and visiting the country only in the wet season, it would appear impossible to account for the unusual fertility. In the dry season the mystery is at once solved, in a very simple and, Mr. Millson considers, in a most unexpected manner; although, taking into account the universal presence of the earthworm, both in temperate and tropical climates, we think there is little reason for surprise; but we do not remember to have heard of a more marked instance of the importance of small agencies in effecting great results.

Mr. Millson continues:—"The whole surface of the ground, among the grass, is seen to be covered by serried ranks of cylindrical worm-casts, varying from a quarter of an inch to 3 inches, and existing in astonishing numbers. For scores of miles they cover the land, closely packed, upright, and burnt by the sun into rigid rolls of hardened clay, which stand until the rain breaks them down into a fine powder. . . . On digging down, the soil is found to be drilled in all directions by countless multitudes of worm-drills; while from 13 inches to 2 feet in depth the worms are found in great numbers in the moist subsoil."

Mr. Millson estimates that the worm-casts, in one season, average over 5 pounds per square foot of soil; and at this estimate, which he considers very moderate, the annual result of the work done by the earthworms of Yoruba gives a total of not less than 62,233 tons of subsoil brought to the surface in each square mile of cultivated land every year. "This work goes on unceasingly year after year, and to the untiring labours of its earthworms this part of West Africa owes the livelihood of its people. Where the worms do not work, the Yoruba knows that it is useless to make his farm."

Mr. Millson estimates that every particle of earth in each ton of soil, to the depth of 2 feet, is brought to the surface once in twenty-seven years, which gives an average of 0·88 inch per annum, or four times as much as Darwin estimated ("Earthworms," p. 130) to be the case in the experiments tried at Maer Hall; but on the Nilgiries, worm-casts are found to average 3 ounces each, the largest weighing 4⅓ ounces (*ibid.*, p. 129). We have, therefore, little doubt that Mr. Millson's estimate of the movement of soil is quite probable.

Mr. Millson considers that, most probably, the comparative freedom of this part of West Africa from dangerous malarial fevers is due, in part at least, to the work of the earthworms in ventilating and constantly bringing to the surface the soil in which the malarial germs live and breed. Darwin (*ibid.*, p. 239) remarked that the disappearance of organic matter from mould was probably much aided by its being brought again and again to the surface in