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YALE COLLEGE AND AMERICAN PALÆONTOLOGY

ALTHOUGH notices have from time to time appeared in European scientific journals of the scientific expeditions sent out from Yale College to the Western Territories of the United States, probably only those palæontologists and geologists who have crossed the Atlantic and have had an opportunity of seeing all that is yet visible of the vast amount of material collected at New Haven can adequately realise the enormous additions which have been and are being there daily made to our knowledge of extinct vertebrate life. Thanks to the generous liberality of the late Mr. George Peabody, who has endowed centres of scientific progress in various parts of America, Yale College has been supplied with an admirable Museum of Natural History and with a fund for its maintenance. By his deed of gift the donor provided that after one portion of the money had been employed in erecting the museum, a certain sum ($20,000) should be set apart and invested until it should reach at least five times its original amount, when it might be employed for further building; while the interest of a further sum of $30,000 should be devoted to the maintenance and extension of the collections, in the proportion of three-sevenths to zoology, three-sevenths to geology, and one-seventh to mineralogy.

The wise intentions of the founder have been most faithfully and successfully carried out by his trustees. The building now erected, though forming only one wing of the magnificent pile which they will ultimately complete, is already amply filled with the collections of the several departments. The rooms open to the public are well-lighted, and the cases are carefully arranged and easy of consultation. But by far the larger part of the collections is still stored in the cellars, awaiting the growth of the premises. Unfortunately, however, the boxes are accumulating in these lower regions at a rate which one fears must be greater than that of the building fund.

The mineralogical cabinet has been entirely rearranged and displayed by Mr. E. S. Dana, who, with Prof. Brush, is amply sustaining the old mineralogical renown of New Haven.

The unique feature, however, in the Peabody Museum, is the vast collection of vertebrate fossils from the Western Territories, made by the enthusiastic labours of Prof. O. C. Marsh. Only a small portion of this enormous series has yet been placed in cases for public inspection. But the Professor, with infinite courtesy and patience, conducted the writer of these lines through the stores from cellar to roof, brought under his notice examples of the more interesting and important of the "finds," and furnished him with notes of the collection and permission to use them, of which he now gladly avails himself.

After having spent several years in bringing together, from the Cretaceous and Tertiary strata of the Atlantic coast, a very considerable mass of material, the Professor came to the conclusion that this field was essentially exhausted, and that it was to the unexplored territory beyond the Missouri River, that the palæontologist must now look for additional facts to help him to an intelligent comprehension of the progress of vertebrate life in the past. This conclusion having been confirmed by his own observations during a short trip to the Rocky Mountains in 1868, he, in 1870, organised the first of the Yale Scientific Expeditions. After spending five months in the field the party returned well laden with fossil treasures from the Cretaceous and Tertiary formations. The success of this experiment having been so marked the four succeeding years witnessed the departure of as many expeditions, all of which were likewise successful. The results may be briefly summed up in the statement that, altogether, within six years, these expeditions under Prof. Marsh brought to light more than four hundred species of vertebrate fossils new to science, of which only about two-thirds have as yet been described. At the time when these explorations began, the West was almost wholly unknown, and the investigators were exposed to great hardships and to no little danger from hostile Indians. It is to be hoped that Prof. Marsh may be induced to write down and publish a narrative of his life and adventures in the wild west in search of fossils. The samples which in friendly talk he communicated to the present writer were so entertaining, that the book could not fail to prove most interesting, and would no doubt help on the cause of palæontology in America.

Among the numerous extinct animals discovered during the progress of these explorations are many groups which differ widely from any forms of life previously known. Prominent among these, and extremely interesting from their bearing on questions of evolution, are the toothed birds of the Cretaceous formation, the *Odontornithes*, all the known specimens of which are in the Yale Museum. These constitute a new sub-class, and have been divided into two well-marked orders: the *Odontolcæ*, which have the teeth implanted in grooves, and the *Odontolormæ*, with the teeth in distinct sockets. The *Odontolcæ* were large swimming birds, somewhat resembling the Divers of the present day, but with rudimentary wings, of no possible use to their possessor. The vertebræ were as in modern birds. The typical genus is *Hesperornis*, and at least three species are known. The second order includes small birds, very different in appearance and characters from the preceding group, with large and powerful wings, and biconcave vertebræ. Two genera and several species are known, which belong to this order. The type genus is *Ichthyornis*. All the toothed birds known at present come from the upper Cretaceous of Kansas, and more than one hundred individuals are represented in the Museum. A memoir on this group, with forty quarto plates, by Prof. Marsh, is now in the press.

In the same formation this active explorer discovered the first American Pterodactyls, or flying reptiles. These animals are extremely interesting, not only on account of their enormous size—for some of them have a spread of wings of nearly twenty-five feet—but more especially from the fact that they were destitute of teeth; in this respect resembling modern birds. They represent a new order, *Pteranodontia*, named from the type genus, *Pteranodon*, of which several species are now known. Numerous anatomical points of much importance will, no doubt, be brought to light by a close study of this remarkable

aberrant group, and the ample material now in the museum, representing more than six hundred individuals, will render their elucidation comparatively easy.

With the toothed birds and the Pterodactyls, have been found great numbers of Mosasauroids, a group of reptiles, which, during Cretaceous times, attained an enormous development both as to numbers and the variety of forms by which it was represented. Several new families, including a number of new genera and many species, here appeared, and flourished abundantly. The *Tylosauridæ* were very large, some of them being more than sixty feet in length, whle the *Edestosauridæ* were much smaller. The very abundant material secured, representing not less than twelve hundred individuals belonging to this order, has enabled Prof. Marsh to settle many doubtful points with regard to the structure of these reptiles, and to determine that they possessed hind paddles, and were covered with dermal scutes.

The Cretaceous formations of the West likewise have yielded numerous turtles and other reptiles, and many fishes, some of them of great interest, and very full series of specimens of all of these, representing not less than five thousand individuals, are at present in the Yale College Museum. The fame of these discoveries has led other explorers into the same field. A most formidable rival in enthusiasm and energy is Prof. E. D. Cope, who has filled the houses at Philadelphia with bones from the West, who has published some valuable memoirs upon them, and to whose work attention will be directed on another occasion.

Besides the discoveries made by Prof. Marsh and his parties in the Cretaceous of the West, the old Eocene lake-basins between the Rocky Mountains and the Wahsatch Range were, during the summer of 1870, explored with most interesting results, their age being then fully determined and announced. Many remarkable forms of life, most of them very different from anything previously known, have been disinterred. Of all of these, perhaps none are more extraordinary than the gigantic *Dinocerata*, a new order recently established by Prof. Marsh. These animals nearly equalled the elephant in size, but with shorter limbs. The skull was furnished with two or more pairs of horn cores, and with enormous canine tusks similar to those of the walrus, while the brain was proportionally smaller than in any other land mammal. Three genera and several species are known. These great creatures seem to have lived in considerable numbers about the borders of the old Eocene lakes and their remains are found quite abundantly, buried in the dirt that once formed the muddy bottom. Remains of more than two hundred different individuals are now in the Peabody Museum, and a volume descriptive of them by their discoverer is now in course of preparation.

Another new order of mammals, made known by the same untiring anatomist from these same deposits, is that of the *Tillodontia*. These animals are in many respects very remarkable, and notably in presenting characters which seem to indicate affinities with several widely different groups. Thus the skull, feet, and vertebræ resemble those of some carnivores; the anterior incisors forcibly remind one of the corresponding teeth in the rodents; the lower molars are of the Paleotherium ungulate type. Two families of this order are known: the *Tillotheridæ*, in which only the incisors, and the *Stylinodontidæ*, in which all the teeth grow from persistent pulps. The largest specimens of this order were about the size of a tapir.

From these Eocene deposits, too, were obtained the first remains of fossil *Quadrumana* known from the New World. These early primates, according to their discoverer, seem to have relationships both with the lemurs of the Old World, and with the South American monkeys. Two families have been discovered: the *Lemuravidæ*, named from the principal genus, *Lemuravus*, which have forty-four teeth, and the *Limnotheridæ*, which have not more than forty. The large number of genera and species by which this group is represented in these Eocene deposits, show that, even at this early period, the American primates had reached a high degree of development, and enjoyed, up to that time at least, very favourable conditions for their existence. They are all, however, low generalised forms, the characters of their teeth and other portions of the skeleton bearing considerable resemblance to the corresponding parts in the ungulates and carnivores. Besides the groups already mentioned, the same Eocene lake-basins yielded the remains of marsupials and bats (neither of which had before been found fossil in America), together with many species of birds, serpents, lizards, and fishes.

Since the original account of American fossil horses given by Leidy, the Eocene strata of New Mexico and Wyoming have yielded two very important ungulates, which have helped to complete the history of the descent of the horse, so well worked out by Prof. Marsh. These relics carry back the ancestry of this familiar quadruped to the oldest Tertiary time. The earliest form, *Eohippus*, was about the size of a fox, had forty-four teeth, the molars having short crowns, and being quite different in form from the premolars. There were four well-developed toes, a rudiment of another on the forefoot, and three toes behind. The structure of the feet and of the teeth in *Eohippus* indicates, beyond question, that the direct ancestral line to the modern horse had already separated from the Perissodactyls. The second of these ungulates, *Orohippus*, is from the Wyoming Eocene, and is evidently next to *Eohippus*, which it now replaces in the line of descent. In size it about equalled its predecessor, but the rudimentary digit of the forefoot has disappeared, and the last premolar has gone over to the molar series. Another Eocene equine, discovered in Utah, is *Epihippus*.

The discoveries made by the Yale expeditions in the "Miocene" and Pliocene formations of the Rocky Mountains and the Pacific coast were scarcely less numerous and interesting. From these deposits were obtained the large series of specimens which served to complete the geneological line of the horse from the four-footed Orohippus of the Eocene to the large *Equus fraternus* of the later Pliocene, which does not differ, appreciably, from the horse of to-day. From the "Lower Miocene" comes *Mesohippus*, which is about the size of a sheep, and has three usable toes of nearly equal size, and a long splint or rudiment of another, corresponding to the second digit of a five-toed foot. *Miohippus*, a somewhat later form, bears a close resemblance to *Mesohippus*, but the side toes are smaller, and the splint is very short. In *Protohippus*,

from the lower Pliocene, there is a considerable increase in size, the splint has disappeared, and the two side toes have become so small that they no longer reach the ground, but are merely dew claws, like those of the deer or ox. *Pliohippus*, which is found in a still higher horizon of the Pliocene, is as large as a donkey, has lost the dew claws, but has the splints much longer than the same bones in the modern equines. Finally, at the top of the Pliocene comes a true *Equus*, which completes the line. Besides the forms mentioned, there are many intermediate ones, which show that the transition has taken place in the order indicated. Many additional characters of the skull, brain, and teeth, add weight to, and confirm, the evidence furnished by the feet.

Among the other treasures of the Museum are bones of mammals allied to the modern rhinoceros, which occur abundantly in strata, said to be of Miocene age, both in Oregon and the Rocky Mountain region. These remains furnish material for tracing the descent of these creatures from the upper Eocene to the close of the Pliocene, when they appear to have become extinct. A strange group of ungulates, found in the so-called Lower Miocene of the plains, were the huge *Brontotheridæ*, which appear to have been allied to the *Dinocerata*, and also to *Rhinoceros*. In size they equalled the *Dinocerata*, and, like them, had an elevated pair of horn cores on the maxillary bones. An immense quantity of the remains of these animals, representing several genera and over two hundred individuals, has been collected, and is now in the Museum.

Until within a year or two, no Tertiary edentates were known from America, although their remains were found in abundance in the superficial post-Tertiary deposits. Recently, however, the Museum has received, from the "Lower Miocene" of Oregon, the remains of two species belonging to this group and to the genus *Moropus*. These are of large size, and were, essentially, huge sloths. From the Pliocene deposits of Idaho and California, and from the same formations east of the Rocky Mountains, other large species have been discovered belonging to the genera *Moropus* and *Morotherium*. Many other groups of mammals, including primates, carnivores, suillines, camels, &c., have been collected in these formations, which also yield numerous birds, reptiles, and fishes.

Although observations had been made by previous investigators, on the size of the brain in Tertiary mammals, Prof. Marsh was the first to institute any systematic inquiry into the laws which governed and the causes which acted upon, brain-growth in these ancient animals. Some of his conclusions, based on specimens now in the Museum, have been already given to the world, but they may be fittingly cited here: (1) All Tertiary Mammals had small brains; (2) there was a gradual increase in the size of the brain during Tertiary time; (3) this increase was mainly confined to the cerebral hemispheres, or higher portion of the brain; (4) in some groups the convolutions of the brain have gradually become more complicated; (5) in some the cerebellum and olfactory lobes have even diminished in size.

Some of the additional conclusions already reached in regard to American Tertiary mammals, so far as they are now known, are stated as follows:—(1) All the *Ungulata* from Eocene and Miocene deposits had upper and lower incisors; (2) all Eocene and Miocene mammals had separate scaphoid and lunar bones; (3) all mammals from these formations had separate metapodial bones.

Although the Cretaceous and Tertiary fossils make up a large part of the geological collections of the Peabody Museum, the other formations are well represented in its store-rooms. This is especially true of the recently discovered Jurassic beds of the Rocky Mountains, which have yielded, since the summer of 1877, a great number of interesting forms. The parties that have been collecting for Prof. Marsh have been more than usually successful, and a study of the strange animals, many of them new to science, which have been sent to the Museum, has resulted in several discoveries of great interest. These Jurassic fossils are chiefly dinosaurs, crocodiles, turtles, and fishes. The first of these are extremely abundant, and the horizon from which they come has been named by Prof. Marsh, from one of the genera there discovered, the Atlantosaurus Beds. These dinosaurs varied widely in size and structure, for while some of them, *e.g.*, *Nanosaurus*, were no larger than a cat, others were, by far, the largest land animals of which we have any knowledge. Among the discovered remains of *Atlantosaurus immanis* is a femur over six feet in length. A comparison of this specimen with the same bone in living reptiles indicates that *Atlantosaurus*, if similar in proportions to the crocodiles, would have been more than one hundred feet in length. The anatomical points cleared up by the discovery of the bones of the feet in these dinosaurs are of great importance and interest. From these same Atlantosaurus Beds come the strange *Stegosauria*, recently described by Prof. Marsh; a new order of reptiles whose affinities are, as yet, but imperfectly understood, but which appear to have most relationship with the dinosaurs. The Atlantosaurus Beds have furnished, moreover, the only Jurassic mammals yet found in America. These remains, apparently all marsupial, belong, so far as known, to four genera and eight species, which Prof. Marsh has described. He has also recently made known, from the marine Jurassic beds of the Rocky Mountains, a peculiar group of reptiles (*Sauranodontidæ*) allied to *Ichthyosaurus*, but without teeth.

An enumeration of the fossil treasures of New Haven would, however, fail to do justice to this marvellous collection if it made no mention of the almost incredible state of preservation of the fossils. A European student is lucky if he finds a tooth or a jaw; most fortunate should he stumble upon a cranium; the envy of the whole tribe of collectors should he disinter a whole skeleton. But even when most successful he meets with the bones often in a fragmentary, or badly preserved condition, or imbedded in so tough a matrix that they cannot be adequately cleared for study without almost certain detriment. The vast regions open to American research in the West, however, are the very paradise of palæontologists. Almost as fresh as if the animals had only recently died, the bones protrude sometimes in great numbers from the edges of the escarpments. When the first explorers went into these tracts they found the skulls grinning at them from the faces of the bare dry verdureless cliffs of the "bad lands." The diligence of Professors Marsh, Cope, and their parties has no doubt cleared away a good many of the prominent objects But the number still to be exhumed must be enormous.

Entire skeletons with almost every bone in place show how tranquilly and thoroughly the remains of the early Tertiary vertebrates were entombed in the mud of the lakes on whose shores and waters they lived.

A. G.

CHRONOLOGICAL HISTORY OF PLANTS

Chronological History of Plants: Man's Record of his own Existence illustrated through their Names, Uses, and Companionship. By Charles Pickering, M.D. (Boston: Little, Brown, and Co.; London: Trübner and Co., 1879.)

THIS is an extraordinary book, difficult alike to characterise and to review. It is a monument of enormous labour and erudition, but it is not easy to discover the plan upon which it is compiled, and it certainly does not fulfil the promise of its title. A "chronological history of plants" would be an interesting and valuable work, if understood to mean a history of the ages and countries in which particular plants have been introduced from abroad, or those of home growth first adapted to the use of man. This, indeed, is the work which Dr. Pickering seems to have contemplated; it is not, however, the work which he has accomplished.

Neither the historian, the philologist, nor the botanist will be satisfied with the huge volume now presented to them. Dates are given with a show of minute accuracy which the materials for ascertaining them unfortunately do not justify. Thus, to go no further than the second page, we find the mysterious paragraph, "Second generation, September 1st, 4234, among living men." As similar entries occur on the following page, with the names of Enoch, Irad, and other descendants of Cain attached to them, I suppose the paragraph must be interpreted to mean that the second generation of living men first saw light on the 1st of September, B.C. 4234. How Dr. Pickering knew this I cannot imagine. If we turn over a few leaves we find the dates of the early Egyptian kings set down with equal minuteness, and, it must be added, with an equally small show of reason. Dr. Pickering even knows the exact dates of the antediluvian monarchs of Babylonia, though he has forgotten the right name of the town of Pantibibla, from which several of them were said to have come. His knowledge of the heroic age of Greece is equally precise. Thus he tells us that in 1290 B.C. Jasus was "succeeded by Crotopus, son of Agenor, and now ninth King of Argos;" and then follows some interesting information about the Pelasgians and their wanderings.

Dr. Pickering's philology is not less remarkable than his chronology. He shocks the Hebrew scholar by calling *tzôn* ("sheep") *tzan*, of which, by the way, he says that it was "regarded even by Dicæarchus as probably the first animal domesticated"—a statement likely to be disputed by those who have occupied themselves with the history of the domestication of animals. Under the year 1720 B.C., he remarks that "the northern language from which certain Greek words were taken probably at this time in existence"—a statement which will be new to most philologists and Greek scholars. Naturally he has never heard of the explanation of the word *foxglove*, which makes it a popular corruption of *folk's-gleed*, or "row of bells."

But it is the botanist who has most reason to complain of Dr. Pickering's work. Instead of a "chronological history of plants," he finds the names and notices of various specimens of the vegetable world catalogued in the most arbitrary way under dates which have little or no connection with the age in which they were first known or used by man. So far as the earlier half of the book is concerned, the notices might in most instances have been as well entered on another page as that on which they are actually found. Why, for instance, should the *Artemisia absinthium* or the *Iris sambucina* be described under the date 1734 B.C., and what possible connection can there be between 1203 B.C. and the *Phragmites communis*? The only relation that can generally be traced between the dates and the plants recorded under them is little better than a pun. Because the almond or *luz*, which Dr. Pickering calls *lwz*, is mentioned in Genesis xxx. 37, it is recorded under the year 1506 B.C., the year in which Joseph was "born to Jacob and Rachel;" because a brick from the small pyramid of Dashur was discovered to contain the straw of the jointed charlock and field pea, an account of these plants is given under the year 2079 B.C., the assumed date of the building of the pyramid; and the mention of "Pelasgus establishing himself as king in Arcadia" in 1354 B.C. calls up a description of the *Quercus esculus*. As a set-off against this learned trifling, a vast quantity of matter is introduced which has nothing to do with plants and their history. Thus it would be quite intelligible if the author had given a list of those Egyptian hieroglyphics which represent plants, but the long, though imperfect, catalogue of hieroglyphic characters of all kinds which he actually has given, though fitted for a treatise on Egyptian grammar, is certainly out of place in a history of the vegetable world.

There is only one explanation that can be offered for the character of this extraordinary volume. Dr. Pickering was an able and learned scholar, trained in scientific methods and capable, as is proved by his "Races of Man," of producing good scientific work. But his "Chronological History of Plants" has been published since his death, and has consequently not had the benefit of his own compilation and revision. It consists simply of the notes he collected during a long course of voluminous reading, arranged, not upon any scientific plan, but under the convenient headings of his common-place book. The student may possibly construct a chronological history of plants out of them, but such a history does not exist at present. The volume is a mine of materials which, thanks to a careful index, can be easily used, though considerable caution is required in doing so. As it stands, however, it is hardly better than a mass of undigested and ill-arranged facts, mixed up with dates and statements calculated to send a shudder through the sensitive frame of the critical historian. Posthumous works are not unfrequently the most cruel injury that can be inflicted by friends upon the memory of the dead, and it is hardly likely that Dr. Pickering would have relished the appearance of his elaborate notes in precisely their present form.

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