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*THE MAMMALIAN FAUNA OF THE SANTA CRUZ BEDS OF PATAGONIA.**

THE magnificent collections of vertebrate fossils brought back from Patagonia by Messrs. Hatcher and Peterson are still very largely in the rough state. The work of cleaning and preparing the specimens is proceeding steadily and satisfactorily, but is necessarily slow, and the preparation of a single skeleton may require the labor of many weeks. Enough has been already accomplished, however, to exhibit the character of this very remarkable fauna in its main outlines and to permit a general statement of its most salient features. Long and patient study will still be necessary before the full significance of this peculiar assemblage of mammals can be made apparent.

The geological age of the Santa Cruz beds has long been a matter of dispute, because the lack of fossils common to that formation and the standard horizons of the northern hemisphere has prevented any direct comparison. Ameghino, to whose indomitable energy so much of our knowledge of Patagonian fossils is due, has always maintained the lower Eocene age of the Santa Cruz beds. On the other hand, European and American paleontologists have been convinced, from the grade of evolution attained by the Santa Cruz mammals,

* Abstract of a paper read before the Princeton Biological Club, November 16, 1900.

that the horizon could not be so ancient and that it much more probably belonged to the Oligocene or Miocene. Fortunately, the solution of this problem does not depend upon theoretical views of mammalian morphology, but may be decided by more direct and satisfactory evidence. The Santa Cruz beds overlie and are, to some extent, interstratified with the marine Patagonian formation, which is very richly fossiliferous and from which Mr. Hatcher gathered very extensive collections of marine invertebrates. These have been carefully studied by Dr. Ortmann, who concludes from his examination that the Patagonian beds are *Lower Miocene*, and the Santa Cruz beds, as a whole, are, therefore, still younger, that is, Middle, or possibly even Upper Miocene.

The first impression that an examination of a representative series of Santa Cruz fossils makes upon the northern observer is that of strangeness, of unlikeness to everything with which his previous studies have made him familiar, and this impression is only deepened as these mammals are compared with those of North America and Europe. Disregarding some very doubtful and incompletely known groups, the Santa Cruz fauna is composed of the following elements.

1. Marsupialia.
2. Unguiculata,
   - (*a*) Insectivora,
   - (*b*) Edentata,
   - (*c*) Rodentia.
3. Ungulata,
   - (*a*) Typotheria,
   - (*b*) Toxodontia,
   - (*c*) Astrapotheria,
   - (*d*) Litopterna.
4. Primates.

One of the most striking features of this fauna may be described negatively, by what it lacks; it has no Carnivora or Creodonta, no Chieroptera (though little importance can be attached to this fact, which may well be accidental); no Artiodactyla, Perissodactyla, Proboscidea or Hyracoidea. Of the nine orders only four are found in the Miocene of the northern hemisphere (for the Old World Edentates, so called, are of no significance in this connection), and even these common orders are represented by totally different suborders and families. That Patagonia had long been cut off from any land communication with North America seems abundantly clear.

The Santa Cruz Marsupials are of two types: (1) Carnivorous animals, which took the place of the carnivores and creodonts of the North; these find their nearest analogues in the *Dasyuiidæ* of Australia, but there are such important differences of structure as to indicate a long geographical separation from that family. (2) Herbivorous animals, of small size, quite remote from any of the Australian forms and typified by the existing South American *Cœnolestes* of Thomas.

The Insectivora are represented, so far as is yet known, by only a single genus, *Necrolestes*, which, as Ameghino has suggested, is very like the 'Cape Golden Moles' of Africa, a most interesting fact, the full significance of which is not yet apparent.

The Edentata are found in surprising variety and numbers, making up one of the most conspicuous and characteristic elements of the fauna. Forerunners of the huge Ground-sloths (Gravigrada) of the Pleistocene, are extremely abundant and are represented in the collection by a number of such well preserved skeletons that a comparison with their great descendants cannot fail to yield results of much interest. One difference is obvious at the first glance, namely, the very much smaller size of the older genera. Much the same statement is true of the Glyptodonts, which are very numerously represented by species much smaller and more primitive than their Pleistocene successors. The Armadillos are likewise extremely varied and abundant, representing not only the various modern subdivisions of the family, but also some

extraordinarily interesting and curious extinct lines. Ameghino has already called attention to some of the peculiarities of these Santa Cruz Armadillos, such as the movable arrangement of the bony scutes of the carapace, which do not form a fixed shoulder-shield, and the imbricatin , overlapping disposal of the scutes in several of the species. As yet no member of the Ant-eaters or true Sloths has been detected in the collection, and it is still too early to say whether this absence is due to the accidents of fossilization and of collecting, to geographical and climatic factors, or to the fact that these families had not yet become distinctly separated from the others.

Even more surprisingly abundant and varied are the Rodentia, of which a remarkable number of genera and species may be distinguished. These are, without one certainly known exception, members of the Hystricomorpha and are all closely allied to types which continue to flourish in South America at the present time. Indeed, several of the fossils cannot be generically separated from living forms. In all this great assemblage of rodents are to be found no beavers, marmots or squirrels, no rats or mice, no hares, rabbits or pikas, but only a bewildering variety of cavies, pacas, chinchillas, agoutis and the like. In no mammalian order are the isolation of the Santa Cruz fauna and its separateness from that of the northern hemisphere more clearly displayed than in the Rodentia.

Still more peculiar are the hoofed-animals. The four orders into which this great series is divided in the table do not represent the results of mature study, but merely of a preliminary survey of the material, and the number of ordinal groups is subject to increase or diminution, as may be the outcome of more careful examination. Of the four orders not one is known in the Miocene of the northern hemisphere, nor, on the other hand, does the Santa Cruz contain representatives of any ungulate order common to it and the northern continents. All the four orders, except the Astrapotheria, continue into the Pleistocene, when most of them had become beasts of great stature or bulk; but then they all disappeared completely and have left no descendants in the modern world.

The Typotheria are individually much the most numerous of the Santa Cruz ungulates and they are, within certain narrow limits, extraordinarily varied. They are all small animals, some of them very small, and except for their long tails, of an aspect which strongly suggests relationship with the Hyracoidea. Whether this resemblance is anything more than an analogy, remains to be determined by a series of careful comparisons. This phylum terminates in the rodent-like *Typotherium* of the Pleistocene, an animal which, though only of moderate size, is yet very much larger than any of its Santa Cruz predecessors. The order has not been found outside of South America.

The next most abundant of the Santa Cruz ungulates is the order Toxodontia, which is very much less varied than the preceding group, though its members are much larger in size. These relatively massive, short-legged and short-footed animals are remarkable for the great size of their heads and for their curved, persistently growing teeth. This line also terminates in the Pleistocene in the great *Toxodon*, which ranged as far north as Nicaragua. The supposed representatives of the order which have been reported from Europe are simply mistakes of identification.

Most remarkable and interesting of all the Santa Cruz ungulates are the Litopterna, which in many respects closely parallel the Perissodactyla. Of these there are two series, one of long-legged, long-necked, camel-like animals, which led up to the

Pleistocene *Macrauchenia;* the other an astonishing imitation of the horses, an imitation so detailed and so close that it has misled Ameghino into believing that this is the actual phylum of equine descent. The resemblance is striking in all parts of the structure; in the teeth, the skull, the backbone, the limbs and especially the feet. The less advanced forms have tridactyl feet, but with the lateral digits already greatly reduced, while the more differentiated species surpass the true horses in strict monodactylism, the splint-bones being almost suppressed and represented only by minute nodules of bone. Yet these wonderfully horse-like creatures prove, on examination, to be not even perissodactyls! A more remarkable and instructive case of convergent evolution it would be difficult to imagine.

The Astrapotheria were the largest of Santa Cruz mammals. In them the great, vaulted skull had such shortened nasal bones as to suggest the presence of a proboscis, and slender, edentulous premaxillaries. The canine teeth in both jaws are enlarged to form powerful and formidable tusks, the premolars are reduced in size and number, while the molars are enlarged. The grinding teeth display a remarkable likeness in size and pattern to those of the northern rhinoceros, *Metamynodon*, from the White River beds—another example of convergent development. The Astrapotheria would appear to have become extinct before the Pleistocene, and it must be the object of subsequent studies to determine whether the group is really entitled to ordinal rank, or whether it should be referred to the Litopterna.

I am not prepared to express an opinion as to the taxonomic position of *Homalodontotherium*, one of the most curious of the many curious Santa Cruz hoofed-animals.

The Primates are not very well known as yet, for the fossils are seldom so complete as those which so often rejoice the heart of the student who works with the other groups. So far as they are understood, the Santa Cruz monkeys would appear to be as characteristically South American, and as different from those of the northern hemisphere, as we have seen to be the case among the Rodentia.

This exceedingly brief outline sketch will have served its purpose if it makes clear the wonderful character of the Santa Cruz fauna and its radical differences from the contemporary life of the northern hemisphere. Much remains to be done before the full account of these splendid collections can be published. I have attempted merely to describe their general nature and the impression which they make upon an observer whose studies have hitherto dealt with northern types.

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IS THERE ANY DISTINCTION BETWEEN SEXUAL REPRODUCTION AND ASEXUAL REPRODUCTION?

The following pages contain rather a full outline of the views advanced by Professor Richard Hertwig in a recent lecture* in which he discusses the relation between fertilization and reproduction. I have endeavored to make this more in the nature of an abridged and revised translation than a review, for it seemed best to follow as closely as possible Professor Hertwig's own way of presenting the subject, which is as follows:

Everyone will admit that most of our general conceptions in biology are greatly influenced by our knowledge of the higher animals and plants. This fact is made very evident to all who study the reproduction

* 'Mit welchen Recht unterscheidet man geschlechtliche und ungeschlechtliche Fortpflanzung?' Vortrag, gehalten am 7, November, 1899. Aus den Sitzungsberichten der Gesellschaft für Morphologie und Physiologie in München. 1899. Heft. II.