

*Otaria minor.* The Smaller Sea-lion.

Skull of an adult male  $11\frac{1}{2}$  inches long, and  $6\frac{1}{2}$  inches wide at the condyles; the nose dilated in front; the palate very deep, wide, broad in front, contracted behind, with the lateral processes rather contracted, the sixth upper grinder behind the edge of the front of the zygomatic arch; the lower jaw  $8\frac{1}{2}$  inches long, wide and strong, contracted and flat on the sides in front, and with an elongated scar behind left by the temporal muscle.

*Hab.* Unknown. Received from Mr. E. Cross, 1854.

This skull may be the same as *Otaria Godeffroyi*, Peters, described and figured from a specimen in the museum at Hamburg, which is about the same size; but the lower jaw is not of the same shape as the lower jaw of the skull in the Museum, the scar of the large temporal muscle is broad and rounded at the end, as in the jaws of the common sea-lion, and the sixth upper grinder is before the back edge of the front of the zygoma; so that I am inclined to think that the Hamburg skull belongs to a small species allied to, or is a small variety of, the common sea-lion (*Otaria jubata*).

*Otaria pygmæa.* The Pigmy Sea-lion.

The skull of an adult (female)  $9\frac{1}{4}$  inches long, and  $5\frac{1}{4}$  broad at the condyles.

The palate is very narrow, deep, scarcely wider behind; the sixth upper grinder is behind the hinder edge of the front of the zygomatic arch. The lower jaw is comparatively slender,  $6\frac{1}{2}$  inches long, compressed and flat in front.

*Hab.* Unknown. The specimen was received from the Zoological Society in 1858.

This skull is partly broken behind, and wants all the grinders and the greater part of the cutting-teeth. The canines are comparatively small, which makes me think that it belongs to a female; indeed I might regard it as the female belonging to the same species as the skull before described, but for the peculiar form and narrowness of the palate.

The palates of the two sexes of the common sea-lion are of the same form, though they become deep with age and those of the males more contracted behind; so that they give no authority for believing that the palates of the two sexes of an allied species are so different.

*The Succession of Life in North America.* By EDWARD D. COPE.

The United States east of the Missouri river and the plains have been free from changes of level for a much longer period than that portion which lies to the west of such an imaginary line. It was alternately dry and submerged during a long period in the infancy of geological time, but became finally so established as to permit of no further descent of level, or, at most, of slight ones only. The last stages of this process of creation were witnessed at the close of the Carboniferous period, when the elevations of land were widespread, inclosing tracts of water within bars or in depressions.



These water areas were of course at first salt ; but, as they had no communication with the sea and received abundant supplies of pure water from streams and rains, they soon became fresh. They then became the centres of rank vegetation, which either as moss filled them up with its dense growth, or as large trees formed forests on the shores. Later submergences covered all this material with a heavy coating of mud-deposit, which now appears to us in the form of strata of clay and sandstone rock. Thus was produced the coal, which has played so important a part in human progress. So frequent were the alternations of level that at one place in Nova Scotia as many as seventy-six beds of coal separate as many strata of other materials, and the whole amount of deposit amounts to fifteen thousand five hundred feet. As the elevating force became more powerful, the amount of dry land increased, until the lifting of the Alleghany Mountains to a height of twenty thousand feet concluded the process.

Previous to this time vertebrated animals had been inhabitants of water only, so far as the preserved remains have been discovered ; but now air-breathers were introduced, which, instead of fins, possessed limbs adapted for walking on dry land. These creatures were all salamanders, and related to the frogs, beginning life in the water and passing through a metamorphosis before reaching the perfect state.

The western regions were during this time occupied by a boundless ocean, whose western limit has not yet been ascertained ; and such it continued for many ages, while the east was bringing forth plant and animal each after its kind. The strata deposited in the bottom of the western sea covered each other successively, so that it is only the later chapters of the history that are now revealed to us in the exposed beds of the upper formations. But the history of the east was repeated. Its eastern coast-line rose and fell gradually and islands appeared in the far west, heralding the birth of another continent. Slowly the land areas extended, the western growing from islands to a long narrow continent, honeycombed with lagoons and lakes. The great central sea (now Kansas, Dakota, &c.) contracted and finally lost its connexion with the ocean altogether. The water areas, however, were for a long period brackish, and brought forth oysters and other shell-fish of dubious proclivities, capable of living in either salt or fresh water, but thriving in a mixture of both. The land was covered with a rich and dense forest vegetation, and the bog-moss again encroached on the lakes ; but the forest was in great contrast to that of the carboniferous period. Instead of huge ferns and tree mosses we have the more highly organized and beautiful forms represented by the existing deciduous trees. Oaks, sassafras, magnolia, and poplar shaded a dense undergrowth of shrubs, while palms and some other tropical families distinguished the general effect from the familiar one of to-day. But the moss performed its old function of coal-maker. Humblest among plants, its existence has been more important in world-building than that of all the lords of the forest. Its masses died,



and new layers of the living plant grew upon them, until the descent of the land and encroachment of waters deposited the stone lid upon their treasury of carbon, not to be unsealed until the long future day of human empire. The alternations of land and water were numerous. At one point on the Union Pacific railroad a section displays one hundred and seventy-three distinct strata, of which thirty-six are either coal or mingled with vegetable matter, while the others are frequently composed almost exclusively of fresh- and brackish-water shells. The elevation, however, exceeded the depressions, the brackish estuaries and lagoons were transformed into freshwater lakes, and at length the noble ranges of the Rocky Mountains bounded the horizon in many directions.

The salt ocean has not only been the dwelling-place of gill-breathing fishes, but also of many forms of air-breathing vertebrates. These were reptiles, and exhibited a great superiority of structure over the air-breathers that peopled the swamps and land of the coal period. When the land and the fresh waters claimed the great west, the sea saurians perished; for their limbs were not fitted for the changed circumstances. Smaller races held the land, and, with a few monsters that never had been ocean-dwellers, represented the swarming reptilian life of the past.

But a new dynasty was to rule the earth; the mammal, with hot blood and active brain, was to use the rich stores of the newer vegetable world; and life was to be exhibited on a higher platform.

The lakes of the west were gradually dried by the cutting of their discharging streams down to the level of their bottoms. This was of course soonest accomplished in lakes of the greatest elevation—for instance, those within the highest range of the mountain-chains. Others continued for a longer period, and others to a comparatively still more recent date. Their deposits contain a faithful record of the life of the surrounding land, doubtless embracing many species that ranged to the Atlantic ocean. We have thus the means of studying the character of five successive periods, which must be to us a mine of interesting inquiry, and a source of evidence as to the nature of that life and the thoughts of its great Author.

The names of the beds, with the regions where chiefly found, are the following:—(1) The Lignite series or Upper Cretaceous (Montana, Dakota, Wyoming, Colorado); (2) Eocene Lake (Wyoming, West Colorado); (3) Miocene (Nebraska, Oregon, E. Colorado); (4) Pliocene (Nebraska, Idaho, Oregon, E. Colorado); (5) Post-pliocene (caves of the east). The quadrupeds begin in full blast in the Eocene; and none whatever are known from beds of the preceding or cretaceous age—a remarkable circumstance, and not easy to account for, especially as it is the case all over the world, so far as known; yet there were a few of this high division during a period that preceded the cretaceous. In Wyoming, therefore, we find life first in the form with which it has pleased Divine power to invest ourselves, but in no case presenting any close resemblance to the human species. The predominant styles were those resembling the tapir, the opossum, the bat, the mole, and the squirrel. There were



no cloven-footed animals that chew the cud (ruminants), no horses, no elephants, no rhinoceros or hippopotamus, and, it is thought, no true cat- or dog-like flesh-eaters. To take their places were strange creatures that combine the characteristics of these divisions now so widely separated. Thus there were forms between the horse and tapir, between the elephant and tapir, and between the rhinoceros and tapir. There were numerous monkeys which resembled nearly as much the raccoon and the coati. The land carnivora resembled in many ways the seals; and the division of the opossum and the kangaroo had sundry representatives. A more curious and, to some, unexpected faunal combination, constituting a homogeneous whole, does not exist in any known formation.

In the next period (Miocene) a great addition to the living types of animals took place; so that the contrast between this formation and the Eocene is very great. A portion of almost any part of the skeleton of a quadruped would thus enable the palæontologist to determine the age of the formation from which it had been procured. Thus ruminating animals exist in the greatest profusion, a few horses appear, two species of elephants (mastodon) are known, and there are a great many species of rhinoceros. The peculiar intermediate divisions of the Wyoming beds no longer peopled the land; the strange beings compounded with the tapir have abandoned the earth in favour of more decided types. One or two tapirs hold over, and one of the anomalous monkeys. The snakes and lizards are nearly the same; but the crocodiles that swarmed during the Eocene have entirely disappeared.

If we examine the character of the representatives of living orders in greater detail, we shall find the phenomenon observed in the structure of the Eocene quadrupeds repeated, but within a narrower limit of variation. Thus the modern ruminants may be roughly stated as belonging to the families of the hogs, camels, musk-deer, and oxen. In the Miocene there are neither oxen nor deer, while many species in enormous droves present structure of hog, camel, and deer combined, or camel plus musk and hog. The horses had three toes and were more or less like tapirs; and some of the rhinoceroses shared similar peculiarities. One strange set of creatures combined characters of tapir and rhinoceros with those of those Eocene beasts that combined the elephant and tapir. The latter have been called *Eobasileus*, the former *Symborodon*. The *Eobasileus* had three pairs of long horns—the first at the snout, the last on the back of the skull; the feet were like the elephant's; and it carried a pair of knife-like tusks. It probably had a short trunk. The *Symborodon* had feet more like the rhinoceros, but it stood high on the legs like the elephant; the tusks were reduced to a small size, while one pair of horns stood upon the top of the head. They represented the front pair of the *Eobasileus*, and either stood on the nose or over the eyes. Their shape differed in the different species: in some they were long and round, in others flat; in others they were three-sided and turned outward. One species had enormously expanded cheek-bones, and was nearly as large as



an elephant; it has been called *Symborodon bucco*. The long-horned species was as large as the Indian rhinoceros, and is called *Symborodon acer*. The species with three-cornered horns is intermediate in size.

Besides these larger quadrupeds there were myriads of the small ones, whose evident adaptation for insect- and seed-eating habits indicate the abundance of such supplies. Thus there were moles, mice, squirrels, and not less than seven species of rabbits. Areas exist where the beds of the formation laid bare by the weather are found to be covered with the delicate remains of these animals. They cover the surface in such profusion as to resemble the loose grain on the farmer's barn-floor in harvest time.

The Pliocene stratum, above the Miocene, is usually present in the regions where the latter occurs, though not invariably. It has a more sandy character, while the older beds are more clayey. The life they disclose is quite distinct from that we have just passed in review, differing from it much in the same way that it differs from that below it, *i. e.* the Eocene. In other words, it is still more like the life of the present time, and the curious intermediate or (to speak inaccurately) the mixed divisions have nearly disappeared. We have now true dogs and weasels, true elephants, and a few true deers and antelopes. The camels are almost like those now living; and while the horses have three toes, the side toes are much reduced, and the teeth are much more nearly like those of living horses. Rhinoceroses still abound; but all their mixed tapiroid and elephantine kindred have utterly disappeared.

A curious feature in the dentition of the horses and camels of this period has been observed. The temporary or milk-teeth of the horses were very much like the permanent or second series of the horses of the preceding or Miocene formation. The second or permanent teeth differed from them, and resembled exactly in type the temporary or milk-teeth of the living horses. The case of the camels is similar. Like the hogs they possessed a full set of upper teeth in front, which they soon shed, thus taking on one of their true camel characters; but their permanent series all round after this shedding was like that of the milk-dentition of the existing camels and llamas. In the latter animals the number of the permanent teeth is less than that of the first series in one part of the mouth, thus producing another type.

In the fifth and last period we observe another marked change in the life. Most of the Mammalia are nearly related to those now living in this and other continents, while a great many forms of the past are lost. The monkeys did not reach into the Pliocene, so far as we know; now the rhinoceros leaves us. A few remnants only survive of the camels and horses. Oxen first appear either as the giant bison or the southern musk-oxen; deer of great size exist. The loss is replaced by South-American types, especially gigantic sloths, in great abundance, with droves of tapirs and peccaries. For the first time we have the raccoons and bears, the latter of the same character as those found with the fossil sloths in Buenos Ayres.



True cats, like the jaguar and the tiger, roam the forests; and weasels and otters inhabit the banks of the streams.

The modern time has come, so far as the patterns of the animals are concerned; but their habitations are still different from those which their representatives preserve at the present day. But nearly all the post-pliocene quadrupeds belong to different species from those now living.

The present appearance of the mammalian family in North America is due to the following changes:—The llamas, sloths, tapirs, and peccaries have all been banished to Mexico and South America; so also most of the large cats. The horses, mastodons, and elephants were extinguished. The deer type seems to have expanded, while one ox (the bison) and an antelope remain. The wild dogs, weasels, &c. number about as many species now as in the past, while the variety of bears seems to have increased; on the other hand only one of the large cats (the puma) remains. That strange creature the opossum still holds his own far away from his Australian kindred. The smaller rodent quadrupeds are almost as much varied as ever. Many of these changes have evidently been wrought by the glacial period. That frozen epoch brought down the arctic life, and either destroyed those forms that could not resist its rigours, or drove them into a more southern climate. The musk-ox then roamed through the southern States; the walrus haunted the coasts of Virginia; and the reindeer peopled New Jersey. With the return of the milder period these again sought the north.

But a small proportion of the actual number of the species which lived during these successive ages is yet known, and the field offers many returns for exploration. As an illustration of the manner in which opinions respecting the history of life may be corrected by discovery, I cite two examples. The bony gar-fishes have been often pointed to as exhibiting a remarkable break in the times of appearance in geological history. Their latest fossil relatives were known to have existed during the ancient period called the jurassic; they did not recur until the present, and now only in the fresh waters of North America. This break of at least one third of all geological time has been recently much reduced by the discovery of gars in great abundance in the Miocene and Eocene periods on this continent. The second case is that of the serpents. They were only known for a long time in the Eocene of New Jersey, then in the same epoch of Wyoming, and lately in the Miocene of Colorado.

Until recently no fossil monkeys, bats, or opossums were known to exist in American formations; and the curious intermediate divisions above described as related to elephant, rhinoceros, tapir, hog, camel, horse, monkey, &c. are all recent American discoveries.—*The Penn Monthly*, Feb. 1874.

*On Xenelaphus, Furcifer, and Coassus peruvianus of the Peruvian Alps.* By Dr. J. E. GRAY, F.R.S. &c.

Mr. Whitely has sent to the British Museum the skins and skulls of a male and female Peruvian deer from Ceuchupate, Peru, at an elevation of 11000 feet.



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