cea. Of the structure of the pelvis and hind-limb we are at present in ignorance.

From the middle Miocene period fossil Cetacea are abundant and distinctly divided into the two groups now existing. The Mysticocetes, or Whalebone Whales, of the Miocene seas were, as far as we know now, only *Balenoptera*, some of which (as the genus *Cetotherium*) were, in the elongated flattened form of the nasal bones, the greater distance between the occipital and frontal bone at the top of the head, and the greater length of the crevical vertebrae, more generalized than any now existing. In the shape of the mandible also, Van Beneden, to whose researches we are chiefly indebted for a knowledge of these forms, discerns some approximation to the Odontocetes. Right Whales (*Balena*) have not been found earlier than the Pliocene period, and it is interesting to note that instead of the individuals diminishing in bulk as we approach the times we live in, as with many other groups of animals, the contrary has been the case, no known extinct species of whales equaling in size those that are now to be met with in the ocean. The size of whales, as of all other things whose most striking attribute is magnitude, has been greatly exaggerated: but when reduced to the limits of sober fact, the Greenland Right Whale of 50 feet long, the Sperm Whale of 60, and the Great Northern Rorqual (*Balenoptera sibbaldii*) of 80 exceed all other organic structures known, past or present. Instead of living in an age of degeneracy of physical growth we are in an age of giants, but it may be at the end of that age. For countless ages impulses from within and the forces of circumstances from without have been gradually shaping the whales into their present wonderful form and gigantic size, but the very perfection of their structure and their magnitude combined, the rich supply of oil protecting their internal parts from cold, the beautiful apparatus of whalebone by which their nutrition is provided for, have been fatal gifts, which under the sudden revolution produced on the surface of the globe by the development of the wants and arts of civilized man, cannot but lead in a few years to their extinction.

It does not need much foresight to divine the future history of whales, but let us return to the question with which we started—What was their probable origin?

In the first place, the evidence is absolutely conclusive that they were not originally aquatic in habit, but are derived from terrestrial mammals of fairly high organization, belonging to the placental division of the class—animals in which a hairy covering was developed, and with sense organs, especially that of smell, adapted for living on land; animals, moreover, with four completely developed pairs of limbs on the type of the higher vertebrata, and not of that of fishes. Although their teeth are now of the simple homodont and diphyodont type, there is much evidence to show that this has taken place by the process of degradation from a more perfect type, even the fossil teeth of Whalebone Whales showing signs of differentiation into molars and incisors, and many extinct forms, not only the Zeuglodon, but also true dolphins, as the Squalodon, having a distinct heterodont dentition, the loss of which, though technically called a "degradation," has been a change in conformity to the habits and needs of the individuals. So much may be considered very nearly if not quite within the range of demonstrated facts, but it is in determining the particular group of mammals from which the Cetacea arose that greater difficulties are met with.

One of the methods by which a land mammal may have been changed into an aquatic one is clearly shown in the stages which still survive among the Carnivora. The seals are obviously modifications of the land Carnivora, the Otaria, or Sea-lions and Sea-bears, being curiously intermediate. Many naturalists have been tempted to think that the whales represent a still further stage of the same kind of modification. So firmly has this idea taken root, that in most popular works on zoology in which an attempt is made to trace the pedigree of existing mammals, the Cetacea are definitely placed as offshoots of the Pinnipedia, which in their turn are derived from the Carnivora. But there is to my mind a fatal objection to this view. The seal of course has much in common with the whale, inasmuch as it is a mammal adapted for an aquatic life, but it has been converted to its general fishlike form by the peculiar development of its hind-limbs into instruments of propulsion through the water; for though the thighs and legs are small, the feet are large and are the special organs of locomotion in the water, the tail being quite rudimentary. The two feet applied together form an organ very like the tail of a fish or whale, and functionally representing it, but only functionally, for the time has I trust quite gone by when the Cetacea were defined as animals with the "hinder limbs united, forming a forked horizontal tail." In the whales, as we have seen, the hind-limbs are aborted and the tale developed into a powerful swimming organ. Now it is very difficult to suppose that when the hind-limbs had once become so well adapted to a function so essential to the welfare of the animal as that of swimming, they could ever have become reduced and their action transferred to the tail; the animal must have been in a too helpless condition to maintain its existence during the transference, if it took place, as we must suppose, gradually. It is far more reasonable to suppose that whales were derived from animals with large tails, which were used in swimming, eventually with such effect that the hind-limbs became no longer necessary, and so gradually disappeared. The powerful tail, with lateral cutaneous flanges, of an American species of Otter (*Pteronura sandbachii*) or the still more familiar tail of the beaver, may give some idea of this member in the primitive Cetacea. I think that this consideration disposes of the principal argument that the whales are related to the seals, as most of the other resemblances, such as those in the characters of their teeth, are evidently analogous resemblances related to similarity of habit.

As pointed out long ago by Hunter, there are numerous points in the structure of the visceral organs of the Cetacea far more resembling those of the Ungulata than the Carnivora. These are the complex stomach, simple liver, respiratory organs, and especially the reproductive organs and structures relating to the development of the young. Even the skull of Zeuglodon, which has been cited as presenting a great resemblance to that of a seal, has quite as much likeness to one of the primitive pig-like Ungulates, except in the purely adaptive character of the form of the teeth.

Though there is, perhaps, generally more error than truth in popular ideas on natural history, I cannot help thinking that some insight has been shown in the common names attached to one of the most familiar of Cetaceans by those whose opportunities of knowing its nature have been greatest—"Sea-hog," "Sea-pig" or "Herring-hog" of our fishermen, *Meerschwein* of the Germans, corrupted into the French "Marsouin," and also "Percepoin," shortened into "Porpoise."

A difficulty that might be suggested in the derivation of the Cetacea from the Ungulata, arising from the latter being at the present day mainly vegetable feeders, is not great, as

the primitive Ungulates were probably omnivorous, as their least modified descendants, the pigs, are still, and the aquatic branch might easily have gradually become more and more piscivorous, as we know from the structure of their bones and teeth, the purely terrestrial members have become by degrees more exclusively graminivorous.

One other consideration may remove some of the difficulties that may arise in contemplating the transition of land mammals into whales. The Gangetic Dolphin (*Platanista*) and the somewhat related *Inia* of South America, which retain several rather generalized mammalian characters, and are related to some of the earliest known European Miocene forms, are both to the present day exclusively fluviatile, being found in the rivers they inhabit almost up to their very sources, more than a thousand miles from the sea. May this not point to the freshwater origin of the whole group, and thus account for their otherwise inexplicable absence from the Cretaceous seas?

We may conclude by picturing to ourselves some primitive generalized, marsh-haunting animals with scanty covering of hair like the modern hippopotamus, but with broad, swimming tails and short limbs, omnivorous in their mode of feeding, probably combining water plants with mussels, worms, and fresh water crustaceans, gradually becoming more and more adapted to fill the void place ready for them on the aquatic side of the borderland on which they dwelt, and so by degrees being modified into dolphin-creatures inhabiting lakes and rivers, and ultimately finding their way into the ocean. Here the disappearance of the huge Euliosaurians, the *Ichthyosauri* and *Plesiosaurs*, which formerly played the part the Cetacea do now, had left them ample scope. Favored by various conditions of temperature and climate, wealth of food supply, almost complete immunity from deadly enemies, and illimitable expanses in which to roam, they have undergone the various modifications to which the Cetacean type has now arrived, and gradually attained that colossal magnitude which we have seen was not always an attribute of the animals of this group.

Please to recollect, however, that this is a mere speculation, which may or may not be confirmed by subsequent paleontological discovery. Such speculations are, I trust, not without their use and interest, especially when it is distinctly understood that they are offered only as speculations, and not as demonstrated facts.

THE SHEEP GRUB.

DURING the hot days of mid-summer, sheep often huddle together with their noses upon the ground, or in some other constrained position. This is done partly at least, to secure them from the attacks of the pestering gad-fly (*Cestrus ovis*), which is the parent of the annoying grub-in-the-head. This insect is closely related to the bot-fly, that deposits its eggs upon the neck, shoulders, and forelegs of horses, from which they are removed by the teeth of the animal to allay the itching and are taken into the stomach, and developed into troublesome bots. The female sheep gad-fly aims to deposit her eggs in the nostrils of the sheep, and the animals, apparently aware of the effects to follow, try to prevent it. If the eggs are laid, they soon hatch, and the young grubs ascend the mucous secretions of the irritated surface to which they cling. When fully grown, the grubs work their way down through the narrow openings by which they entered when first hatched and again cause the sheep much pain. The grubs fall to the ground, and burrowing for a few inches, become chrysalids, which developed into the perfect flies in about two months. The grubs pass from the sheep in early summer, and the flies come out of the ground from July to September. A daub of tar upon the nose is the best preventive, and should be frequently applied during the summer months. This may be done by sprinkling some meal or salt over the tar in a trough when the sheep will apply it themselves as they eat the meal. Some farmers plow furrows in the pasture, to furnish the sheep a good place to bury their nose. The sheep grub is not fatal, but very disagreeable, and doubtless has a bad effect on the general health of infected sheep. If any one desires to study the grubs, he may find them in many of the heads of sheep killed at the shambles.—*American Agriculturist*.

THE ELEVATED CORAL REEFS OF CUBA.

By W. O. CROSBY, Proc. Boston Soc. Nat. Hist.

MR. CROSBY describes, in this paper, the elevated coral reefs of Cuba, and draws from them the apparently well sustained conclusion that they indicate a slow subsidence during their formation, and hence, further, that Darwin's theory of the origin of coral islands is the true theory. The lowest reef-terrace, of the northern side of the island, has a height of thirty feet, and varies in width from a few rods to a mile; it was once, plainly, the fringing reef of the shore. The second reef-terrace rises abruptly from the level of the lower to a height of 200 to 250 feet, and bears evidence of having been of like origin with the lower. The altitude of the third reef is about 500 feet; and the fourth has a height east of Baracoa, near the Yumuri River, "of probably not less than 800 feet." These old reef-terraces extend, "with slight interruptions, around the entire coast of Cuba; and in the western part of the island, where the erosion is less rapid than farther east, they are the predominant formation, and they are well preserved on the summits of the highest hills. Mr. Alexander Agassiz states that the hills about Havana and Matanzas, which reach a height of over 200 feet, are entirely composed of reef-limestone."

In the precipitous mountain call El Yunque (the Anvil), five miles west of Baracoa, reef limestone, 1,000 feet thick, constitutes the upper half of the mountain, the lower part, on which the reef rests, consisting of eruptive rocks and slates; and originally the upper limit of this modern limestone formation must have been 2,000 feet above the sea-level. Mr. Sawkins gives 2,000 feet as the maximum thickness of the Jamaica elevated coral reefs above the sea.

Evidence that the reefs were not formed during a progressive rising of the land is drawn from the thickness of the reefs. Mr. Crosby observes that the reefs reaching to a height of 500 and 1,000 feet—if not also that to a height of 2,000 feet—show, by the remains within them, that they were not made chiefly of reef-building corals, and hence, that they were not begun in deep water, as is assumed in the theory of Mr. Agassiz, but that they were made in shallow water during a progressive subsidence. Mr. Crosby concludes as follows:

"We have then apparently no recourse but to accept Darwin's theory as an adequate explanation of the elevated reefs of the Greater Antilles; and, therefore, to admit that

upheaval of this portion of the earth's crust has been interrupted by periods of profound subsidence, during which the reefs were formed. The subsidence of 2,000 feet, of which El Yunque is a monument, must have reduced the Greater Antilles to a few lines of small but high and ragged islands; and, as Mr. Bland has shown, this fully accounts for the absence in these immense tracts of all large animals, although they were abundant here in Pliocene and earlier times."

The writer adds here the following objections to the theory of the formation of coral atolls in deep waters out of the calcareous secretions of deep-water life: (1) It is very improbable that submarine eruptions ever make the large and well defined craters, like those of subaerial action, which are appealed to in order to explain the lagoon feature of atolls; (2) many coral atolls are twenty miles or more in diameter, which is vastly larger than the largest of craters; (3) the atolls are never circular, and the larger have the irregularities of outline or diversities of form characterizing other large islands of the ocean; (4) in the actual reefs and islands of the Fiji group (see the map of the Islands in the writer's Coral and Coral Islands), all the conditions, from the first stage to that of the almost completed atoll, are well illustrated, one island having only a single peak of rock within the lagoon, not $\frac{1}{100}$ of the whole area, which a little more of subsidence would put beneath the waters and leave the lagoon wholly free.—*American Journal of Science*.

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