The Progressive Science Series

Edited by F. E. BEDDARD, M.A., F.R.S.

(*American Editor*—Professor J. McK. Cattell)

A BOOK OF WHALES

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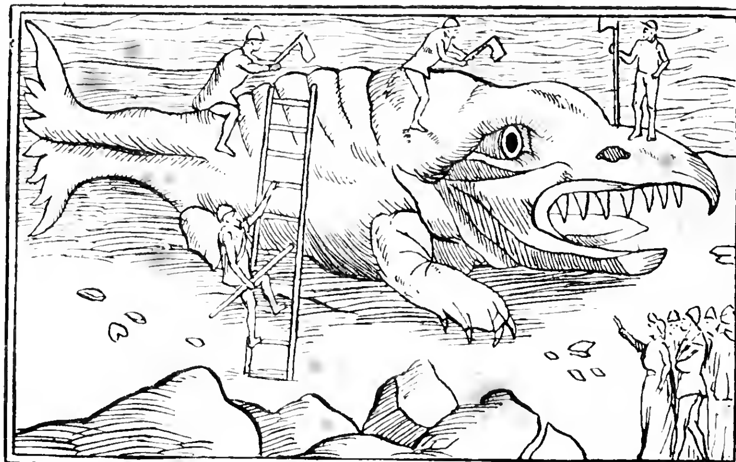

A Stranded Rorqual (?).

(From Olaus Magnus.)

Sidney Berridge

A BOOK OF WHALES

By F. E. BEDDARD, M.A., F.R.S.

WITH FORTY ILLUSTRATIONS BY

W. SIDNEY BERRIDGE

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PREFACE

SO far as I am aware there is no recent general work of a comprehensive kind dealing with the Cetacea in the English language. There are, of course, sections devoted to this group in many Natural Histories, such as the *Royal Natural History* of Mr. Lydekker, Cassell's *Natural History*, *The Standard Natural History*, etc., as well as the long section contained in Sir William Flower and Mr. Lydekker's *Mammals, Recent and Extinct*. I think, therefore, that there is at present a distinct gap to fill on behalf of those who would have in a comparatively small compass a general account of this group of mammals, and a selection of the voluminous literature which relates to that group. I have attempted to perform this task, and to steer a course between too much exposition of technical facts and a too popular account of whales. I have aimed at producing a solid book tempered by anecdote. It need hardly be pointed out that this book is not a monograph of the Cetacea; but on the other hand, I hope that at least the main facts of structure and mode of life of these creatures will be found in the following pages.

Whales are, from many points of view, so interesting and remarkable a group of animals, that no apology is, in my opinion, needed for devoting a whole volume to them. It may be suggested, however, that desirable though a book devoted to the whales may be, it has not a place in a series like the *Progressive Science Series*, which is devoted to the exposition of larger subjects than the present appears at first sight to be. It has, however, been my attempt in the present volume to endeavour to illustrate by means of the group of whales a very important biological generalisation, the intimate relation between structure and environment. No group shows this to a more striking degree than that with which I have occupied myself.

The section on the Delphinidae will, I fear, be found less interesting than those relating to other subdivisions of the whale tribe. They are not, as a rule, sufficiently well known to have accumulated much anecdote; and the structural differences present nothing of importance save to the systematist. However, it is clearly necessary to include them, as they form the bulk of the known Cetaceans. Their synonymy, too, is perplexing and far from settled. I have, as will be seen, followed True in the main, adopting some subsequent alterations of his views. As the present volume is not in any sense a catalogue of whales, I have forborne from giving a synonymy in the orthodox way; but I have mentioned most of the names which have been at one time or another applied to dolphins. Those who desire to pursue this portion of the subject further can refer to Mr. True's account of the family Delphinidae, which is frequently referred to in the text.

I may remark, finally, that a large number of the actual facts have been verified, and that here and there some small details appear which have not been hitherto recorded.

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INTRODUCTORY

THE subject of which the present volume treats is undoubtedly one of interest to the general public as well as to the naturalist. The huge size of many of these creatures, the rarity of the occurrence of some of them, and the mystery which envelops the habits of the great bulk of the species is attractive. Besides, to many people the whale is an ingenious paradox, by reason of the fact that it lives in the water and yet is not a fish. At no more remote a date than 1895, thought Professor Huxley,* this question of the fish-like nature of whales was not settled for many persons. Such persons, however, had on their side the naturalists of the sixteenth and even the seventeenth centuries, who classified whales with fish. Even so recently as 1818 (I quote from Sir William Flower) the current edition of *Johnson's Dictionary* defined a fish as an animal inhabiting the water; hence a whale undoubtedly coming under the

* Professor Huxley's doubts are borne out by a sage note to Milton's *Paradise Lost*, in a Clarendon Press edition of 1872. "By dolphins are here meant porpoises," observes the commentator; "the modern dolphin is another kind of fish." It would be difficult to embody in a single sentence more pretension to knowledge and more ignorance.

definition would be classified by the author of that dictionary as a fish. To the naturalist the remarkable adaptation to its mode of life with the resultant fish-like form is no less interesting. But no competent zoologist has any longer any doubt of the mammalian character of the Cetacea. It is even possible to assert that whales are remote from some of the existing and vanished groups of mammals, but the exact affinities of these creatures is a matter which is still disputed; there is thus a field for speculation which at present has hardly any limits. In cases of this kind new and important evidence may be forthcoming at any minute, which lends a particular fascination to the study of this group, much more than to the study of those groups whose affinities are more thoroughly known. The existing knowledge of this group is very far from being complete. From the nature of the case whales are exceedingly difficult to investigate. The opportunities for dissection are practically confined to stranded specimens, and the stranding of whales is not an every-day occurrence. Obvious difficulties, moreover, hamper the naturalist who is so fortunate as to receive timely information of the stranding of a desirable specimen. On the other hand, there is much more accumulated knowledge concerning the skeleton of the Cetacea; but even here there are many regrettable lacunæ, not only by reason of the frequent imperfections of the skeletons, but also by sheer lack of material in the case of many forms, particularly among the dolphins. The often fragmentary character of the available Cetacean remains, and the consequent and necessary inability to distinguish between what might be fairly regarded as real specific or generic differences and what were mere variations, led the late Dr. Gray to create a vast number of species and genera of whales; comparatively few of those new forms which he instituted are now allowed by the students of this group. Though doubtless a good many forms remain for identification and establishment, the total number of real species and genera of whales is a comparatively small one. This is itself an inducement to the study of the order, since it is possible to acquire a general knowledge of the whole group. The naturalist who hopes to have a thorough acquaintance with such an order as that of the Rodentia has much work before him. The student of the Cetacea, on the other hand, has to deal with not more than thirty-five genera and at most eighty species. It will be attempted to give the bulk of what is known concerning all of these in the present volume.

A BOOK OF WHALES

CHAPTER I.

THE EXTERNAL FORM OF WHALES

SIZE OF WHALES

SINCE the most obvious characteristic of the whale tribe is their large, occasionally colossal, bulk, we cannot do better than commence with this salient peculiarity. Whales vary in length, from barely four feet (*Pontoporia*)* to as much as 80 or 85 (*Balænoptera sibbaldii*). But their dimensions have been grossly exaggerated by modern writers as well as by the ancients, for whom there was more excuse. It is an unquestionable fact that no creature, known to science, ever existed† which was larger than the largest whale; even the colossal Dinosaurs of the secondary epoch fell some feet short of *Balænoptera sibbaldii.* As a consequence, size is the one thing

* Lesson saw a smaller dolphin still (which has been named *Delphinus minimus*), only two feet long. But more facts are wanted before this most dwarfish of Cetacea can be admitted.

† Unless the newly-discovered Dinosaur, referred to below under *Balænoptera.*

that is expected of a whale. Actual length measurements have been swollen by taking into account the bulging sides of the Cetaceans, and with this help some astounding dimensions have received the sanction of not specially credulous persons. One Octher, a Norwegian, reported to King Alfred that the best whales caught in his own country were as much as 50 yards long. This is some diminution from Pliny, who held that "in the Indian sea the fish called *balæna,* or whirlpool, is so long and broad as to take up more length and breadth than two acres of ground." Nine hundred feet is another measurement given by the same natural historian. But the size of whales by no means decreased with the advance of the centuries. Olaus Magnus allowed 960 feet in length to certain "hirsute" whales, but when the latter authority comes down to definite and recorded fact, he is more careful with such measurements. In a section of his well-known work Olaus Magnus figures a "monstrosus piscis," stranded on the northern shores of England in the year 1532, which was naturally regarded as a portent. This animal, or another seen by the archbishop on the Norwegian shore, was 90 feet in length, a measurement which may conceivably have been accurate, since it seems to have been a *Balænoptera*, which is known to reach 85 feet in length.

Apart, however, from all exaggeration, it is evident that whales are not only the largest of living mammals, but the largest of all animals, mammalian or otherwise, which have ever existed. It is interesting to inquire into the reasons for their excess of bulk over the animal world in general. There are various causes which seem to contribute to the acquisition of a mighty frame. In the first place, the medium in which the animal lives must have something to do with it. Aquatic creatures have naturally less difficulty in sustaining a colossal bulk than have animals which live in a less dense medium. We find, in fact, a distinct relation between size and habitat. "The blue shark, *Carcharias*," remarked the late Professor Milnes Marshall, "attains a length of 25 feet; specimens of *Carcharodon* have been measured over 40 feet in length; while of the genus *Rhinodon* examples of 50, 60, or even 70 feet in length have been described." Purely volant animals, bats, birds, and pterodactyles, have far greater difficulties in sustaining themselves in the air; hence these classes of animals are relatively small. We may believe in *Æpyornis*, but we cannot accept a flying Roc. The middle position is occupied by mammals, which require more muscular effort to stand or crawl than aquatic creatures, but not nearly so much as aerial. We find that their size is in correspondence. The Mastodon and the great ground sloths were larger than any pterodactyle or bird, but not so large as whales. The Dinosaurs are thought by some to have been at least partially aquatic, to have frequented at least marshes and estuaries. But, even if they were purely terrestrial, they do not acquire absolutely the same colossal dimensions as do some whales.

Not so intelligible as the last reason for enormous growth in size, but apparently to be proved by statistics, is the inference that large size is in proportion to the degree of organisation of the creature. The simplest of all living creatures, the Protozoa, are at the same time the smallest. Vertebrates grow to a larger size than Invertebrates, and finally Mammals, as represented by whales, grow to be the giants of the animal creation.

Another favouring circumstance to large increase in size is abundance, and easiness of capture, of food, as well as freedom from foes.

The tiger or lion, at the expense of great expenditure of force, hunts down an antelope or a deer, while the whale gulps in huge mouthfuls of "whale food" with ease and comfort. Protected by its thick covering of fat, it does not readily fall a victim to any foes; indeed, the only powerful enemy that it has at all is the Killer whale, *Orca*, and it is not always that a Greenland whale succumbs to a shoal of those marine tigers. An ingenious suggestion has been made, which covers some of the apparent exaggerations in the dimensions of whales attributed to the ancients. M. Pouchet* thinks that, since in old times whales were not hunted, at any rate to the extent that they are now and have been lately, they may possibly have had the opportunity of growing to larger dimensions. The sailor, Nearchus, is quoted by M. Pouchet upon the size of a *Megaptera* of the Persian Gulf—perhaps the

* *Comptes rendus Soc. Biol.*, 1890, p. 686, and 1892, p. 422.

Megaptera indica of M. Gervais referred to below. The Greek described it as 48 metres; but another rendering of the text says 23 metres, which, though large, is nearer to what we now regard as the truth.

SHAPE OF THE BODY

In their shape whales present a remarkable uniformity; indeed, next to bulk, this is perhaps their most salient characteristic in the popular mind. They are all "fish-like," with tapering body, big flukes, one pair of paddles, no apparent vestiges of hind limbs, no external ear, tiny eyes, and black or black and white colouration.

Contrast this state of affairs with what obtains in many other groups of mammals. Compare the sloth and the ant-eater, near allies in structure to each other. One is tailless, long limbed, short snouted, inactive, inconspicuously coloured, and with long, hooked claws. The other is bushy tailed, comparatively short limbed, enormously long snouted, vigorous in its motions, conspicuous in colour, owing to the broad white band upon its black body, and with strong, tearing claws. Or to take an example from another group of animals—what a large difference seems to separate the active, four-legged, brightly-coloured, green lizard from the snake-like, inactive, dully-coloured blindworm, and yet they are very closely allied.

But one very important reason for diversity in the two examples selected, and for uniformity in the case of the whales, will at once strike the reader. The whales live under like conditions; the other animals lead totally different lives. The sloth never leaves the trees to whose branches it clings by the help of its long curved claws, and upon whose leaves it browses. The ant-eater digs up with its sharp claws the firmly-welded ant-hills of tropical America, and licks up with its long tongue the ants which it thus disturbs. Whales, on the other hand, not only all live in the sea (or in rivers), but spend a great deal of their time below the surface, and are nearly all animal feeders. Moreover, it seems to be a well-established fact that the majority of whales range freely over wide stretches of ocean, the same species occurring in such widely-separated localities as Tasmania and the coast of Britain (*e.g.*, the Sperm whale), while some perform regular migrations. Hence diverse temperatures can have but little effect in producing differences. It is an interesting fact to note that those whales which are restricted in their range are at least often more different from their allies. The members of the family Platanistidae are restricted in range, and show differences among themselves. No one could confound the *Platanista* of the Ganges with *Inia* of the Amazons. Beluga and *Monodon* are peculiar types, and they are both Arctic in habitat. We cannot, however, push this matter further, since, as is the case with most general statements, there are exceptions. Among these exceptions we may note the Greenland Right whale, which differs but slightly from the widely distributed *Balæna australis*, or *biscayensis* as it is sometimes called.

THE TAIL

The "flukes" of the whale, which form its tail, are set, as everyone knows, at right angles to the plane of the body, and not vertically as in fishes. It has been noticed by several that the two halves of the tail fin have surfaces which are not precisely parallel to each other. They have, in fact, a screw-like form —one half being convex upwards, the other concave; and the use of the flukes seems to imply such a conformation. Captain Scoresby observes of the Greenland whale that it is "by means of the tail principally that the whale advances through the water. The greatest velocity is produced by powerful strokes against the water, impressed alternately upward and downward; but a slower motion, it is believed, is elegantly produced by cutting the water laterally and obliquely downward, in a similar manner as a boat is forced along, with single oar, in the operation of sculling."* It is the latter motion, of course, that would be brought about by the slightly screw-like form of the tail fin. The tail, however, is also used in balancing, as a whale when dead falls over on its side. They are also of service in turning—and indeed as a weapon of offence for striking boats. This seems to be deliberate in the case of the Californian whale. (See p. 170.)

A dissection of the tail shows a beautiful and elaborate complex of tendons, which are attached to

* Dr. Murie (*Proc. Zool. Soc.*, 1865, p. 210) says the same of a living porpoise at the Zoological Society's gardens.

the muscles of the trunk. These run in all directions, and so account for the varied movements of the organ.

There are diverse opinions as to the nature of the whale's tail. The late Dr. Gray was strongly of opinion, as are or were some others, that this organ is to be looked upon as the degenerate equivalent of the posterior pair of limbs.

It must be admitted that there is a *primâ facie* possibility in favour of this view, which is not unattractive. We should have on this hypothesis the whales exhibiting the last term of a series commenced by the sea-lions. It has been also pointed out that the backwardly-directed rudiments of the bony hind limbs conform to such a way of regarding the matter. It seems as if they had shrunk while the folds of the integument originally connected with them had remained, forming the flukes. There are not wanting analogies to support this theory. It is known, for instance, that there are, as a rule, fewer rectrices (tail feathers) in modern birds than in *Archæopteryx*, where each of the free caudal vertebræ supported a pair of these strong feathers. In modern birds the rectrices are all attached to the terminal ploughshare-bone of the tail, which is produced by a fusion of not more than six or seven vertebræ. Now as there are occasionally more than six or seven pairs of rectrices, it looks much as if the epidermal structures had remained while the corresponding skeletal structures had vanished. Again, to take an example from a widely different class—there is a

PLATE I.

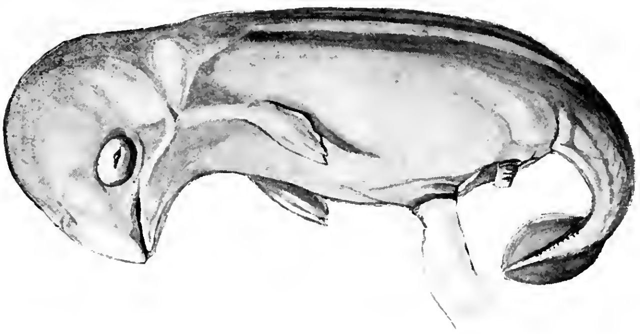


FIG. 1. Embryo of Porpoise to illustrate form of Tail.
(From Kükenthal.)

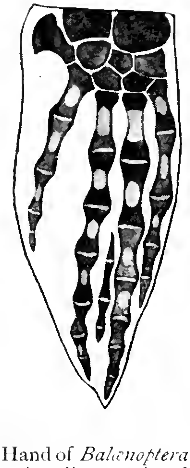


FIG. 2. Hand of *Balænoptera musculus*, showing disappearing finger.
(From Kükenthal.)

FIG. 3. Hand of Beluga, showing commencing bifurcation of finger.
(From Kükenthal.)

[*To face page 9.*

lamprey with a pair of skin folds in the neighbourhood of the vent, which are believed by some to represent a pair of otherwise missing hind limbs. Apart from these folds there is no trace of limbs, no skeletal elements that is to say.

Plausible though such a derivation of the flukes of the whale may be, there are arguments which seem to be absolutely fatal to their entertainment. The tail (of *Phocæna communis*), when it first appears, is a prolongation of the body sharply marked off from the body, and precisely, so far, like the tail of a typically-tailed and terrestrial mammal. This tail has at first practically no lateral flanges. When these put in an appearance they are obviously lateral expansions of the integument, and the tail has a diamond-shaped outline; it is indeed not unlike that of a Manatee in general shape.

It is interesting to note this fact, for the Manatee is clearly an animal whose ancestors were less remotely terrestrial in habit. (See p. 90.) Finally, the characteristic flukes of the adult are acquired. But the argument which seems to conclude the matter is that in this same porpoise, coincidentally with the appearance of the lateral flanges of the tail (the supposed hind limbs, be it remembered), distinct traces of those same hind limbs are visible in their proper place, that is to say, considerably in front of the tail.

If a further argument in the same direction be wanted, it is afforded by the analogy of the *Ichthyosaurus*. These aquatic reptiles have been lately discovered to have possessed a dorsal fin not unlike that of the whales, and a caudal fork which, unlike that of the whales, was vertical in direction. Now the *Ichthyosaurus* had undoubted hind limbs, so that there can be no question of any correspondence here. The fact, therefore, that the whale's tail, unlike that of the fish, is at right angles to the axis of the body, and so far resembles the complex "tail" of the seal is no argument, even from analogy, in favour of its having a limb-like character. The *Ichthyosaurus* has no more right to a tail than the whale, save by virtue of its being an aquatic creature; the tail is in both a secondary adaptation to the needs of their existence.

We must look, as Dr. Kükenthal remarks, to the broad tail of the beaver for an analogy to the flukes of the whale.

It is, however, somewhat astonishing to find that the whale, unlike the *Ichthyosaurus*, which is with equal certainty derived from a terrestrial ancestor, has transverse tail fins; astonishing, since the universality of a vertical fin in fish seems to argue its greater use as a swimming organ. The only conclusion to which this question seems to lead is that reptiles, that are not so thoroughly modified for an aquatic life as the *Ichthyosaurus*, and are yet largely or entirely aquatic, such as crocodiles and sea-snakes, have a vertically compressed tail, while among mammals it is generally flattened from above downwards in such forms, instances of this being the beaver and the platypus. But this is not universal, only prevalent, for in the West African insectivore otter (*Potamogale*) we have a vertically compressed tail. It is possible that we may be justified in putting the question out of the category of a "whale question" by adopting the belief that whales have been derived from Sirenian-like ancestors.

Perhaps the ingenious Ray was nearer the truth when he wrote that, "In Cetaceous fishes . . . the tail hath a different position from what it hath in all other fishes; for whereas in these it is erected perpendicular to the horizon, in them it lies parallel thereto, partly to supply the use of the hinder pair of fins which these creatures lack, and partly to raise and depress the body at pleasure. For it being necessary that these fishes should frequently ascend to the top of the water to breathe or take in and let out the air, it was fitting and convenient that they should be provided with an organ to facilitate their ascent and descent as they had occasion." There can indeed be no reasonable doubt but that this is an important function of the whale's tail. It remains under water for a long time—until the air taken in by respiration is exhausted; it must then rapidly ascend to the surface, perhaps from a great depth, to take in a fresh supply. An air-breathing creature must be in touch with the air. A powerful series of strokes with the flukes would cause it to ascend with great rapidity. But the *Ichthyosaurus* was also an air-breathing creature, at least so we must assume from its place in the class of reptiles; it is, of course, conceivable, even probable, that it may have possessed accessory respiratory organs in the shape of vascular fringes, such as certain aquatic tortoises have at the present day. But no doubt can exist as to the possession of lungs. Therefore the extinct "fish lizard" also must have come to the surface of the Cretaceous seas to "spout."

But its tail is fish-like in its verticalness; and, if we are to suppose that it resembled the whale in its diving and ascending to the surface, it is difficult to understand how it is that the tail is not made after the best pattern for affecting such movements. As a matter of fact it seems, according to Professor Ahlborn, that the *Ichthyosaurus* tail was suitable to a life of constant interchange between air and water, but in a different way from that of the whale. Dr. Ahlborn has remarked in a recent and highly interesting paper * that the *Ichthyosaurus* and the shark stand in regard to their tail at the two opposite poles of aquatic creatures. They both possess what is termed in the fish a "heterocercal" tail. This kind of tail is marked by the fact that the backbone is continued into the edge of the actual tail fin, the upper edge in the case of the shark, the lower edge in the reptile; so that in both cases the bulk of the actual fin itself lies either above or below the strengthening bar of bones and cartilages. It is suggested that the "epibaty" or "hypobaty" of the tail corresponds to a different function in the two cases.

In the shark the movements of the body generally

* "Ueber die Bedeutung der Heterocerkie," etc., *Zeitschr. wiss. Zool.*, lxi., p. 1.

and of the tail would tend to move the fish downwards; in the "hypobatous" tail the movements of the tail would raise it, and thus depress the head; and in consequence the direction of progression would be away from the air—a state of affairs which is precisely what the shark would want. On the other hand, the same movements of the epibatous tail would tend to direct the course of the reptile towards the surface of the water; so that, after all, the *Ichthyosaurus* has a tail which is as useful, or nearly so, for enabling its possessor to get quickly to the top of the water, as are the horizontal flukes of the whale.

DORSAL FIN

Most whales have a fin on the dorsal side of the body, nearer to the posterior than to the anterior end of the body. The resemblance of this fin to the similarly placed dorsal fin of fishes is obvious. It has even been asserted that there are two dorsal fins in some whales; but the existence of a second and of a fish-like anal fin seems to be purely mythical. This fin is especially analogous to the fatty fin of the Salmonoid fishes. It is not, however, present in all whales, and, when present, is of very varying size. According to Kükenthal the fin is not present in the young embryo of those whales which will eventually have a fin. But it is represented by a long dorsal fold reaching back to the flukes. This structure appears to persist in *Monodon.* The series of low, irregular humps which take the place of the dorsal fin in the Sperm whale may also be ascribable to the retention of an embryonic condition.* In *Delphinapterus* and *Neomeris*, which are finless in the adult condition, there is simply a low ridge in the embryo. There is an ascending series in length of the dorsal fin, when it is fully present, as in most Delphinidae, which culminates in *Orca*, where the fin is so large as to sometimes lie over at the top to one side. So high and pointed is the dorsal fin of this fierce Cetacean that it has been figured as a sharp horn capable of sticking into the body of the whalebone whale, which this creature persecutes. The function of the dorsal fin seems to be that of a balancing organ; and it is important to notice that it is at its largest in the swift and carnivorous *Orca*.

Dr. Murie is inclined to see in the dorsal fin a representative of the hump or humps of the camels and zebu.

Such evidence as there is of the existence of two dorsal fins consists in the first place of some observations made by MM. Quoy and Gaimard during the voyage of the French ship *Uranie*. The testimony of such observers must not be lightly rejected; it will be better to leave them to tell their own tale: "In the month of October, 1819, going from the Sandwich Islands to New South Wales we saw in latitude 5.28 N. a number of dolphins performing their rapid evolutions round the ship. Everybody on board was surprised to see, as we did, on the

* The dorsal fin of *Ichthyosaurus* was curiously like that of the Sperm whale in this particular.

forehead a horn or fin curved backwards, similar to that upon the back. The size of the animals was about double that of the common porpoise, and the upper surface, as far as the dorsal fin, was spotted black and white. We carefully examined these dolphins for the whole time that they accompanied us; but, although they passed close enough to touch the prow of our corvette, having the highest part of the body out of the water, their head was so deeply plunged below the surface that M. Arago (the draughtsman of the expedition) and we ourselves were unable to distinguish whether the snout was long or short." They called this animal "Le Dauphin rhinoceros." The relation of these gentlemen gains support from some observations of Rafinesque, who recorded a dolphin from the Sicilian coast also with two dorsal fins, and which he named "Mongitore." Further than this, Mr. Couch was "informed that a dolphin with two dorsal fins had been observed in April, 1857, on the coast of Cornwall." (GRAY, *Catal. Seals and Whales*, p. 267.)

These dolphins, or whatever they were, must, however, remain problematical for the time being. But there is clearly a case which cannot be absolutely ignored, and there is no inherent improbability, especially when we remember the series of low humps upon the back of the Cachalot.

THE PECTORAL FIN

The flippers of the whale correspond of course to the anterior pair of limbs in other vertebrates. Whales have only the rudiments of posterior appendages. The limbs vary much in length and shape, being sometimes rounder and sometimes longer and narrower. The tip may or may not be curved round the appendage, in the former case acquiring a falcate form. The limbs of whales do not seem to be much used for progression. They are rather used as balancers, and thus resemble the anterior fins of fishes. Scoresby studied the action of the fins through a telescope, and came to the conclusion that they were balancers; and besides, when a whale is dead it heels over on to the side, a fact which seems to be a further proof that this is the function of the flippers.

The superficial likeness of the whale's flippers to the fish fin has been mentioned. It is exceedingly interesting to find that there are deeper seated likenesses; these are of course coupled with essential similarities to the hand of the mammalia; and by comparing the two series of facts with each other, and with facts derived from the study of other aquatic creatures, such as the seals on the one hand and aquatic reptiles, such as *Ichthyosaurus*, on the other, it seems possible to extricate characters that are due to the aquatic mode of life.

It will be necessary, however, to preface the description of the actual facts in the structure of whales, with which we are concerned in the present chapter, with a brief account of the essential likenesses and the essential unlikenesses between the fins of fishes and the limbs of higher vertebrates.

The fins of fishes consist of a number of cartilaginous pieces arranged in rows of which the proximal one to four are larger than the rest, and articulate with the shoulder girdle or the pelvic girdle as the case may be. The cartilaginous, or bony pieces, are continued on at their ends by the horny fin rays which extend to the end of the fin.

The number and arrangements of these various cartilages or bones is naturally subject to some differences in different fishes. It is not our object, however, here to do more than to call attention to the essential features in which the fins of fishes differ from the limbs of the vertebrates which lie higher in the scale. The fish fin is termed the "Ichthyopterygium" to distinguish it from the limbs of all vertebrates higher than fishes which possess what is called the "Cheiropterygium." The actual facts of difference are these:

The cheiropterygium, or hand-like limb, always consists of a proximal bone, the humerus or femur, which alone articulates with the shoulder girdle or pelvic girdle; this is followed by two bones, the radius and ulna (in the hind limb the tibia and fibula); after this follows the carpus or tarsus, composed of a varying number of small bones or cartilages; then follow the fingers or toes, composed of a varying number of bones—there are never more than five fully-developed fingers or toes, and often there are less; but rudiments of one or two additional digits are believed to be represented by certain supplementary bones at the side of the first and of the last digit.

In the ichthyopterygium, or fish fin, there is no such clear distinction into the several regions which characterise the cheiropterygium. The whole limb is shorter, and often two or more pieces articulate with the limb girdle. The distal cartilages are generally more numerous than five; but they are not so much subdivided as they are in the cheiropterygium into a series of pieces following one another. It is not possible in the ichthyopterygium to recognise clearly the several regions of the cheiropterygium —arm, forearm, wrist, digits.

Now there are two points in which the whale's hand and arm have come to be slightly modified in the direction of the Ichthyopterygium. In the first place the distinction between hand and arm is commencing to vanish. The proportions between the bones is not so unequal as in typical mammals. The radius and the ulna are short bones, and there is less distinction between the bones of the carpus and the ensuing metacarpus than is seen in terrestrial mammals. This modification, however, has not gone very far. As may be seen from the drawing on p. 25, it is still perfectly easy to distinguish the several elements of which the arm is made up. It follows from this that the hand proper is larger in comparison with the arm than it is in terrestrial mammals. This is precisely what is found in the ichthyopterygium. We may regard, perhaps, the larger cartilages which articulate with the shoulder girdle as corresponding with the humerus, radius, and ulna. The commencing disappearance of marks of distinction between the different elements of the arm is, of course, correlated with the absence of a differentiation of function between its several parts. A broad fin, like that of a fish and of a whale, would be as efficient if there were an absolute similarity between its several cartilages as if there were a differentiation.

The second point of likeness is not shown in all whales. In Beluga, however, the last finger is divided into two fingers, incompletely it is true, but still the division is plain enough. This is a step in the direction of the polydactylous fin of the fish. In no whale, however, is this feature of resemblance shown to a greater extent. (Pl. I., fig. 3, p. 9.)

Together with these points of likeness, not numerous or strong, it must be admitted, are obvious points of difference. The increased surface of the whale's paddle, desirable in an organ used as a fin, is affected in a different way from the fin of the fish.

In the whale the area is increased, not much by a multiplication of the fingers, but by their spreading out in a divergent fashion, so as to require a larger skin area, and by the increase of their length caused by the reduplication of the finger bones. The phenomenon known as "Hyperphalangy" is usual in whales. The typical mammalian foot or hand is composed of digits which have but three phalanges, the thumb indeed possessing but two. In whales the number of phalanges may reach so great a number as seventeen. In the fish fin, on the contrary, the required area is obtained: firstly, by the multiplication of rays, and, secondly, by the continuation of the fin as an expansion supported by the horny or calcified fin rays, which have nothing to do with the cartilages of the fin, but are exoskeletal structures. Rarely, as in the Batoid fishes (Skates), the cartilages of the fins increase and the horny fin rays disappear.

The closest analogy with the whales is offered by those extinct aquatic reptiles, the *Ichthyosauria*. Like the whales, they are clearly to be derived from terrestrial reptiles; there is no suggestion that is at all tenable that they have sprung separately, on their own account, from fishes. Their hand is still further advanced than is that of the whale, but along the same lines. There are, it is true, only five fingers, of which the last is split into two, so far resembling the whales; but the number of phalanges is great in all these fingers; not only is the hyperphalangy of the ichthyosaurian manus more pronounced than is that of the Cetacea, but the individual elements are less separable by their distinctive characters. A recognisable humerus is followed by a series of bones which can hardly be classified into radius and ulna, carpus and metacarpus, by their position and relations, so much alike are they in general appearance.

But it must be noted that the number of phalanges in any given digit is not greater than what is to be met with among the whales.

"This," observes Prof. Kükenthal, "is a case of convergence, of which no better example could be imagined." In two groups of animals so remote in the vertebrate series as are the whales and Ichthyosaurs we have a modification into a paddle which has proceeded along precisely the same lines, only carried further in the reptile than in the mammal. It will now be interesting to inquire to what degree the limbs of other aquatic animals that have been derived from terrestrial ancestors resemble the fins of the whales. We naturally turn first of all to the Sirenia and to the Seals and Sea-lions.

In comparing the pectoral limb of the whales with the ichthyopterygium and with the paddle of the *Ichthyosaurus*, it was unnecessary to point out the absence of nails upon the former; for the presence or absence of these structures does not bear upon the question of comparison in those two cases. But the absence of nails must be mentioned in comparing the whale's flippers with the limbs of Manatees and Sea-lions; for the more perfect adaptation of the whales to an aquatic existence has led to the total disappearance in the adult of all traces of nails upon the digits. But Dr. Kükenthal has found rudiments of these structures in the fœtus, as has also Leboucq. These structures consist of a thickening of the epidermis, which is situated above the last phalanx.

Now in the Sea-lions and Seals nails are fairly well developed; but they do not lie at the extremities of the digits to which they belong; they are situated some way in front of this point, and the limb is continued beyond them as a cartilaginous rod, not divided up into separate phalanges. It seems, therefore, that this cartilaginous continuation, superadded to the bony phalanges which lie on the proximal side of it, can have nothing to do with the hyperphalangy of the whales. But the explanation, or attempted explanation, of hyperphalangy is a matter which will be treated of presently. As to the Manatee, nails are present or absent, evidently therefore on the wane, as might be expected in marine, or at least aquatic, animals, which have been longer denizens of rivers and the sea than have the Sea-lions; longer in all probability, that is to say, since their adaptation to the aquatic life is more complete. *Manatus inunguis* is so named on account of the total absence of nails upon the hands; this has been noted by several writers, and there can be no doubt about the matter. Now it is precisely in the group of the Sirenia that hyperphalangy is also met with, but to a very small extent—nothing like what we find among the whales. Finally, among the Amphibia the same phenomenon is met with, so that the occurrence of hyperphalangy may, as it seems, be fairly set down to the need for an increased surface of hand to form a competent paddle. A very singular fact about this hyperphalangy in the whales is the existence of more numerous phalanges in the young than in the adult. Thus in *Phocæna communis* the phalangeal formula of an embryo seven cm. long is I. 3, II. 8, III. 9, IV. 5, V. 4; of an adult, 2, 8, 6, 4, 2 are the figures. This looks as if the adaptation to an aquatic life had, as it were, at first overshot the mark, the reduction taking place later; that the creatures started with too ample a provision for its needs, to be later curtailed. Or, indeed, it seems more likely that the pectoral fin was originally a swimming organ, and is now reduced to a mere balancer. The degenerating muscles argue the same way.

The hand muscles of *Balænoptera musculus* are in all four. On the extensor side, *i.e.*, the "back of the hand, is a single extensor, the extensor communis digitorum." This has a short muscular head arising between the radius and ulna, it soon passes into tendon, and on the wrist divided into four tendons, one for each finger. On the opposite side of the hand are three muscles; two of these, the flexor profundis digitorum and the flexor longus pollicis, join together by their tendon, and then split up into four tendons for the four digits. The fourth muscle is the flexor carpi ulnaris; it runs from the ulna to the pisiform bone in the wrist. We should, therefore, consider the pectoral fin as an organ which has undergone a change of function. Originally a paddle, large size—mainly brought about by hyperphalangy—was necessary to it. The assumption of this function by the tail led to a reduction in the hand, which has progressed very much further in some whales than in others.

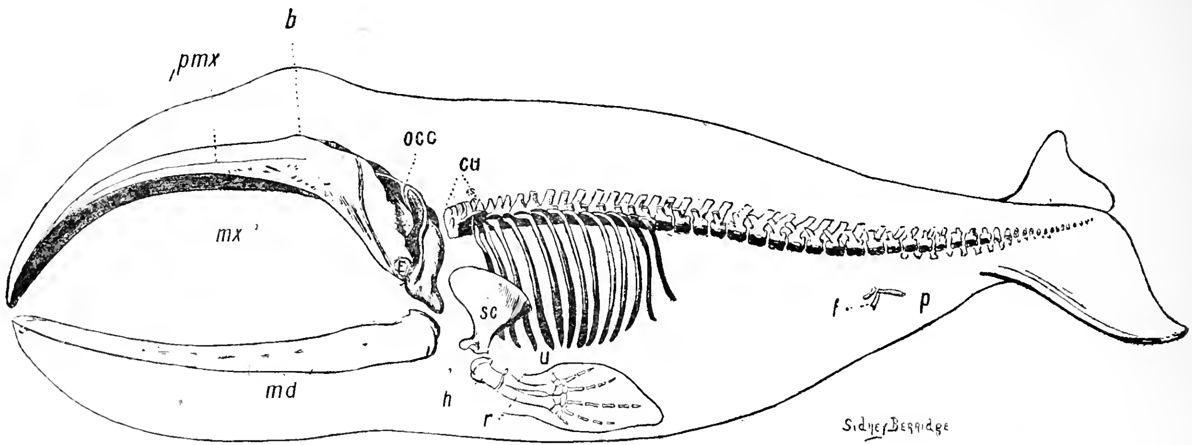
HIND LIMB

Traces of a hind limb have been found in many whales; it is possibly represented in all; but it has not been discovered in a good many. Of all whales, whose structure is known best, the hind limb is less reduced in *Balæna mysticetus*. This is rather a curious fact in view of the usual opinion that the Right whale, and indeed the whalebone whales generally, are the most modified of existing Cetacea. Nevertheless in that whale there is a single bone representing the pelvis, and there are in addition small pieces of a bone or cartilage, which correspond respectively to the femur and to the tibia. The femur is ossified—is some 4 to 9 inches in length. The tibia is only cartilaginous. In the rorquals there is an instructive series of stages in the reduction of the hind limb. In *Balænoptera musculus* the femur is represented by a spherical bony nodule, first discovered by Sir William Flower; in *B. borealis* and *B. rostrata* no traces of a femur appear to exist. The actual limb itself does not appear to be represented in the toothed whales.

It is the general view that the curved bone, which is all that is left of the actual pelvis, is the homologue of only one of the three bones, out of which each half of the pelvis is formed in terrestrial mammals. It is considered to be the equivalent of the ischium, mainly on account of certain muscles which are attached to it. Added to this, stress has been laid on the fact that it ossifies from one centre only and

Fig. 4. Skeleton of Right Whale

(From Nat. Hist. Mus. "Guide").



b, blow hole; *pmx*, premaxilla; *mx*, maxilla; *md* mandible; *occ*, occipital; *ch*, cervical vertebræ *sc*, scapula; *h*, humerus; *r*, radius; *u*, ulna; *p*, pelvis; *f*, femur.

not from three, as might have been the case were it the equivalent of the three bones—ilium, ischium, and pubis, which constitute the normal mammalian pelvis. Professor Delage has ingeniously argued in favour of the theory that the single bone of the Cetacea represents the entire series in the ordinary mammals.*

The continuity of the partly bony, partly cartilaginous mass is not necessarily fatal to the view; for where there are three separate bones (not to mention the small cotyloid) the cartilage which they replace is at first a perfectly continuous mass; and as to the appearance of but one centre of ossification in this mass which gradually invades the whole, or nearly the whole, it may be that prolonged investigations will show that there are other ossifications; and in any case it might be that the whole mass being so reduced had only room, so to speak, for one centre of ossification. In any case there is a considerable superficial similarity between the small pelvis of *Balænoptera* and the fully developed pelvis of other mammals; there is a forward extension suggestive of an ilium, a downward process which might do duty for a pubis, and a hollow in the middle of the bone which is not at all unlike the glenoid cavity; in this, indeed, the rudimentary femur is lodged. The question is interesting as a general example of what happens when reduction through degeneration takes place.

We shall recur to it presently, and in the meantime

* *Arch. de Zoolog. Experimentale*, 1887.

deal with one or two other points in the structure of the hind limb. In *Balænoptera musculus* the rudimentary femur is attached to the pelvis by two ligaments, one anterior, and the other posterior. In these ligaments rudiments of muscle appear in the shape of a few fibres. The actual correspondence of these muscles with those of terrestrial mammals depends of course on what view is taken of the homologies of the ischium. If the pelvis is simply an ischium, then the arrangement of the bands of ligament would seem to show that of all femur left is the great trochanter, a process of that bone particularly well developed in many mammals. In *Balæna mysticetus* there are three recognisable slips of muscle.*

HAIR

One of the most universal definitions of the mammalia is the possession of a hairy covering. No other animals have any epidermal structures which are strictly comparable to hairs; and hairs are present in almost all mammals. The whales indeed are the only exception to the universality of this statement, and they are, after all, only a partial exception. The White whale, Beluga, and the Narwhal, *Monodon*, appear never to possess any hairs, either as adults or fœtuses. But in many other species hairs have been found to persist in the adult condition sometimes in diminished numbers;

* STRUTHERS, "Rudimentary Hind Limb of a Great Finwhale," *Jour. Anat. Phys.*, xxvii., p. 291.

in others, there are hairs in the fœtus, but none in the adult animal. These hairs are, however, entirely limited, in every case, to the jaw region, and are so few that they can be, and have been, counted. Thus in the common Porpoise there are but two on each side in the fœtus. The adult *Balænoptera borealis* has, according to Dr. Collett,* twenty-six. Some additional facts will be found below in the systematic part of the present volume. The most noteworthy point, however, about these hairs, next to the scarcity of them, is the fact that they seem to be in all cases rudimentary. A careful investigation of the structure of the skin has shown Dr. Kükenthal that the hairs of whales are entirely without those small glands associated with the hairs in other mammals, and secreting an oily matter for the lubrication of the hairs; these sebaceous glands, as they are termed, are not found in Cetacea at all. Their absence clearly denotes a degeneration in the hairs.

Now the question arises, Is this loss of hair a matter of aquatic life; is it in any way connected with their aquatic existence; or has it some other explanation? The usual view, of course, is that the hair is absent as not necessary to an aquatic animal; the use of hair is largely that of retaining the heat of the body. The loss of heat in whales is prevented by the thick covering of blubber as well as by the thickness of the skin itself. Thus a hairy covering would be unnecessary, and, perhaps, even in the way, though this is not so clear. For

* *Proc. Zool. Soc.*, 1886, p. 255.

whales, as a rule, do not swim very fast, and many hairy creatures like the otter do swim with considerable rapidity. The whales are the most purely aquatic of all mammals, and they are undoubtedly the least hairy; there seems, therefore, to be some connection between the two facts. But it must be borne in mind that in the Seals and Sea-lions there is an outer coating of fat, and yet the hair is retained, particularly, of course, in the species which furnish the sealskin of commerce, and which possess a soft, thick under-fur as well as a coating of coarser hairs. Among aquatic mammals, however, there appears to be an undoubted tendency to lose the hairy covering. Among the Sea-lions some do not possess the soft under-fur which makes the pelages of their allies so valuable; the hair is with them apparently becoming reduced. Then we have the Sirenia, Manatee, Dugong, in which the hair has almost disappeared. The Walrus is another case in point, and so is the Hippopotamus. But the latter instance is suggestive of another possible reason for the loss of the hairy covering in whales. There are several Ungulate types which have gradually got less hairy in the course of their evolution; the Elephants of to-day contrast, by their almost naked skin, with the Mammoth of the Pleistocene; the modern Rhinoceros is hardly more hairy, except, indeed, the Sumatran species; while there was, contemporary with the Mammoth, the hairy Rhinoceros. Another division of the Ungulates shows the same tendency; in the pig tribe we have the largely hairless Babyrusa, as well as the Hippopotamus already referred to. It is conceivable, therefore, that we have in the whales an exaggeration (of an Ungulate tendency), and there are some who would derive the whales from an Ungulate ancestry, as will be pointed out in more detail in a future chapter.

There is yet another possible explanation of the hairless condition of the whale tribe. Whales are at present smooth-skinned animals; a few exceptions will be dealt with on another page (p. 31). But there is evidence, which will be gone into on the page quoted, that the ancestors of whales had dermal scutes, forming an armature comparable to that of such a creature as the Armadillo. Now in that animal the hairs have become reduced; they have been replaced by the "scales," and there is no room for them except between the scutes. If the view be correct that the ancestral whales were creatures clothed with scutes, it is easy to see how the nude condition of the modern whales has been arrived at, for the original hairy covering would have been destroyed by the appearance of the scutes, and when these latter disappeared the hair would not reappear—at any rate, that is a legitimate assumption.

It must not, therefore, be assumed off-hand that the absence of hairy covering in whales is a simple question of their aquatic life.

DERMAL SKELETON

In smooth-skinned creatures like whales, without anything more than at most a vestige of the original mammalian hairy covering, it may appear at first somewhat unnecessary to devote a section to a subject with such a title as that selected to head the present page. Nevertheless, the interesting fact is true, that in two whales, at any rate, among living forms, considerable traces of a dermal armature exist, which seems to be fairly interpretable as a remnant of what seems to have been a more extensive armature of a similar kind in certain of the extinct Zeuglodonts. Some years ago (in 1865) the late Dr. Gray descried from the shores off Margate a porpoise, which he regarded as new, and described under the name of *Phocæna tuberculifera*, on account of the fact that it possessed "a series of spines on the upper edge" of the dorsal fin. Dr. Gray was not then aware that the same character occurs in the common Porpoise, that it had been noted so long ago as Pliny. The common Porpoise, in fact, is marked by this character, as is also *Phocæna spinipinnis* of Burmeister, and the allied, if not identical, genus *Neomeris phocænoides*. The latter animal has a more extensive series of these tubercles, which have been fully described by Kükenthal.* There are several rows of them running along the back (this genus has no dorsal fin), from not far behind the head to a point not remote from the

* "Walthiere," in *Denkschr. Med.-Nat. Gesells.* Jena, 1889.

commencement of the tail. In *Phocæna spinipinnis* there are more numerous tubercles than in *P. communis*, present on the back as well as on the front margin of the dorsal fin. Dr. Kükenthal has pointed out that these tubercles are especially large comparatively, and obvious, in the embryos of *Neomeris*, an important fact in view of their inheritance from a more completely armoured ancestor. These tubercles have a form which is indicated in the accompanying figure. (Fig. 7.) There is a more especially roughened area in the centre of each. The general outline is squarish. As will be also seen in the figure, these structures are by no means unlike scales. But the term "scale" is one which is often used in more than one sense; it is necessary to inquire as to what kind of scales these integumental tubercles of the porpoises are to be likened to. The scales of a lizard or a snake are simply horny thickenings of the epidermis; they are, therefore, not at all comparable to the scales of such a fish as the perch or pike, where the scales are calcified plates produced in the dermis lying below the epidermis. In other fishes, such as the sharks and rays, the scales are calcified structures produced by the joint activity of both epidermis and dermis. Professor Kükenthal discovered that the rudimentary scales of the common porpoise are calcified, and that the calcification is only met with in the dermis. It follows, therefore, that the rudimentary dorsal armature of the porpoise is comparable to the skin plates of an armadillo—to compare it with an animal that is nearer to it in the

PLATE II.

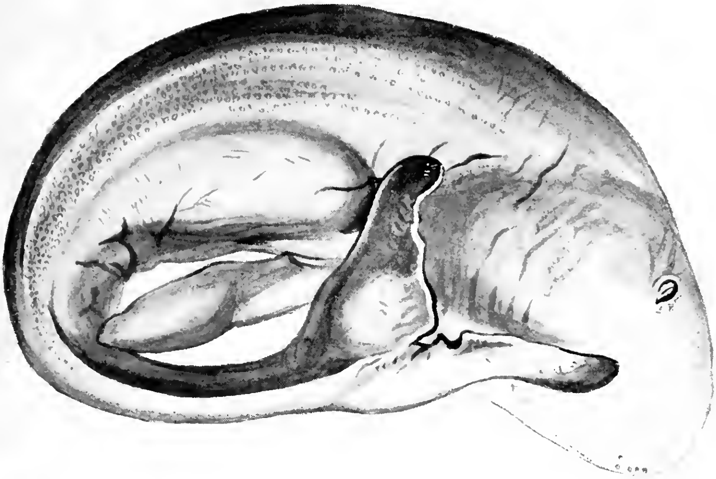


FIG. 5. Embryo of *Neomeris*, showing dorsal dermal plates. (From Kükenthal.)

FIG. 6. Portion of dorsal fin of Porpoise, showing dermal ossicles. (From Kükenthal.)

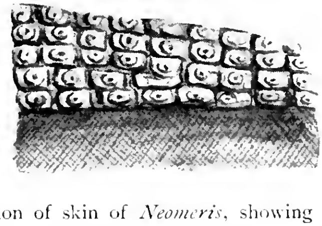


FIG. 7. Portion of skin of *Neomeris*, showing dermal ossicles. (From Kükenthal.)

[*To face page* 32.

series than any type of reptile or fish. Now although these structures are much reduced in the common porpoise, they are not really absolutely limited to the anterior margin of the fin as had been thought, for Professor Kükenthal made the important observation that here and there scattered over the general body surface on the ventral as well as on the dorsal side were similar, but rather more rudimentary, tubercles. It thus appears a fair conclusion that we have to deal here with a creature which has descended from an armoured ancestor, such as an armadillo. By this supposition it is of course not meant that the whales are the offspring of creatures exactly like the armadillo, or even referable to the same group of mammals —the Edentata—which includes that form; it is merely meant to suggest that their ancestors were as completely armoured as the armadillo. Nor is this mere theory.

It seems to be an undoubted fact that a fossil whale, called by Johannes Müller *Delphinopsis freyeri*, has its body covered in many regions with small, closely-set tubercles. These tubercles are described as being "harder than stone," and they must be comparable to the comparatively feeble tubercles which the descendants of this whale and its allies have retained to-day.

THE BLOW HOLE

The blow hole, or the blow holes (where there are two separate orifices), of the whale, are, of course, its nostrils. They are situated on the top of the head, as a rule some way behind the front of the head, except in the Sperm whale. This is in accordance with the aquatic life. We see in such diverse types as the Crocodile and the Hippopotamus analogous arrangements of the nostrils, which allow of the animal coming to the surface to breathe, and at the same time exposing the minimum of its person to possible enemies.

The blowing or spouting of a whale is, of course, the act of expiration; it takes place, as the whale reaches the surface or just before, after an immersion more or less prolonged. But the real nature of this process has received more than one false interpretation. Milton wrote—and probably many believe with him at the present day—of the whale who "at his gills draws in and at his trunk spouts out a sea." Olaus Magnus figures the spouting of a very large whale as a means of offence. His cut represents what may be a Sperm whale, maybe by reason of the teeth in the lower jaw only; a quite unnecessary frill of spines surrounds the head. But there are two spouts which overwhelm a ship whose bulwarks the whale has seized in his jaws. "The Physeter," observes this writer, whose Latin we attempt to translate, "raises itself above the masts of the ships and belches forth draughts of ocean from its blow holes in such a way that it overwhelms with this rainy cloud even the strongest ships, or exposes the sailors to the greatest danger." The older naturalists, including the archbishop from whom we have just quoted, regarded the blow holes as apertures additional to the nostrils. According to Professor Kükenthal it was the celebrated anatomist and embryologist, Karl von Baer, who in 1826 first showed clearly from anatomical considerations that the whale could not spout forth a volume of sea-water; the water which does actually leave the blow hole is simply the breath of the creature condensed, mingled often with a little of the surface water of the sea, which the whale disturbs by commencing the act of expiration when still a little way beneath the surface of the water. Rapp, however, deservedly considered an authority upon the Cetacea, went back to the earlier view, and held that the spouting was a means of getting rid of the abundant water taken in with the food. After this date there were recurrences to the correct view, and again lapses therefrom. There is now no doubt about the matter at all.

As to the actual structure of the blow holes there are some important facts which must be dealt with, though briefly. The internal part of the nose in man and in other mammals serves an olfactory as well as a respiratory function. The sense of smell is there located. In the whales this sense, as is evinced by the structure of the brain, is rudimentary or absent, and the nostrils therefore have but one function to perform, *i.e.*, that of taking in and expelling respiratory air.

Moseley ("Notes of a Naturalist on the *Challenger*") described the blowing of a hump back which followed the *Challenger* for several days in the South Pacific: "The appearance of a whale's spout as seen from the level of the sea is very different from that which it has when seen from the deck of a ship; it appears so much higher, and shoots up into the air like a fountain discharged from a very fine rose. The whale, of course, in reality does not discharge water, but only its breath; this, however, in rushing up into the air hot from the animal's body, has its moisture condensed to form a sort of rain, and the colder the air, just as in the case of our own breath, the more marked the result. When the spout is made with the blow hole clear above the surface of the water, it appears like a sudden jet of steam from a boiler. When effected, as it sometimes is, before the blow hole reaches the surface, a low fountain as from a street fireplug is formed, and when the hole is close to the surface at the moment a little water is sent up with the tall jet of steam. The cloud blown up does not disappear at once, but hangs a little while, and is often seen to drift a short distance with the wind. The expiratory sound is very loud when heard close by, and is a sort of deep bass snort, extremely loud and somewhat prolonged; it might even be compared to the sound produced by the rushing of steam at high pressure from a large pipe."

CHAPTER II.

SOME INTERNAL STRUCTURES

VERTEBRAL COLUMN

THE series of bones which constitute the vertebral column or backbone in the whales offer a number of peculiarities distinctive of the group.

Like all other mammals (with inconsiderable exceptions, Manatee, Sloth) the neck vertebræ are but seven in all. But in the whales these vertebræ are very generally partially or entirely fused together (Fig. 8), the degree of fusion also varying from species to species. Hand in hand with this melting together of the vertebræ goes a thinning of the actual vertebræ themselves, so that the neck region of the Cetacea is excessively short. They are the shortest necked of all mammals. It is, however, important to emphasise the fact that the mysterious and "perfect" number seven, which characterises all mammals (with the very few exceptions already noted), is preserved in these exceedingly short-necked creatures. It is by a reduction of individual vertebræ, not by a dropping out of one or more in the series, that the neck is reduced in length. At first sight it is tempting to put down the remarkable consolidation of these neck vertebræ to the necessity for holding up the heavy head of the great whales. And it is undoubtedly a fact that in the Right whales and in the huge-headed *Physeter* these peculiarities are seen in as exaggerated a form as anywhere. On the other hand, we must set against this the fact that in the great Rorquals there is usually a freedom between these vertebræ, which, in some species, is complete. A further consideration of the variations in the degree of fusion between the cervical vertebræ seems to point to the conclusion that the peculiarity is one which is, as it were, gaining ground, for the Platanistidae, which some other considerations lead us to regard as among the most primitive of existing Cetaceans, have all these vertebræ quite free; between this extremity and that offered by the Right whales are almost every possible step in the fusion of the individual bones; some, for instance, have two, three, etc., fused and the rest free.

In fact, it seems difficult to explain this anomalous state of affairs by any adaptation to a particular need. Nor is it possible to seek for any explanation of the peculiarity by looking for its occurrence in any possible allies of the whales. If it were suggested that the Sirenia are creatures which are, so to speak, on the way to become whales—which connect the whales with the terrestrial Ungulates—it might be urged that here, at any rate, is a trace of the same fusion of the neck vertebræ, for in the Manatee two of these vertebræ are thus fused. But we have, on the other hand, the Armadillos, where the same thing, precisely, occurs. And even in another group of vertebrates altogether, the Hornbill offers an example of a bird in which two of the cervical vertebræ are fused.

We shall deal presently with some facts in which the Dugongs and Manatees resemble the whales, but

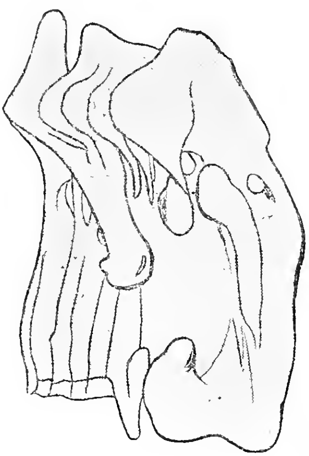


FIG. 8. CERVICAL VERTEBRÆ OF RIGHT WHALE.
(From van Beneden and Gervais.)

this view of the relationships of the whales is not one which at the present day commends itself to naturalists. It is a curious fact, however, that one of the most remarkable peculiarities of one of these Sirenia, the Manatee, *i.e.*, the dropping of one cervical vertebra, already referred to, is hinted at in certain whales. The late Dr. Gray used as a specific, and even as a generic, character the fact that in some whales the first rib is a double structure, looking like two ribs melted together, and that one part of this double rib is attached to the last cervical vertebra. This looks like a commencing dropping out of the last cervical vertebra from its own proper series; it has been partly, at any rate, transferred to the ensuing dorsal row. Another Sirenian feature in the cervical vertebræ of the whales is the slenderness of the cervical series. This is seen not in the Manatee, but in the recently extinct *Rhytina* of Behring's Straits; in that animal, however, the vertebræ are not in the least degree fused.

In all mammals, with the exception of the whales, the atlas is peculiar in that its centrum has broken loose, and has attached itself to the following vertebræ, the axis or epistopheus, from whose centrum it projects as the "odontoid process." In whales, as a rule, this process is entirely wanting, but it is a significant fact that the most considerable rudiments of it exist in *Platanista*, and among the Platanistidae, upon whose probably basal position among the Cetacea we have already commented. The dorsal vertebræ among these animals are of course those which bear ribs, and their number varies much from species to species, or from genus to genus. Nine to sixteen are the limits of variation. The curious divergences in the mode of articulation of the ribs serve to divide the Cetacea; and under the description of the Sperm whale, the *Inia*, and some other types, the differences are dealt with. It has been pointed out that the Cetacea differ from the Sirenia by the fact that the latter have but few lumbar vertebræ, while in the

Cetacea these same vertebræ are very numerous. But in *Inia* there are only three, a number which is repeated in the Manatee. In this connection it is interesting to recall the fact that in *Rhytina*, the most "cetacean" of the Sirenia, the lumbar region has increased to six vertebræ. As the pelvis (see p. 25) is so rudimentary a structure it is not surprising to find that there is no sacrum; no lumbar vertebræ are fused to make the complex and firm mass of bone which in terrestrial creatures supports the arch of the hind limbs.

As there is no sacrum it would seem at first a little difficult to define the commencement of the caudal series of vertebræ. Practically there is a difficulty, owing to the frequent incompleteness of skeletons in museums. But theoretically there is none, since the first caudal is provided below with a V-shaped appendage of bone, the intercentrum or chevron bone. Professor Delage has also pointed out that in *Balænoptera musculus* at any rate the lumbar series is defined by the termination opposite to the last one of the abdominal cavity.

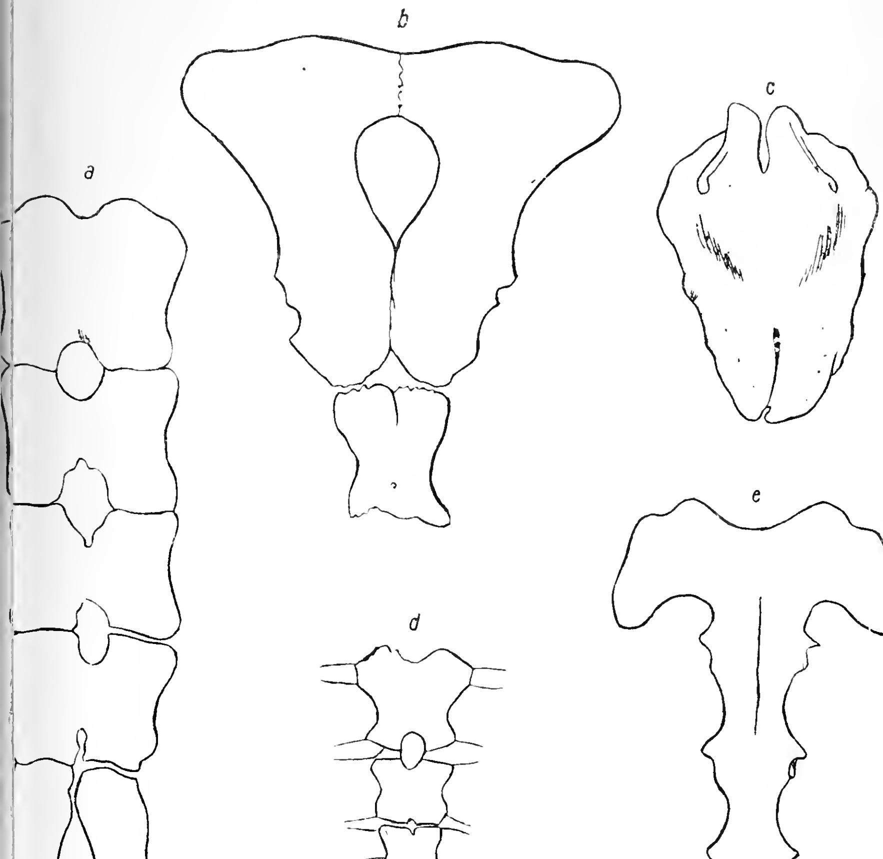
In terrestrial mammals there is not, as a rule, much "give" in the backbone. They cannot "wriggle" their bodies to any great extent. The reason for this is clearly the desirability of a firm support for the limbs by which locomotion is affected. This is brought about not only by the fusion of vertebræ in the region of attachment of the hind limbs to form the sacrum already mentioned, but elsewhere in the series the successive vertebræ are locked together by special joints, which, allowing of a certain amount of movement, curtail that movement within very narrow bounds. In some Edentate animals (Anteater, Sloth) these usual joints are increased by the presence of supplementary articulations between successive vertebræ, which renders the backbone of the creatures in question a much more rigid rod than it is in the majority of mammals. Now to the whale an eminently flexible backbone is obviously a desideratum. It moves mainly by powerful strokes of the tail and of the hind part of the body generally. Hence we find that the interlocking joints, the zygapophyses as they are technically termed, are much reduced, and indeed do not exist at all in the hinder part of the series, where their presence would interfere with the necessary undulations of body by means of which the whale forces its way through the water. Furthermore, a large development of the discs of fibrous tissue which lie between the centra of the vertebræ adds efficiency to this important part of the whale's skeleton. It is interesting to note that in *Platanista*, so frequently referred to as an archaic type of Cetacean, the interlocking of the vertebræ is much more marked than in other forms.

THE STERNUM

All whales possess a sternum or breast-bone. But the form of this bone, or series of bones as it actually is in many forms, varies (see Figs. 9, 10); and the variations concern us in the present chapter, inas-

Fig. 9. Series of Breast-bones of Toothed Whales.

(After van Beneden and Gervais.)



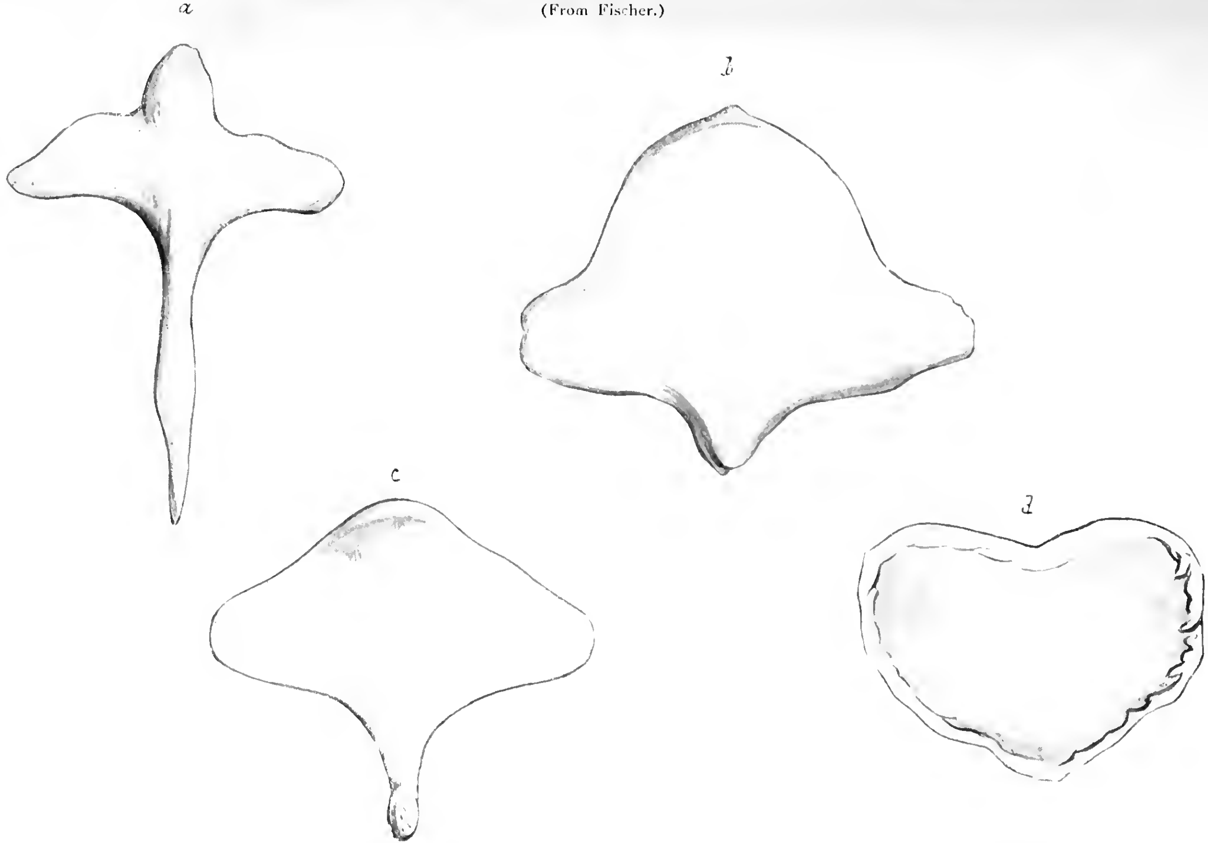
a. Berardius. *b.* Physeter. *c.* Inia. *d.* Hyperoodon. *e.* Delphinus.

much as they bear upon the broad lines of modification which these aquatic mammals have undergone in their gradual change and adaptation to a life in the ocean.

The typical mammalian breast-bone consists of a number of separate pieces of bone, often spoken of as "sternebræ," and forming a row along the middle line of the breast. Between each of these separate bones is inserted a rib. The number of pieces out of which the sternum is formed is sometimes very large; as many as fourteen elements occur in the Sloth (*Cholœpus*) for instance. Among the toothed whales the sternum shows what we must regard from a comparison with land mammals as the most primitive conditions. In *Berardius*, for example, the sternum consists of five pieces placed end to end, and these bear facets for six ribs. A very interesting feature of this sternum is to be seen in the fact that it is not only distinctly bifid behind, but that it is also somewhat incomplete in the middle line, gaps being left in the dried skeleton from which probably pieces of cartilage have dropped out. Now the interest of what seems to be a mere detail of anatomy is this: the sternum of mammals is developed from a fusion between the lower ends of the growing ribs; it is at first in two longitudinal pieces, and the ossification — the conversion into bone—of this cartilage is also double, paired centres of the deposition of bony matter appearing. Thus in *Berardius* (and in other forms) distinct traces of the original paired state of affairs are left. In other toothed whales the number of

FIG. 10. BREAST-BONES OF WHALEBONE WHALES.

(From Fischer.)



a. *Balænoptera rostrata.* b. *Megaptera "nodosa."* c. *Balænoptera musculus.* d. *Balæna biscayensis.*

[To face page 44.

pieces composing the sternum is reduced. In *Mesoplodon* there may be only four, and in the Sperm whale there are but three pieces; moreover, in this latter whale the double character of the sternum is especially obvious. Two of the three pieces out of which it is composed are paired bones, while the last shows some indications of a longitudinal division into two. A further shortening of the sternum is exhibited in the Cachalot by the fact that there are only four ribs which reach it.

These three types of Cetaceans seem to show that there has been a progressive shortening of the sternum. But the facts are not, it is hardly necessary to point out, conclusive as a demonstration of this probability. More certain evidence is afforded by the actual stages of development of the breast-bone of the common Porpoise. In this whale the actual proportions of the sternum during growth to the adult condition have been found to lessen in a marked fashion, which leaves no doubt that here at least the sternum is a part of the skeleton which is shrinking.

The extreme of the shrinkage of the sternum is realised in the whalebone whales, in which we have seen, and shall see, so many grounds for regarding as in many respects the most modified of whales. In these animals the sternum is reduced to a single piece, which is heart-shaped in the *Balæna australis*, and sometimes cross-shaped in the Rorquals; more generally it has in these latter Cetaceans the form of a T. With the sternum in these whales articulates but one pair of ribs, the first. It is a matter of interest to inquire into the exact nature of this simple bone, which is all that is left of the sternum in the Mystacoceti. In many mammals the sternum in the adult is no more than a single solid bone; but here the apparent simpleness of the sternum is due to the co-ossification of originally separate elements. The articulation of several pairs of ribs is a clue to the number of those elements. Now as in the Right whale and Rorquals but one pair of ribs articulates with the small sternum, we should infer that it is the front piece of the sternum—that piece which has been fancifully termed the manubrium—the handle of the sword-shaped sternum. It may be remarked here that the end piece of the sternum is generally called the processus ensiformis, or ensiform piece, thus completing the analogy derived from the comparison with the sword. It is extremely important to notice that there is evidence here too that the shortening of the sternum has really taken place, and that comparatively recently. In the first place, Sir William Turner found in that giant among giants the huge Rorqual, *Balænoptera sibbaldii*, a second piece of sternum identified by him with the ensiform cartilage, or xiphisternum as it is sometimes called; and, in the second place, the well-known cetologist —the late Prof. Eschricht, of Copenhagen—found in a whalebone whale that a fibrous band arising from the end of the sternum was attached to the second and third ribs. This is clearly a rudiment of a posterior prolongation of the sternum.

The question now becomes pressing, Is this shortening of the sternum a character of whales unconnected with anything in particular, or is it related to the aquatic life? The answer to this question is to be derived from two sources. We have first the argument from analogy. We can consider how far, if at all, the same kind of change has gone on in other aquatic creatures. The Seals and Sea-lions do not help us in the very least; but then it must be borne in mind that they are comparatively recent inhabitants of the water. The Sirenia, on the other, offer us a precisely similar series of stages. The "Morskaia korova," "Steller's sea-cow," or *Rhytina gigas*, had five pairs of ribs reaching the sternum; the Dugong of eastern seas but four; while in the Manatee the ribs are reduced to three pairs. The sternum, too, in these animals is naturally reduced in correspondence with the failing attachment of the ribs. But it is somewhat contradictory to bear in mind that the first two genera, the least modified as regards ribs, have a crescentric tail more like that of whales, while in other particulars —referred to on other pages—*Rhytina* is more whale-like than either of its congeners. To go to quite another group—to which we have often had occasion to refer in dwelling upon the peculiarities of whales—the Ichthyosaurians were devoid of a sternum, at least of an ossified one; and the same statement holds good for the Plesiosaurs. There would seem therefore to be some connection between the aquatic life and an absent or rudimentary sternum.

Dr. Müller, however,* would answer the question, which we asked some few lines above, in another fashion. He is of opinion that the whalebone whales breathe more with the thoracic musculature and less with the diaphragm than do the toothed whales. The diaphragm in them is not so purely muscular an organ as it is in those toothed whales in which it has been examined. Hence the greater part of the exertions requisite for inspiration are thrown upon the muscles of the trunk. The freedom of the ribs and a consequent shortening of the sternum is favourable to this supposed increased activity. It is also ingeniously suggested by the same authority that the whalebone whales, pursuing as they do minute prey instead of the comparatively large cuttlefish eaten by the bulk of the toothed whales, have to remain longer under water before they can obtain a sufficient supply of their food. The freedom of the ribs, etc., not only allows of a greater extensibility of the alimentary canal, but a greater expansion of the lungs, and, in consequence, a greater indraught of air. Whatever may be the explanation, however, the facts are as stated.

THE SKULL

The most obvious and the most remarkable feature of the whale's skull is its asymmetry in the toothed whales. So unintelligible does this aberration from what is normal in mammals appear to be, that it has

* Quoted on p. 54, where the connection between the respiratory organs and the dwindling sternum is further elaborated.

even been suggested that the peculiarity was originally a pathological state of affairs caused by injury, and that a one-sided face has been the consequent inheritance. One associates symmetry with vertebrate animals, and so especially with aquatic ones swimming head foremost through the water that symmetry would seem to be their most necessary attribute. It must be borne in mind, however, that the asymmetry is not nearly so apparent in the head when clothed with flesh. But the Sperm whale is markedly asymmetrical in the single S-shaped blow hole.

This absence of symmetry in the skull affects especially the pre-maxillæ and the nasals. The latter, indeed, are often reduced to a single very small bone. There is one toothed whale in which the asymmetry of the skull is not so hard to understand, that is, of course, the Narwhal with its one—rarely two—"tusk" projecting in front. This one-sided development could be readily imagined as having affected to a considerable degree the neighbouring parts of the skull. But we cannot assume that other toothed whales are the offspring of narwhal-like forms, though it is certainly true that the narwhal is in some respects a primitive whale. It is easier to say that the asymmetry, being, as it is, chiefly developed in the regions of the blow holes, has something to do with those structures, than to find any adequate reason for connecting the two.*

* Of course the unsymmetrical head of the flat-fish is not in any way comparable; in those fishes it is related to the fact that the sides of the body are used as dorsal and ventral surface respectively.

Seen from the ventral surface the whale's skull is quite symmetrical; this is the case even with *Kogia* and *Physeter*, which are the most asymmetrical of whales above. It is important to note that in the fœtus the asymmetry is less marked than in the adult. This leads us to the conclusion that the singular deformity of the head which characterises the toothed whales is, at least comparatively speaking, a new development.

The whale's skull also offers us an excellent instance of how great a departure from the typical appearance of an organ may be produced without any real change in its structure. There are no bones in the skull that are not found in other mammals, and none of the bones found in other mammals are wanting; and yet the skull as a whole departs widely in general appearance from that of other mammals.

The brain case proper is relatively small (see Figs. 19, 20, pp. 118, 119), and the snout, the facial portion of the skull, is very elongated, the degree of elongation varying from genus to genus. It is most developed, perhaps, in the extinct *Eurhinodelphis* (apparently a Platanistid), of which a figure is appended. The toothed whales, in fact, embody the extremes of shortening and elongation of the facial region of the skull. Thus it is very short in *Orcella*, in *Kogia*, and in a few others.

Several of the individual bones show peculiarities, of which some will be mentioned in the present general account of the whale's skull. The parietals deserve their name, for they are really walls to the skull and not a covering also, as in other mammals; this, at any rate, applies to the majority. In the extinct Zeuglodonts, which in many other respects conform to a more generalised mammalian condition, these bones are, so to speak, normal; but among the toothed whales they do not meet above, and the part of the roof of the skull which should be occupied by the parietals is invaded by the huge supra-occipital. This does not, however, apply to the whalebone whales, though it appears to do so. In these whales the fœtus has normal parietals meeting above; in the adult the upper portion of the bones is overlaid by the supra-occipitals. We have here the first stage in the disappearance of the median portion of the parietals; being overlaid by the supra-occipitals their function ceases, and, in accordance with what is always found in

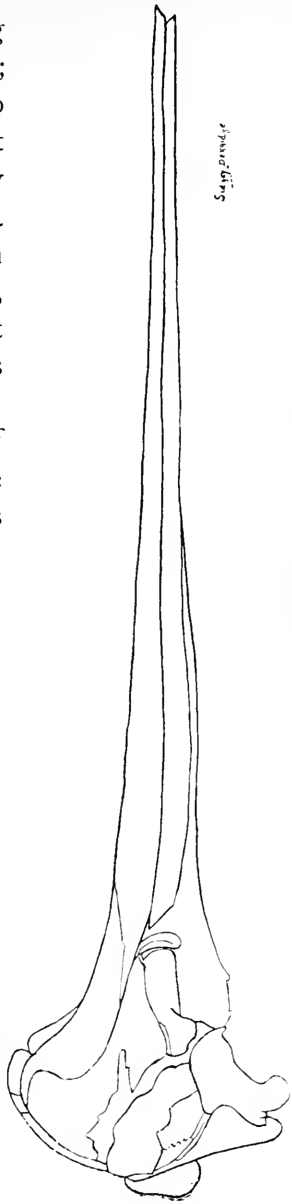


Fig. 11. Skull of *Eurhinodelphis*, lateral view. (After van Beneden and Gervais.)

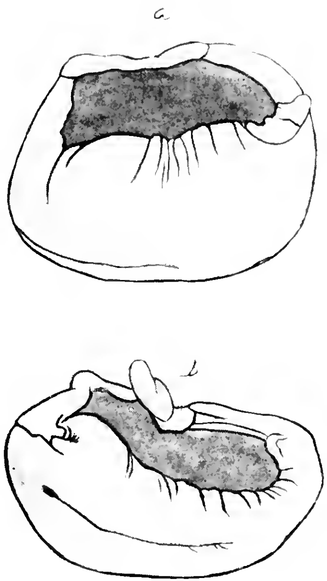
nature, being useless they disappear. The enormous size of the supra-occipital bone reduces the size of the frontals with which it articulates. The latter are very narrow above where they form the forehead, and expand below where they protect the small orbit from above.

The pre-maxillary bones are remarkable for two peculiarities. In the first place they do not, except in some of the extinct forms (Zeuglodonts), bear any teeth; but, in the second place, instead of having degenerated in bulk in consequence, they are greatly increased; they stretch backwards and touch, or indeed partly cover, the frontals. The small size of the nasals, which are almost rudimentary in all existing whales, and especially so in the Odontocetes, permits this junction to be effected. Laterally these pre-maxillary bones are ensheathed by the maxillæ, a feature very characteristic of the whales, that is to say, of existing forms. The maxillæ also cover over the frontals, and in some Odontocetes are greatly crested on their dorsal surface, a feature which is carried to a maximum in *Hyperoodon* and in the Gangetic *Platanista*.

The bones related to the organ of hearing are extremely strong and stony in the whale tribe; they are imperfectly attached, as a rule, to the surrounding portions of the skull, and are thus readily detachable; they are often found in a fossil condition quite separate. The tympanic bone (Fig. 12) has a shell-like form, not unlike a cowrie; it is not always firmly attached to the periotic, which ensheathes the actual organ of hearing.

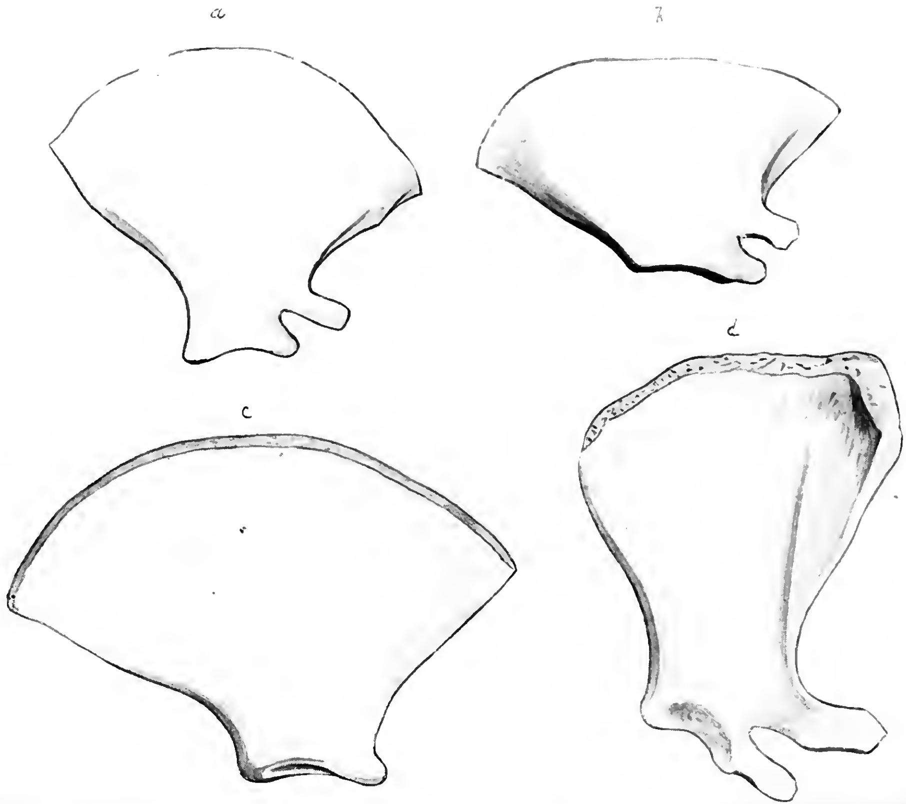
PLATE IV.

FIG. 12. TYMPANIC BONES.
(From van Beneden and Gervais.)



a. *Balæna.*
b. *Balænoptera.*

FIG. 13. SHOULDER-BLADES OF WHALES.
(From Fischer.)



a. *Balæna biscayensis.* b. *Balænoptera sibbaldii.*
d. *Physeter macrocephalus.*

Some other peculiarities of the skull bones of the Cetacea are dealt with under the description of the different families.

THE SHOULDER GIRDLE

The shoulder girdle of the whales consists of an apparently single bone, which has a highly characteristic form, liable to some range of variation. The major part of this bone is formed of the scapula, while a process directed forward is the coracoid, more pronounced in the larger number of whales than in any other among the higher mammalia. The scapula is broad and flattened, but both the breadth and the degree of flattening is not by any means uniform. In the Sperm whale the bone is gently concave. It is very much broader (*i.e.*, longer in an antero-posterior direction) in the Rorquals than in the Right whales. Near to the anterior edge of the blade-bone is a ridge, which ends in a particularly long process the acromion. Only in the *Megaptera* is this process, and also the coracoid process underlying it, markedly reduced. In *Platanista* there is another abnormality of structure. The acromion coincides absolutely with the anterior margin of the blade-bone, so that the ridge of the "spine" of the scapula is quite absent as a distinct structure. It is worthy of note that in *Megaptera*, which has the longest flippers of all whales, the acromion and the coracoid process should be reduced to a minimum or even practically absent.

ORGANS OF RESPIRATION

Not only is the influence of a purely aquatic life to be seen in the outward form of whales, the respiratory organs and parts annexed show the same modification. Bearing in mind the peculiar habits of whales, their capacity for remaining a long time under water, and the necessity therefore of supplying themselves with a good stock of air for use during these prolonged immersions, we should indeed expect to find that in the vascular, as well as in the respiratory organs, there were differences to be seen not found in mammals, which are purely terrestrial. And this is precisely what we do find. But here again it is not always easy to distinguish between adaptational likeness and real affinity; it is, that is to say, not always clear that structures supposed to be modified owing to the habits of the creature are not marks of likeness to some other family of mammals. But we shall consider these points as they arise.

Dr. Otto Müller, who has recently and elaborately dealt with this matter,* has particularly dwelt upon the form of the chest cavity in these aquatic mammals. Among terrestrial creatures the shape of this cavity is, as a rule, boat-like in transverse section. The cavity narrows below and is wider above. Furthermore, its ventral boundary line is about as long as its dorsal; the result of this being that the

* "Untersuchungen uber die Veränderungen welche die Respirations organe der Saügethiere durch die Anpassung an das Leben im Wasser erlitten haben."—*Jen. Zeitschr. f. Naturwiss.*, 1898, p. 93.

diaphragm, the partly tendinous, but chiefly fleshy, septum which separates the chest cavity from that in which are lodged the liver, intestines, and stomach, has a vertical direction, and stands, as it were, upright in the body.

In the whales, on the other hand, the chest cavity is more barrel-shaped, oval in section—sometimes, indeed, transversely oval ; its dorsal boundary is much longer than its ventral, and in consequence the diaphragm is distinctly, and mostly very, oblique in direction. It is, however, one thing to state these differences, and quite another to assert that they are modifications connected with the aquatic habit. It might be suggested, in the first place, that these marks of distinction are merely characteristic of whales, just as it is characteristic of one division of whales to have a free malar bone, a fact which is simply of classificatory significance, and has no bearing (at least so far as we can see) upon any special difference in the mode of life of its possessor. Furthermore, the obliquity of the diaphragm might be associated with the shortening of the sternum, which is so marked a character of the whales, especially of the whalebone whales. A whole series of facts, however, upset these at first sight reasonable objections, and seem to prove the contrary, *i.e.*, that the modifications in question are really connected with the aquatic life, and with nothing else.

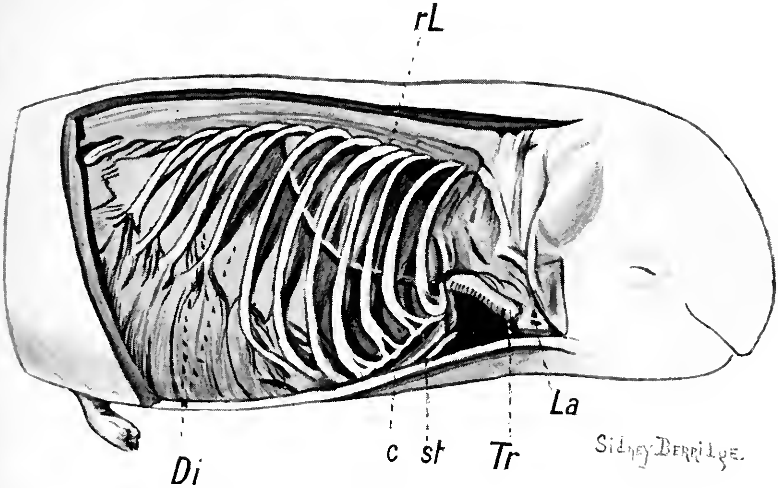
In the otter, and still more in the seal, which are examples of two stages in the literally downward progress of a land animal towards an aquatic existence, these several characters are seen in a condition intermediate to that which obtains in the purely land animal on the one hand, and in the purely aquatic whales on the other. And, furthermore, in the Manatee, which, if it be an ally of the whale, can hardly be regarded as an ally of the carnivora (to which group, of course, the otter and the seal belong), there is the same obliquity of the diaphragm. Thus in three types, the whale, the manatee, and the seal, we have the same series of modifications existing. If the whale is a relative of the manatee, it is not of the seal, so that any renewed attempt to urge the argument from affinity fails. As to the obliquity of the diaphragm being due to the reduction of the sternum, this is disproved by several instances among the whales. In Beluga the diaphragm is attached to the sternum before its end; in *Hyperoodon* the same is the case; while in *Balænoptera* the attachment is altogether behind the sternum. There is thus no special relation to be observed between the end of the sternum and the ventral insertion of the diaphragm.

Moreover, as showing that it is a modification of a recent kind, it is interesting to notice that in the porpoise of the youngest stage that has been observed the relative proportions of the ventral and the dorsal line of the thoracic cavity are as 1 : 1·75; while in the adult the same proportions are as 1 : 2·25. Thus these peculiarities are developed quite late, showing that they are a recent acquisition, and tending therefore to prove that they are developed

PLATE V.

Fig. 14. Fœtus of Beluga.

(From O. Müller.)



rL.	Right Lung.	*Di.*	Diaphragm.	*c.*	Heart.
st.	Breast-bone.	*Tr.*	Trachea.	*La.*	Larynx.

[*To face page* 56.

in consequence of altered habitat. The lungs themselves are characterised by their simple form. In the mammalia generally the lungs are more complex. They are divided into a number of separate lobes, the practical result of which is to increase the lung surface, without any corresponding need for an enlarged chest cavity to contain them in. The same result is brought about in the whale by the increased length of the lungs themselves. As already mentioned the chest cavity is proportionately larger than in terrestrial mammals; therefore it follows that the lungs can be bigger without any lobulation. As a matter of fact they are. What is uncertain at present is whether the simplicity is a primitive feature in the organisation of these animals, or whether it is a reduction following upon the alteration of other conditions. It is exceedingly difficult to decide such matters. But before we attempt to decide, another important feature of the structure of these aquatic mammals must be mentioned. In many parts of the body of whales the blood vessels form to a very copious degree the anastomosing networks which are known technically as "retia mirabilia." A rete mirabile is produced by the breaking up of an artery into a meshwork of minuter arterioles. The net physiological result, so far as concerns the mechanical effects of such a breaking up, is the slowing of the blood stream at such spots, and the increase of the surface of blood exposed to the surrounding organs and tissues. It seems to follow from this that the oxygen contained in the blood would be more fully utilised by the tissues through which the retia pass than in the case of a single tube. In fact, in the whale we have a state of affairs which in some degree suggests the respiratory conditions occurring in an insect, where the ramifying tracheæ bring the air to the organs individually, instead of—as in the bulk of air-breathing animals—the air having to be extracted from the blood by the tissues. These large reservoirs of oxygen within the body, and in close relation to various organs which need abundant oxygen, then do away with the need for an increased lung surface in these diving animals. But not altogether; it looks as if the simpler condition of the lung had been retained, for in reptiles the lungs have the same simple unlobulated structure, the increase being simply brought about by an increased length rendered possible by the greater obliquity of the diaphragm.

THE WHALE'S STOMACH

It is a highly characteristic feature of whales, and one which is absolutely universal, that they have an exceedingly complicated stomach. In man the stomach is simply a bent, somewhat U-shaped, wide region of the gut; there is, however, a difference observable in the structure of the lining membrane between what is called the cardiac portion of the organ (so called because it lies nearest to the heart) and the distal pyloric region, out of which opens the intestine. As a rare abnormality, however, the stomach of man is divided by constrictions into three chambers.* Among rodents it is common for the stomach to be divided into two more or less sharply marked off chambers by a median constriction. This chambering of the stomach is, however, carried out to a large extent only in the Sirenia (Manatee), the Sloth, the Ruminants (oxen, antelopes, deer, camels), and in the whales. It must not be at once concluded from this circumstance that the whales are related intimately to one or other or to all of these groups. We shall see presently that the divided stomach of the whales is essentially different from the divided stomach of the other animals. They simply have in common the bare fact that it is divided.

But before proceeding to generalities it will be convenient to lay before the reader some of the facts. We cannot give here a detailed account of the stomach in the entire order. Dr. Jungklaus,† the most recent writer upon the subject, quotes no less than sixty-three memoirs, apart from his own, which deal entirely, or more or less incidentally, with the Cetacean stomach. To this memoir of Dr. Jungklaus' we must refer for additional details, and for this list of literature.

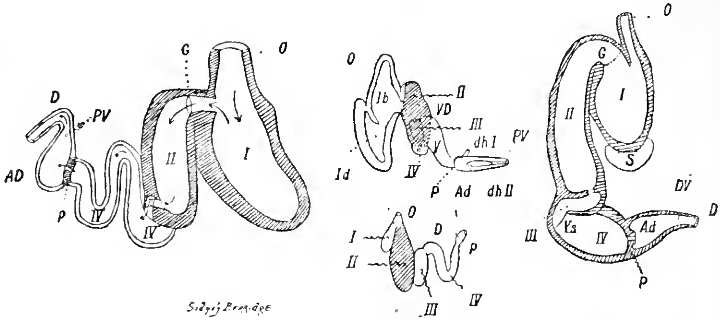
The common porpoise may conveniently serve as a starting-point. Its stomach is among the least complicated, and it is clearly the most accessible of whales for study. In that creature the stomach has

* WIEDERSHEIM, *The Structure of Man*. Ed. by Howes. Macmillan and Co.

† "Der Magen der Cetaceen," *Jen. Zeitschr.*, xxxii., p. 1. 1898.

the form which is indicated in a diagrammatic form in the accompanying sketch. The œsophagus opens into a wide blind sac, near to the upper œsophageal side of which opens out of this the second division of the stomach. At the lower end of this latter and in the thickness of its wall is a small passage,

FIG. 15. STOMACHS OF VARIOUS CETACEA.
(From Jungklaus.)



Left hand fig., Common Porpoise. Right hand fig., Rorqual. Middle upper fig., *Globicephalus*. Lower fig., Hypothetical transitional form between two types of stomach. *I*, Chambers of stomach. *O*, Œsophagus. *P*, Pylorus. *PV*, Entrance of bile duct. *D*, Duodenum. *S*, Spleen. *AD*, Ampulla duodenata. *Dh*, Bile duct. *G*, Boundary between first and second stomach.

regarded as the third division, which leads into a long and rather narrow division of the stomach; this is the fourth chamber; it is curved in an undulating fashion, and from it arises the commencement of the small intestine, which commencement is dilated, and might be regarded by some as a fifth stomachal chamber were it not for the fact that into it opens the combined duct of the liver and of the pancreas.

Beluga and the Narwhal have stomachs which agree in many points with each other, and differ slightly from the porpoise. Those whales, as will be seen later, form a well-defined group of dolphins contrasting in other points with the remaining Delphinidae. In both of them the first division of the stomach is strongly divided into two separate chambers; the minute third chamber of the porpoise stomach, simply in that animal an excavation in the thick wall of compartment II., is here larger, and a distinct chamber visible before the stomach is dissected. Finally, there is a fifth chamber, separated off from the fourth, and, like it, of an elongated intestiniform shape.

Of other dolphins, while *Globicephalus* and *Grampus* are most like *Monodon*, *Orcella* is most like the common porpoise. So too are *Platanista* and *Pontoporia*.

The stomach of *Balænoptera musculus*, our example of a whalebone whale, is constructed upon the same plan as that of those dolphins that have been already considered. It has four chambers like that of the porpoise, but the proportions are a little different. This will be observed from the accompanying figure. It will be noted that the second chamber is larger than the first, and that the fourth is relatively small.

A still greater reduction is seen, according to Sir William Turner, in the stomach of *Balæna mysticetus*, at least in the fœtus of that whale. The author just mentioned counted but three chambers in its stomach; the small intermediate chamber III. appears to be absent.

The stomach of the Ziphioid whales is in one important respect different from that of the whale group that we have hitherto considered.

The stomachs of the genera *Hyperoodon*, *Mesoplodon*, and *Ziphius* have been carefully examined by more than one observer.* *Berardius* alone is as yet unknown as regards its "soft parts." As a general rule the Ziphioid whales differ from others in the very large number of compartments into which the stomach is divided. Nine, ten, even thirteen or fourteen divisions have been recorded; and the varied statements which occur in the literature of the subject with respect to the exact number of compartments in the stomach of a given species are not, it is thought, evidence of inaccuracy on the part of one or more of the describers, but simply an expression of actual variability. This, however, is a detailed difference. The most important difference is that the first division of the stomach gives off the second at its posterior and not at its anterior end. In the stomachs of the whales that we have been considering a cuttlefish or a herring when swallowed might, so far as anatomical arrangement is concerned, pass at once into the second compartment as well as into the first, as will at once be seen in division No. II. That would be impossible in a Ziphioid. The first compartment

* "The Anatomy of a Second Specimen of Sowerby's Whale" (*Mesoplodon bidens*), *Journ. Anat. Phys.*, 1885, p. 144.

of their stomachs is large, and from it lead—from the opposite extremity, be it remembered, to that where the œsophagus enters—6–13 smallish, round, orange-shaped cavities of which the last, that immediately preceding the duodenum, is often the largest. It is so, for instance, in *Mesoplodon bidens*. What, then, is the exact correspondence between the stomachs of these whales and those of the dolphins and whalebone whales? The inevitable conclusion is that the first compartment of the latter whales is missing in the stomach of the Ziphioids. This conclusion is not only supported by a comparison of the actual structures concerned; as is so often the case, the solution of the problem is aided here by those occasional occurrences, so useful to the morphologist, of rudiments. In *Hyperoodon* Dr. Jungklaus has detected a small representative of the first stomach of other whales in the form of a slight cæcal dilatation of the œsophagus just before it opens into the normal first stomach of that whale. This rudiment seems obviously to have the significance that he suggests. And, moreover, it showed internally a characteristic meandering arrangement of the folds of mucous membrane, an arrangement which is universal, or nearly so, in the first division of the stomach of dolphins. It appears, therefore, that the stomach of the Ziphioids is to be derived from that of dolphins, and not *vice versâ*. This is in harmony with other considerations, which point to the Ziphioids as modified, not archaic, forms of whales. (See below.)

We may now compare the complicated whale stomach with the complicated Ruminant's stomach. The latter, when typically developed, has the characters shown in the following description: The œsophagus leads into a large paunch, the rumen; it equally leads into a smaller pouch, the reticulum; from this latter arises the psalterium, so called from the leaf-like arrangement of its folds of mucous membrane. Finally, there is the abomasum, the truly digestive part of the stomach. In having four compartments the stomach of a typical ruminant agrees with that of the porpoise. But at this point the agreement stops. The first three divisions of the Ruminant's stomach are clothed with œsophageal epithelium; it is only the abomasum which is the truly digestive part of the stomach. Thus in the Ruminant the stomach may be regarded as being primarily divided into two regions, the last of which only is the digestive portion; the first part is again sharply marked off into three regions. In the Cetacea, on the other hand, the stomach, although like that of the Ruminant divided primarily into two parts, shows a further subdivision of the digestive part which may be exceedingly complicated in the Ziphioids, while the non-digestive region is generally not divided at all, and if it is (*i.e.*, *Monodon*, etc.), the division is not of so marked a character as in the Ruminants. Even in the Manatee the stomach is more ruminant than cetacean; for the true digestive stomach, apart from its two cæca, is not divided. Thus the stomach of ruminant and cetacean have only this in common, that the stomach is primarily divisible into two parts; but that is a universal character, and is indeed seen in other vertebrates, for example, in birds, sharks, etc. From such a simply-divided stomach as is seen in various Rodents, and in other types of mammals, both the Cetacean and the Ruminant stomach may have arisen, and the resemblances between them will in this case be an example of that frequent phenomenon in the organic world, convergence.

To account for this likeness by convergence is a matter of interesting inquiry. The other complicated stomachs which are found in mammals are invariably associated with a vegetarian diet. The Sloth, the Oxen and Sheep, and the Manatee and Dugong are all vegetable feeders. The whales are most distinctly carnivorous animals.

It has been suggested, however, that whales ruminate like oxen. This process (in the Ruminantia) consists of the following series of acts. The animal bites off and swallows an immense amount of herbage, leaves, etc., and swallows them hastily; the mass thus swallowed is permeated by the saliva and is then returned to the mouth, where it is thoroughly masticated at leisure, and re-swallowed to be properly digested. It is held that the Ruminantia, being as a rule timid creatures, who have to be on their guard against their numerous carnivorous foes, gain an advantage by this apparently complicated and even disadvantageously complicated act. They can lay in their store of food hastily and with rapidity, and then at a more convenient season, when danger

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is not so pressing, re-masticate and digest it at their leisure. Whales often feed among dense swarms of cuttlefish, Crustaceans, etc., and it might seem that here, too, a kind of rumination might take place. The immense amount of food swallowed might be kept in the first division of the stomach and regurgitated for subsequent chewing. The fact that a large number of seals and porpoises, perfectly whole and intact, were found in the first division of the stomach of an *Orca* seems to favour this hypothesis, as does also the statement of many that whales when captured generally allow some undigested, even unlacerated, food to escape by the mouth. But on the contrary view, which is that usually accepted, we must consider the structure of the mouth, teeth, and tongue, all of which have an important bearing upon the existence or non-existence of prolonged mastication such as characterises Ruminantia. The numerous and homodont teeth (see p. 68) are not fitted for chewing, they are fitted simply for catching and retaining slippery fish and squid. The great length of the jaw in many forms does not permit of the essential lever action of the jaws in chewing, and, finally, the immobile tongue is not of any use in aiding the performance of the function of mastication; a mobile tongue is obviously required to push back the food as it escapes from between the teeth.

It is thus practically certain that whales do not ruminate. But in that case, of what use is the first stomach, devoid as it is of glands? In the ruminant it is a large storehouse; in whales this would seem to be needless. It is thought that the first stomach of the whale is a chamber in which the food is to some extent broken up and softened by mechanical means; it is analogous, in fact, on this view, to the bird's gizzard. The muscular layers of its walls are thicker than in the thin-walled rumen of the ruminant. Often, too, this compartment has been found to contain sand and stones, just as does the bird's gizzard, and for the matter of that, the stomach of the Sea-lion. This introduction of sand and stones may be accidental; but, on the other hand, its presence may be explained as an accessory to the trituration of the food. It is obvious that a trituration of this kind and rumination are mutually exclusive. The balance of probability is in favour of the former action of the first stomach. But even now we have not accounted for the complication of the true digestive stomach. It is to be noticed, however, that here, as already stated, we are free from any analogy with the herbivorous stomach; in the Sirenia and Ruminants this part of the stomach is not complicated. It is only the first part associated with the non-digestive functions of the stomach. This problem, it is to be feared, we must leave unsolved. Finally, there is the fact of the absence of the first stomach in the Ziphioids to explain physiologically. Dr. Jungklaus thinks that this is associated with their exclusive diet of cuttlefishes, which require no stomachal "mastication." Their tissues are soft, and are easily digested by the digestive part of the stomach without any previous maceration and pressing.

TEETH

Whales are, as is well known, divisible into two groups—those with and those without teeth, the Odontoceti and the Mystacoceti of various authors. The Mystacoceti, however, the "whalebone whales," possess teeth in the young condition, while there are plenty of instances of the commencing disappearance of teeth among the Odontoceti. Thus the line which separates the two divisions of existing whales is not so hard and fast as was stated before recent discoveries in the growth of the teeth of these animals.

Before considering the growth of the teeth, however, it will be well to lay briefly before the reader the principal facts in the structure of the teeth of existing toothed whales.

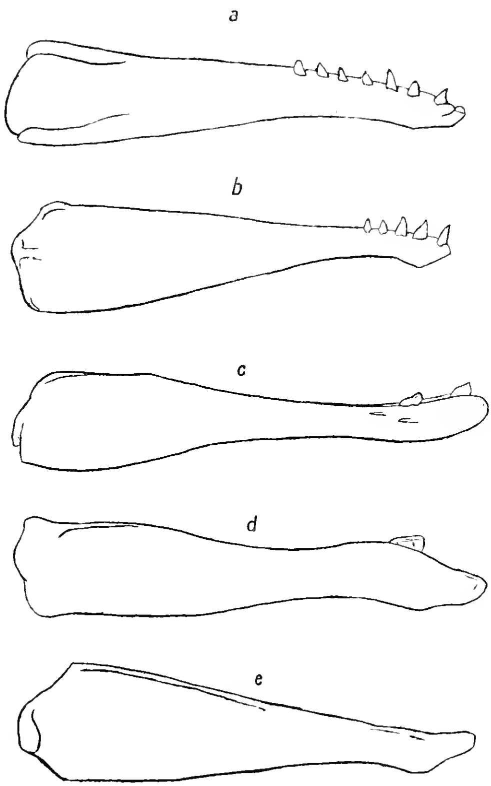
A very marked feature of their teeth is the characteristic "homodonty." This term, it should be explained, is applied to teeth when the whole series is composed of teeth which are alike. In most mammals there is what is known as Heterodonty, *i.e.*, the teeth are specialised in different directions. Thus in man there are the anterior incisors, cutting teeth, which are different in form and in function from the posterior cheek teeth, molars or crushing teeth. The differentiation is more emphasised still in some other animals, less so again in others. But on the whole the mammals stand apart from all other vertebrate animals by the fact of their Heterodonty. The teeth of a frog, of a snake, or of a lizard, are all more or less alike; there is no possibility of speaking of incisors, canines, and molars. Another characteristic feature of mammalian dentition will be postponed until after the actual dentition of adult whales has been described and compared with that of other mammals.

Broadly speaking, it is correct to define the toothed whales as mammals in which there is no specialisation of the teeth; but there are some slight exceptions, which will be dealt with presently. The number, size, and position of the teeth of the Odontocetes varies, but the majority have a large number of smallish, conical teeth embedded in both upper and lower jaws. The actual numbers vary much; the greatest number are seen in the genus *Inia*, where no less than 221 are reckoned up. As will be seen in the account of the different kinds of whales, the number of the teeth is often made use of as a generic character. Among the Delphinidae there are a gradual series of genera, in which the number of teeth gets reduced. It must not be imagined, however, that we can actually start from some such form as *Inia*, with abundant teeth, and derive from it the various genera in which the teeth are reduced, and arrange those genera in the order of this reduction. But it will be convenient to take them in such an order.

Through a gradual reduction in the number we arrive at the genus *Delphinapterus* (the Beluga), where there are but nine teeth on each side of each jaw. In *Grampus* this dentition is still further reduced; the teeth in the upper jaw have disappeared altogether, and there are only a few, three to seven, on each side of the lower jaw, arranged near to the symphisis of the mandibles. Another line culminates in the Narwhal, *Monodon*, where all the teeth have vanished in the adult animal save the well-known tusk, and an accompanying tusk of smaller size, sometimes equally developed, in the upper jaw; in this

FIG. 16. SERIES OF LOWER JAWS TO ILLUSTRATE GRADUAL DIMINUTION OF TEETH.

(From van Beneden and Gervais.)



a. Beluga. *b.* Grampus. *c.* Berardius.
d. Mesoplodon. *e.* Monodon.

case it is the lower jaw which has become edentulous. A second series of modifications is seen among the Physeteridae, the Cachalot, and the Ziphioid whales.

The Cachalot has functional teeth only in the mandible, where they form a row of strong conical teeth; but in addition to these are a series of smaller teeth in the upper jaw, which are not to be seen in the dried skull, as they are not embedded in the bone, but only in the gum, which naturally is stripped off or decays away in the course of preparation of the skull for museum purposes. This kind of reduction is still further exaggerated in the Ziphioid whales. In all of these the number of teeth actually used is very limited, not more than two pairs—usually one pair, and those are limited to the lower jaw. But in addition to these there are in most, if not in all, Ziphioid whales a set of smaller teeth only in the upper jaw or in both jaws, which are—like the corresponding teeth of the Cachalot—embedded only in the gum, and so are, as a rule, lost in skulls acquired by museums. These teeth are clearly on the wane; and as even the teeth of the lower jaw are sometimes not extruded, and in other cases lost before the animal dies, it is evident that these whales are not so very far removed from the whalebone whales; but it should be observed that they exhibit no trace of the compensating whalebone.

So much then for the general modifications of the teeth, as regards numbers, which are exhibited in the series of toothed whales.

The question arises, Are those whales with the most teeth the most primitive, and have they given rise to those with a reduced dentition? Or is the converse true? Or finally, is it safest to take the middle path and make two series, one ascending and one descending? Are, for instance, dolphins with a moderate number of teeth nearest to the ancestral form from which have arisen by multiplication on the one hand the *Inia*, and by reduction the Narwhal? This supposition agrees in some ways more nearly with what we know of mammalian dentition in general. It has been pointed out that the typical mammalian dentition is heterodont. It is also limited in numbers, and those numbers are definite. Apart from the Marsupials (in which, moreover, fifty-six is the greatest number of teeth) and a very few other instances, no mammal has or had more than forty-four teeth. Even here there is nothing like the abundance of teeth of *Inia* or *Platanista*. Furthermore, the numbers of teeth of the many-toothed dolphins appear to be not exactly fixed to a tooth or two; whereas in the mammalia, as a rule, with but few exceptions (such as *Priodon*, an Armadillo, and the Manatee), the number does not vary, except, of course, in occasional abnormalities.

On *a priori* grounds, therefore, (dangerous grounds sometimes on which to build an argument intended to last!), we should be rather disposed to regard the excessive dentition of the typical dolphins as not a primitive state of affairs, but one derived from something more nearly approaching to what is characteristic of mammals in general.

In a number of skulls belonging to various genera of Delphinidae with numerous teeth, Professor Kükenthal found here and there that the regular arrangement of the relative positions of teeth in the upper and in the lower jaw was lost. The regular arrangement is that the teeth of the two jaws should alternate—an obviously convenient arrangement for the due prehension of the fish or octopuses upon which they feed; alternating teeth would be better able to lay hold of this slippery food. When this accurate correspondence ceases it is brought about by the intercalation of teeth—a proceeding which naturally increases the total number. If this process is going on now, there is nothing unreasonable in thinking that it has been going on in the past in correspondence, perhaps, with the increase in length of the jaws themselves. Thus the number of teeth in dolphins is greater now than it has been. They are, therefore, to be derived from creatures with fewer teeth, so far more like the typical mammalia. Another argument pointing in the same direction is afforded by the ancient Zeuglodonts, treated of more fully on another page. (See p. 308.)

These Cetaceans had a dentition conforming in number of teeth to the more typical mammalia. Their teeth were also more conformable to those of the mammalia generally in their heterodonty; but we shall recur to this after considering the traces of heterodonty still remaining in the group of whales.

Having dealt generally with the number of teeth among existing Cetacea, their shapes remain for consideration. As a rule the teeth of whales are simple and conical in form, directed either upwards or, rather, forwards. They resemble in fact the canine teeth of other mammals, not only in this shape, but in their being implanted by a single root.

There are, however, a few examples of some, though not a great deal of, specialisation in the form of the teeth. In *Inia Geoffrensis* the posterior series of teeth have a distinct lateral cusp, so that they have ceased to be simply peg-like teeth. In the common Porpoise, *Phocæna communis*, the teeth have broad divided crowns, which are sharply marked off from the root; there is a reminiscence here of the more complicated teeth of ancestral forms, such as the Zeuglodonts. The extraordinary strap-shaped teeth of *Mesoplodon layardi* (see p. 220) and the tusks of the Narwhal need not be referred to in the present connection; they appear to be simply exaggerations (perhaps originally pathological) of the simple conditions obtaining in other whales; they are probably not to be looked upon as an inheritance from terrestrial ancestors.

Professor Kükenthal has a theory that the simple teeth of whales are to be derived from the splitting up of more complicated teeth, such as are found in other mammals. In Zeuglodonts (called so on this very account) each tooth is formed of two pieces, each with its separate root. By division of these the more numerous teeth of a dolphin can be arrived at. But recent investigations into the Manatee seem to negative this theory, for in that animal an indefinite succession of complicated teeth occurs.*

In almost all Mammalia the individual is provided with two sets of teeth; there is the dentition found in the young; this is later replaced by the dentition of the adult. The two sets of teeth are spoken of respectively as the "milk" and the "permanent" dentition. This is characteristic of the mammalia, and distinguishes them from lower vertebrates where there is not this merely double dentition; new teeth in the lower vertebrates are formed as they are wanted. If a mammal loses one of the teeth of the second series that tooth is not replaced. The relative importance of these two sets of teeth varies much. The milk teeth are sometimes only developed as rudiments, never of functional use, while in other cases the milk teeth persist for a long time, and are very distinctly functional. It has been even attempted to be shown that in the Marsupials it is the permanent dentition which is suppressed and only represented by rudiments, while the teeth of the full-grown animal are the persistent milk teeth. This general character of the Mammalia has been described as "Diphyodont," and it was thought that by this the majority of mammals were to be distinguished from some that have but one set of teeth, and were accordingly to be termed Monophyodont. In some of the Edentata (the Sloth) it is still believed that only one set of teeth is ever produced; and the same view was originally held about the toothed whales. There is, however,

* See LYDEKKER and THOMAS, *Proc. Zool. Soc.*, 1897, p. 595.

now not the least doubt that the Dolphins are truly diphyodont mammals, thus conforming in a very important character to their terrestrial allies. But it is not quite settled which of the two dentitions it is that persists. It is held by Kükenthal that the dental series of whales belongs to the milk dentition. Thus the whales are clearly descendants of purely diphyodont mammals.

We have now to consider the whalebone whales, which, in the adult condition, have no teeth, only the plates of baleen, which will be treated of on another page (p. 80). As long ago as the year 1807 Geoffroy St. Hilaire discovered the rudiments of teeth in a fœtus of the Greenland whale, *Balæna mysticetus;* and this important discovery was afterwards confirmed by the great Cuvier, as well as by his less-known brother, Frederick Cuvier. Since then the facts have been confirmed by others. (Pl. VI.)

The first discoverers of the facts contented themselves with little more than a statement of them. But later Professor Julin laid great stress upon the additional fact that the teeth of *Balænoptera rostrata* which he examined were not merely simple conical teeth, but of a more complicated pattern; he found teeth with one cusp (like those of Cetacea generally), with two, and even with three cusps. The simple teeth, moreover, were those in the anterior part of the jaws, the more complicated teeth further back. In fact, there is an obvious likeness to a set of incisors, followed by the more complicated cheek teeth. This arrangement is typical of mammals, and is found

PLATE VI.

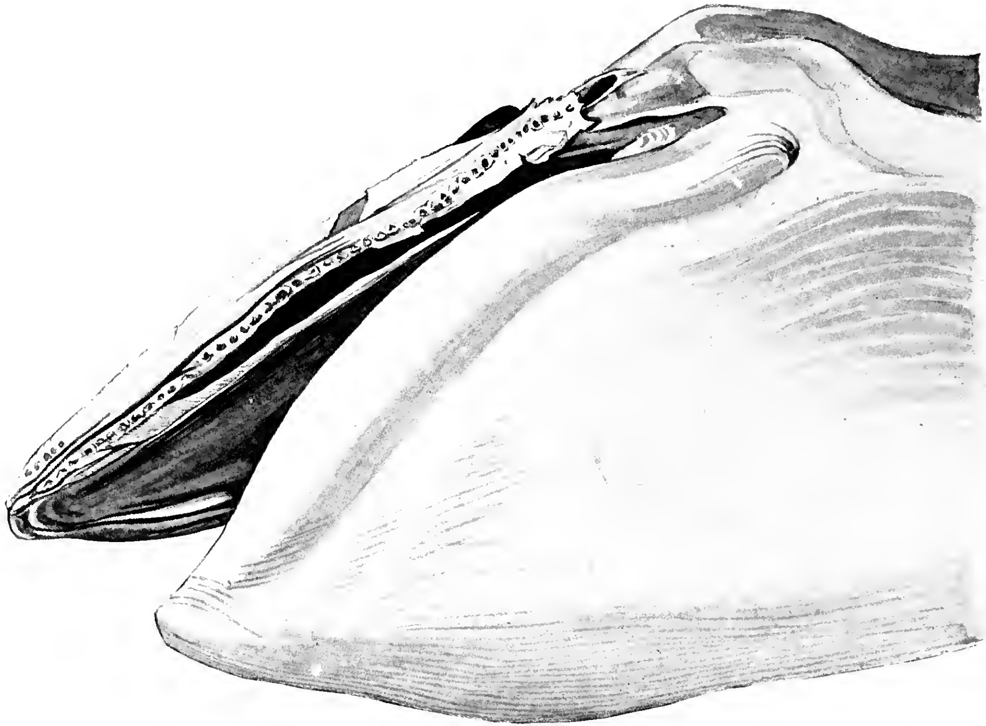


FIG. 17. Embryo of *Balænoptera musculus*, showing rudimentary teeth.
(From Kükenthal.)

[To face page 76.

in the Cetacean, *Zeuglodon*. An addition of great weight has been made to these discoveries by Professor Kükenthal, who found besides the fairly well-developed rudiments of teeth very rudimentary traces of a second dentition, thus showing that the whalebone whales, like their toothed allies, are diphyodont like other mammals. Furthermore, he has given reasons for believing that in them, as in the toothed whales, it is the milk dentition which persisted longest, as it is represented by the most fully developed rudiments.

THE BRAIN

The brain of all whales presents a most unusual shape of that organ. It is very much compressed from before backwards, and is thus broader than it is long. It looks almost as if these creatures, rushing through the waves, had flattened their brains in the effort to oppose the weight of water. But though so much shortened and comparatively small in total bulk, the cerebral hemispheres of the Cetacea make up to some extent by the highly-developed convolutions of the brain surface. It used to be held, and the belief is often seen in popular books, *i.e.*, books which deal loosely with the facts and inferences of science—that the furrows of a brain corresponded with its thoughtfulness; that the higher the type the more abundant those grooves and furrows upon the surface, which separate the complicated system of ridges of brain substance known as the convolutions. It is, of course, perfectly true that the brain of the highest animal of all, man, is markedly and abundantly convoluted. It cannot be said, however, that the titanic whale is largely superior in intelligence to the small and active Marmoset; and yet, if the convolutions of the brain were to be alone considered, this would have to be the opinion. For the Marmoset's brain is not far from being quite smooth, while we have already commented upon the markedly convoluted character of that of the whale. The real relationship appears to be between size of body and complication of the brain's surface. And this is more obvious when nearly-related animals are compared with each other. The Marmoset, for instance, has a smoother brain than the Gorilla; the Rhinoceros and the Hippopotamus have much more furrowed brains than the smaller Ungulates. Our whales are, curiously enough, an exception to this generalisation; it cannot be said that the great Rorqual or Sperm whale has a brain which is at all definitely superior in the number of its convolutions to the brains of smaller whales. Can we in any way account for the curious shape and the great convolution of the brain surface in Cetacea? In the first place it is as well to be convinced that they do want accounting for. This can hardly be doubted; the singular shape of the hemispheres of the whale are so peculiar that they suffice to define the group; there is nothing like it elsewhere among mammals. Then again there are some reasons for considering the whales to occupy a low position in the mammalian series, reasons which will be dealt with on another page. We should expect, therefore, to find a lowish type of brain; instead of this we are confronted with the most specialised. Nothing is more difficult in zoology than to arrive at convenient generalisations — for the paradoxical reason that it is so easy to frame hypotheses. The expression "simplex sigillum veri," not composed for the purpose for which it is used, and yet used with such frequency in zoological writing, especially in the newer developments of what is called sometimes "Darwinism," has had a most deleterious effect upon speculation. A simple and obvious explanation often seems to such writers to settle the question at issue. And yet in the long run it seems to be plain that the processes of nature are not so simple. It is certain that the brains of some of the early and extinct forms of mammals were not only small but smooth. It is equally certain that their descendants —or at least allied forms subsequent in date—have not only larger, but more rumpled brains. The whales, we can fairly assume, are an ancient stock, and may have started even as "whales" with small and smooth brains. The requisite increase was brought about by a more extensive crumpling of the surface, while the small frontal bones and the large development of the facial region of the skull prevented the extension of the brain cavity forwards, its extension laterally being permitted partly by the non-union of the parietals above, and by the feebly-attached bony apparatus connected with the organ of hearing. It seems to follow further that the whales cannot be nearly related to any existing form of mammal as the brain development has pursued so different a path. Sir William Turner has pointed out that a large number of the smaller convolutions of the whale's brain are transverse to the long axis of that organ, which suggests that there has been, as it were, a tendency to grow forward in the ordinary mammalian fashion, but a check to the same growth, which has naturally resulted in furrows having the direction referred to. In any case the whale's brain is partly characterised by the features to which attention has been called.

It is also remarkable for the fact that in the toothed whales there is absolutely no vestige of those fore parts of the brain which are connected with the sense of smell; while in the whalebone whales the same region is only feebly visible. It is sometimes erroneously asserted that creatures living in the water cannot smell owing to the suspension in the water of the odoriferous particles; but this is at once negatived by the case of fishes, which have a well-developed olfactory apparatus. Anyhow, whales have not; but it is apparently not to be put down to their marine habitat, one of the very few structures indeed which cannot be correlated with that mode of life.

WHALEBONE

The real nature of whalebone was frequently, like that of spermaceti, misunderstood in past times. Belon (translated by Scammon) wrote upon the matter as follows: "And that which is called whalebone ("coste de balene"; literally, whales' ribs), with which ladies nowadays make their corsets and stiffen out their dresses, and which the beadles of some churches carry as wands—these are certain pieces cut off and drawn out from that which serves as eyelids for the whale, and which covers his eyes, and which is furnished at its extremity with a kind of long, stiff hair. This is what the Latins call the pretentures, and which they say enables the animal to direct his course through the sea." "The latter notion," as Sir William Flower points out, "is probably connected with the old feudal law cited by Blackstone, that the tails of all whales belonged to the Queen as a perquisite to furnish her Majesty's wardrobe with whalebone." Scaliger, too, in his commentaries upon Aristotle, observes of whalebone, "In superciliis lamellas habet quae cum caput mergit attolluntur ab aqua: atque ita videndi potestas sit: ubi vero ex aqua exerit, concidunt lamellae, atque tegunt oculos." Probably this and the former view is due in part to the tiny eye which escaped attention, and indeed seems on account of the peculiar development of the skull to have an abnormal situation.

Nevertheless, at the same period at which Belon wrote the accurate location of whalebone was understood. For Olaus Magnus described in a stranded Rorqual (?) the whalebone, of which he remarked: "Palato adhaerebant quasi laminae corneae," and proceeded to point out that these laminæ were not all of the same size, a fact which is well known to be the case with the laminæ of whalebone.

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Later still whalebone was quite properly described by T. Johnson (in 1634) as "the finnes that stand forth of their mouths, which are commonly called whalebones, being dried and polished, serve to make buskes for women." Shakespeare, however, seems to have confused the true meaning of the term. He writes of "teeth as white as whalebone." But it is believed that by whalebone in this case is meant the tusks of the walrus, an animal which was often and at many times confounded with whales; indeed, it is not always easy to decide whether a given illustration refers to this animal or to some large toothed whale, such as *Orca*. There is, however, curiously enough, some justification for accepting Shakespeare's epithet of white in a perfectly literal fashion, for in many whales the whalebone is white, or whitish in parts or altogether.

The more celebrated Dr. Johnson, in the *Dictionary* (edition of 1818), defines whalebone as "the fin of a whale cut and used in making stays," thus reverting to earlier errors.

It is, however, just possible that the stiff, tendinous tissue of the actual tail was made use of as a material for stiffening articles of wear. It is quite conceivable that when dried it might form a cheaper substitute for real whalebone; the number of times that the expression "fin" is employed, and the evident knowledge possessed by at any rate some persons who correctly located the true whalebone, may perhaps point this way.

Whalebone has—it need hardly perhaps be remarked—nothing to do with true teeth; but it is

PLATE VII.

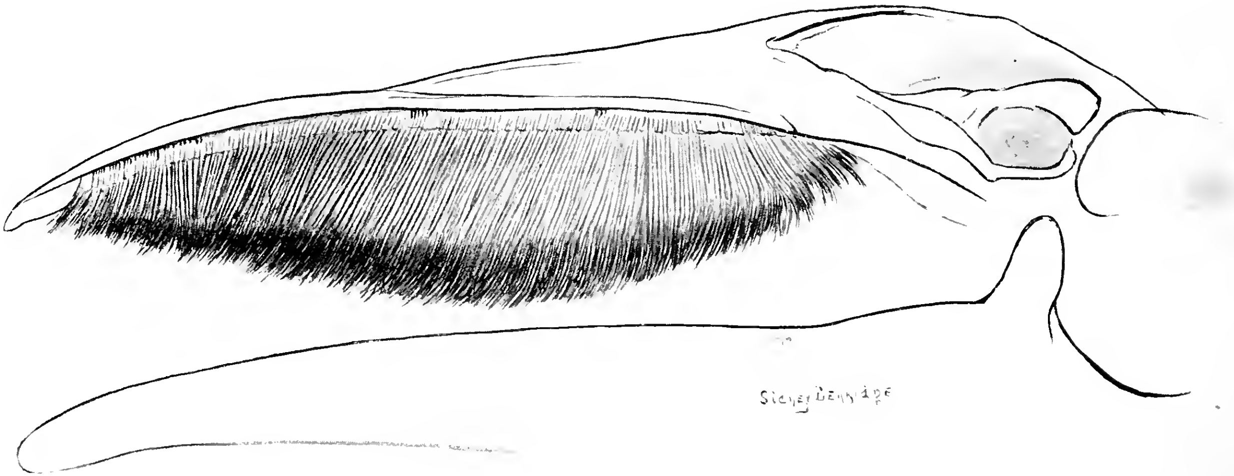

FIG. 18. Head of *Balænoptera*, showing whalebone.
(From a specimen in the Nat. Hist. Museum)

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distinctly analogous to the horny so-called teeth of the Ornithorhynchus. And it is an interesting fact that the whales show the same tendency observable in other groups of the animal kingdom to the replacement of teeth by horny structures. The horny teeth of the Platypus have their forerunners in the shape of true teeth, which are shed early. In birds the most archaic forms had true teeth; but the birds of to-day have developed in their place the horny beak which characterises them.

The whalebone whales start life with rudimentary teeth, which ultimately disappear on the appearance of the whalebone. (See p. 68.) The general character of whalebone resembles that of horns or hair. The colour is black or white or brown. The place where the whalebone is formed is the roof of the mouth, the palate. The plates of whalebone are triangular in shape, the base of attachment being broader than the lower, free extremity. The plates are attached by the broad base to the roof of the mouth, and they may indeed be regarded as an exaggeration of the ridges, often horny in character, which are found upon the roof of the mouth of all mammals. The plates are arranged in a direction transverse to the long axis of the mouth and are very numerous, as many as three hundred and seventy having been counted. The blades are longest in the middle of this long series, and gradually diminish towards both ends of the mouth. The outside of the blades, that turned towards the lips, is straight and hard; the inner side is frayed out into innumerable hair-like processes. Thus an exceedingly efficient straining apparatus is formed. The fine hairs entangle the minute creatures upon which the Greenland whale feeds, and at the same time allows the water to escape through the sides of the mouth between the lips. A more detailed description of the mechanism of the whalebone in the Greenland whale will be found under the account of that whale.

It has been suggested that certain transverse lines upon the plates of baleen are annual rings. In this event the Greenland whale lives to an age of nine hundred years!

The use of whalebone for ladies' stays, and formerly for the ribs of umbrellas, is well known. But it may be one of those things not so generally known that certain rich silks which "stand of themselves" owe some of their firmness to very thin shreds of whalebone incorporated with the silk threads!

Another little known use of whalebone was its employment in the thirteenth century as plumes for helmets. This use is proved by two passages from William the Breton, where the Count of Boulogne is described as wearing upon his helmet the "Branchia Balaenae Britici . . . ponti." This reference has been collected by M. Fischer in his careful account of the Biscayan whale, to which further reference will be made below when that species comes to be treated of. Whalebone is still a costly article. Mr. Southwell, in an article in the *Zoologist* for 1897 (p. 56) upon the whale fishery of the preceding year, observes that the value of the "bone" was £2000 per ton. As twelve Right whales produced 135¼ cwts. of whalebone, the results of a successful whaling cruise are considerable.

CHAPTER III.

A COMPARISON OF WHALES WITH OTHER AQUATIC MAMMALS

WHALES COMPARED TO SEALS

IN the preceding pages a great deal has been said about the influence of environment upon structure, or to put the matter in a fairer way without prejudging the issue, of the connection between environment and structure. A study of other aquatic mammals, however, and a comparison of them with whales, brings out very clearly the fact that the organism is not moulded in precisely the same way in every case. It would be strange indeed if it were so, seeing that the material upon which the same influences have to work is different.

The tribe of seals forms a very convenient starting-point in such a series of comparisons, for there is no doubt at all about the affinities of these marine Carnivora, and they show a series of stages of more and more perfect adaptation to an aquatic existence. It is easy, therefore, here to distinguish between structural features which are related to the aquatic life and those which are definite peculiarities of the group not so related.

The "seals" unquestionably form a subdivision of the Carnivora to which—on account of the fin-like character of the fore limbs—the name of Pinnipedia has been given; further than this, it is possible to place them nearer to the Bear division of the land Carnivora than to the other groups.

The effects of a seafaring life are more plainly seen in the true seals than in the Walrus or the Sea-lions. The latter group in fact is a stage leading towards the more completely aquatic seal.

In the true seals (Phocidae) the form is more fish-like; the nostrils have come to lie upon the top of the head instead of terminally; the external ears have completely vanished, the auditory organ being marked externally by a hole only; the hind limbs are quite useless for progression on land, being quite bound up by integuments with the tail. The sea-lions can move with some rapidity upon dry land, since the hind limbs have not so nearly lost their original functions. The external ears are present but much reduced; they vary, moreover, in the degree of reduction, being much larger in the Cape Sea-lion, *Otaria pusilla*, than in the beast of Patagonia, *Otaria jubata*.

In these external characters there are certain obvious resemblances to whales—the fish-like form, the disappearance of the conch of the ear, the form of the fin, which is even falcate in form in both groups of aquatic mammals; the removal (in the seals) of the nostrils to the top of the skull, though not to a point so far back as in the whales; these are plain and obvious likenesses. There are others, which a closer study and comparison of the two groups bring to light. The flippers have no nails in the whales, though in the fœtus traces of the structures have been discovered by Kükenthal. In the sea-lions the nails, though still recognisable, are exceedingly small, and not of the faintest use for scratching or any other nail function. This is not always the case with the true seals; in *Phoca*, the seals of our coasts, there are well-developed claws on the hand, but on the other side we have the Antarctic genus, *Ommatophoca*, with the fore limbs furnished only with quite rudimentary nails. The nails, therefore, may be fairly said to be disappearing in all these animals.

Another feature in which there is a functional resemblance between whales and seals is in the hind limbs. Considering that the latter are merely represented by tiny rudiments in the whales, the comparison may seem at first sight to be a little ridiculous. But there is, as has been observed, a functional likeness in spite of this obvious dissimilarity. The hind limbs of the seal tribe play the part of a tail; they are extended beside the tail and act precisely as do the flukes of the tail in the whale; it is by their means chiefly that the creature is propelled through the water. In the one group the unnecessary hind limbs have nearly disappeared altogether; in the other they have, as it were, become part of the tail. It is evident that an aquatic beast does not need the usual two pairs of limbs; the fact is shown also among fishes, but again in a different way from that which we see in whales and seals. In many fishes the hinder pair of limbs persists, but is moved forwards so as to lie in the same straight line, or thereabouts, with the anterior pairs of limbs. In primitive fishes, on the other hand, such as *Ceratodus*, the Australian mudfish, both limbs persist in what we have to consider as the normal position. It is exceedingly interesting to note that in the three groups cited a practically similar result is obtained in a totally different manner.

In the last-mentioned character, therefore, as well as in others which will be dealt with presently, the seal tribe have pursued a different path towards the complete adaptation to the aquatic life to that followed by the whale tribe. But there is still a point remaining, among what are practically external features, in which the seals resemble to a certain extent the whales. It is usual among terrestrial mammals for the humerus to be longer, sometimes much longer, than the radius. On the other hand, with the sole exception of *Inia*, the whale's humerus is shorter than the radius. Dr. Mivart* has given some measurements of these bones in representatives of the three kinds of aquatic Carnivora, and his figures are as follows: "In the common seal, *Phoca vitulina*, the length of the humerus is 11 inches and that of the radius the same; in *Otaria jubata*, the Patagonian sea-lion, the two bones measure respectively 23 and 24 inches. Finally, in the walrus the proportions are 30 and 23. It is curious to observe that the sea-lion is the most whale-like of the three types."

* "Notes on the Pinnipedia," *Proc. Zool. Soc.*, 1885, p. 485.

Now as to external features in which the seal tribe differ from the whales. In the first place the former have completely retained their hairy covering. There is no hint of a commencing baldness whatever. Moreover, there is not here a case of the substitution of one organ for another that plays a similar part; for the seals have an abundant layer of fat, and are pursued for purposes of oil as much as are whales. They have fur and blubber. Again, the extra length of digit required is not brought about in the Cetacean fashion by the increase in the separate phalanges of the fingers, but by the formation of cartilaginous extensions of the fingers beyond the nails. That these are beyond the nails shows that they are not comparable to the extra phalanges of the whales; for the rudiments of nails, which have been discovered in whales, are terminally placed upon the hand.

A peculiarity which the sea-lion shares with the whales is the great breadth of the scapula; for some reason or other this seems to be useful to an aquatic animal, for it is in these two types that the scapula seems to attain to its greatest diameter. It is true that in Edentates the same bone is also very broad, and that it is relatively narrow in the Manatee; but the breadth is most striking in the sea-lion and in the whale. But on a close comparison of the blade-bones of the two it is to be noticed that, in spite of superficial likeness, there are fundamental differences. In the sea-lion it is the front part of the bone, that which lies headwards of the spine, that is expanded most;

in the whale it is precisely the reverse. Hence the same general result is brought about in a totally diverse way in the two orders of aquatic mammals.

WHALES AND SIRENIA

The Sirenia form the third most important and the last group of aquatic mammalia. They are a limited race to-day, though there are remains of more abundant genera in the past. Living now are only the two genera, *Manatus* and *Halicore*. The former are South American, West Indian, and West African; they are coast-living and fluviatile animals, which browse along the bottom of the sea or of rivers upon algæ. Thus is derived their name of Sea-cows. There seems to be four species of this genus. *Halicore*, the Dugong, is an eastern creature apparently of only one species.

Most persons are aware that quite recently there lived on the shores of Behring's Straits a third variety of this group of mammals, the *Rhytina*, or Steller's Sea-cow. This has been extinct since about 1770. But, as its external characters are known, it may come into the following comparison of Sirenia with whales.

The general form of the body of these sea creatures is not especially whale-like; they offer, as it were, an intermediate, incomplete form, half-way between the purely terrestrial animal and the totally aquatic whale. Dr. Semon, who observed the Dugong in Torres' Straits, remarks of it that it appears to the eye "more fish-like than seals, and more mammal-like than whales."

The Dugong, however, and the Rhytina are so far whale-like in that they possess a forked tail, set, of course, as in whales, and not as in fish. In the Manatee the tail has another form, which, as has already been mentioned, is not unsuggestive of the tail of the fœtus of certain whales. It is interesting to notice that here, as in some other points, the Dugong and the Rhytina are more whale-like, or at least more purely aquatic in their structural features, than is the Manatee.

There is one small point of possible comparison between the whales and the Sirenia which seems to have been overlooked. It is well known that the upper lip of the Manatee is cleft vertically, and that the two halves of the upper lip thus divided act as a pair of grasping organs for the leaves on which the animal feeds. Rudiments of the same structure, which are much more pronounced in the fœtus, also exist in the Dugong.

Now it has often been noticed that in whales between the two blow holes is a furrow. It seems to be just within the bounds of possibility that this groove is a still further reduction of the same splitting of the lip which is so useful to the Manatee. Apart from this, however, we may notice that in the Sirenia the nostrils are superior in position, and that in *Halicore* they are more so than in *Manatus.* Another reason is to be seen here for regarding the Dugong as the more perfectly modified animal of the two. The external ear of the Sirenia has vanished, leaving only a minute ear-hole, as in the Cetacea.

The body of the Sirenia is, however, more hairy than that of whales; yet the hair is scant and coarse. Dr. Kükenthal has discovered that formerly these animals possessed, in addition to the sparsely-scattered strong hairs, a covering of finer hairs. In these animals, therefore, as in the whales, the aquatic life leads to the loss of the hairy covering of the body, so characteristic of land mammalia. It may be mentioned, moreover, that the hairs are especially strong upon the upper lip, thus recalling the only hairs that are left in the whales, which clothe, or rather are found upon, the same region. Sweat glands, moreover, fail entirely, as in whales. Only in an embryo of *Manatus latirostris* did Kükenthal find some after all rather doubtful traces of these glands. They are, of course, absent in whales.

Finally (so far as concerns the skin), the sebaceous glands, such constant companions of the hairs in mammals generally, are beginning to vanish altogether in the Sirenia. They occur, however, though in a rudimentary shape, in the fœtus, while they are completely absent in the few hairs of the whales.

As in the whales, the skin of the Sirenia is underlaid by a copious blubber, which doubtless plays the part, that should be performed by the hair, of preserving the heat of the body. It has, however, been remarked that in the Sirenia the blubber is unlike that of the whales in that there is no free liquid oil comparable to the spermaceti of the Sperm and other whales.

The Sirenia have, like the whales, the fore limb of a fin-like form. But there are differences in the completeness with which this metamorphosis has progressed. The Dugong has become more completely aquatic in this particular than the Manatee. The latter, with the exception of the species *M. inunguis*, has preserved the nails upon the extremities of the fingers, while these have entirely disappeared in the Dugong. Moreover, in the latter genus the forearm no longer takes any part in the formation of this "fin"—a feature which, of course, is shared by the Cetacea. Professor Kükenthal has, however, called attention to a curious similarity which exists between the hand of these Sirenians to that of the sea-lions, in the shape of numerous papillæ and grooves upon the under surface. This is associated in the Otariidae with a partial life upon land, and the existence of these structures in the Sirenia seems to indicate a more recent abandonment of the terrestrial life than has been the case with the Cetacea, whose flippers are smooth. A reason for their retention, however, in the Dugongs is perhaps to be found in the fact that these creatures graze upon beds of seaweed as a Herbivorous mammal does upon a field of grass; and the rough papillæ prevent the animal from slipping when thus engaged in cropping its food. In the skeleton of the fore limb there are no strong resemblances to the whales, for the joints between the bones are well developed, and there are only slight beginnings of hyperphalangy, so characteristic a feature of the Cetacea.

When we turn to the internal structure of the

Sirenia, the resemblances which they exhibit to the Cetacea by no means disappear.

The bony framework of the head is perhaps the part of the skeleton which shows most unlikeness in the two groups. And this fact is not without significance, for it is precisely in that region that external influence would not play so strong a part as it might well be supposed to do elsewhere. "The skull," remarks Professor Zittel,* "shows not the least resemblance to the Cetaceans." Nevertheless, the nasal bones are much shortened, though that is a character found elsewhere. It is no use to give any detailed analysis of the skull and comparison with that of the whales. In the vertebral column the fusion of the second and third vertebræ of the neck must not be looked upon as being really a strong point of likeness to whales, since in the Edentata the same fusion occurs. More important, perhaps, as a likeness is the thin character of the centra of those vertebræ in *Rhytina*. The reduction in number of the vertebræ of the lumbar region is paralleled in *Inia*, which, as has been often remarked, would appear to be an early type of whale.

More striking as evidence of likeness between the Sirenia and the Cetacea is the shortened sternum, and the fewness of the ribs attached thereto. But here again we may have to do with the need of powerful respiratory movements in these diving animals. As to the hind limb, it is instructive to notice that a pair of hind limbs do not seem to be at all necessary to swimming and diving creatures.

* *Handbuch der Palæontologie*, Abth. I., Bd. iv.

CHAPTER IV.

THE POSITION OF WHALES IN THE SYSTEM AND THEIR CLASSIFICATION

IN order to pursue matters in logical order we must go back, first of all, to the question raised before, Why is a whale not a fish? For the sake of those who are not well versed in the facts of comparative anatomy it may be convenient to state briefly a few main reasons for placing the whale among the Mammalia, and not only not among the fish, but also in a position remote from all other groups of vertebrated animals—that is, the Amphibia, Reptiles, and Birds. A whale is a hot-blooded creature, breathing by means of lungs, which lie in the interior of the body in a definite chest cavity, shut off from the rest of the cavity of the body (that which contains the intestines, liver, etc.) by a largely muscular partition—the diaphragm. It has (frequently) vestiges of the hairs which cover the bodies of other mammals in the presence of a few scattered hairs in the neighbourhood of the mouth. It brings forth its young alive, and suckles them with milk. The bones of the skull are precisely those of other mammals, and only differ slightly in their relative arrangement. These characters are quite sufficient for the present purpose; many might be added to them of course. No creature which has these characteristics is anything but a mammal. One or two of them are wanting in those lowest of the mammalian tribe—the Ornithorhynchus and Echidna; they do not bring forth their young alive, but lay eggs; still, when born the young Echidna and Platypus are nourished by milk. Fishes—a very few of them—may have what are believed to be the representatives of lungs, and with which, indeed, they actually breathe; but they have also gills, and the vast bulk have no breathing organs except these gills. Lungs are found higher in the series, but no diaphragm like that of whales until we get to mammals.

But to go further than this, and to decide whereabouts in the long series of mammals the whale tribe should be intercalated, is a matter which is at present beyond our knowledge. We may, however, discuss the matter for a little in order to show the grounds of our ignorance.

From the sketch which has just been given of the outward form and the internal structure of whales, it will be apparent that the nature of the medium in which they live has profoundly affected the characters of the different organs. There is positively no part of the body, with the exception perhaps of the brain and the stomach, and one or two other points to be referred to later, that has not been evidently altered in some way, more or less, in different cases, to meet the changed conditions of life as we believe them to have been. There is, therefore, obviously some difficulty in ascertaining, or endeavouring to ascertain, what are the real differential characters of the group; to separate, that is to say, characters due to the environment and those which have been inherited from the long extinct terrestrial ancestor. The current definitions of the group Cetacea are obliged to be founded on these, as we must assume them to be, recently-acquired characters. To take one or two as examples.

Professor Zittel* defines them in the following terms: "Naked, smooth-skinned, fish-like water-dwellers, with cylindrical body. Head not separable from the body. Nasal orifices on the upper side lying far back. Anterior limbs fin-like, hind limbs wanting. Tail fin horizontal. Milk glands abdominal in position."

Messrs. Parker and Haswell† use the following language: "Aquatic Eutheria, with large head, fish-like, fusiform body, devoid of hairy covering, with the pectoral limbs paddle-like, the pelvic limbs absent, and with a horizontal caudal fin. A vertical dorsal fin is usually present. There is a long snout, and the nostrils open by two lateral external apertures or a single median one, situated in all recent forms far back towards the summit of the head. The cervical region of the spinal column is very short, and its vertebræ usually completely united together. Clavicles are absent. The humerus is freely movable at the shoulder, but all the other articulations of the

* *Handbuch der Palæontologie*, iv., p. 155.
† *Text-book of Zoology*, vol. ii., p. 450.

limb are imperfect. The phalanges of the second and third digit always exceed in number the number (three) normal in the Mammalia. The pelvis is represented by a pair of horizontally-placed styliform vestiges of the ischia. Teeth may be absent and their place taken by sheets of baleen or whalebone; when present they may be very numerous and homodont, or less numerous and heterodont, or reduced to a single pair. The epiglottis and the arytenoids are prolonged, and embraced by the soft palate, so as to form a continuous tube for the passage of the air from the nasal cavities to the trachea. The brain is large, and the cerebral hemispheres are richly convoluted. The testes are abdominal. The teats are two, and are posterior in position. The uterus is two-horned; the placenta diffuse and non-deciduate."

This definition is more comprehensive, but it still does not state all those features in which whales differ from other animals, which are not clearly connected with the need for a fish-like form and life at times in great depths of the ocean.

It seems possible to extract from what has been said here, as essential characteristics of the group, the following facts of structure:—

In the Skull.—The separation of the two parietals by the intervention of the supra-occipital, or their concealment by its overlapping.

The overlapping of the muzzle generally by the premaxillæ.

The loose attachment between the various bones surrounding or connected with the organ of hearing.

The absence or feeble development of the coronary process of the lower jaw.

In the Fore Limb and Girdle.—The absence of clavicle.

The greater length of the radius and the ulna than the humerus.

The frequent presence of the typical number of bones in wrist.

The long and simple lungs.

The unlobulated liver and complex stomach.

The extraordinarily shortened, but much convoluted, brain.

This combination of characters is found nowhere else among the mammals, and, indeed, the bulk of the peculiarities are confined to the whales. I might also perhaps have added some few others, and certainly more than one characteristic feature might have been included in the list, had I not limited myself to those which occur both in whalebone and in toothed whales. As there is some idea to the effect that the two great divisions of the Cetacea have had a separate descent, even from unlike ancestors, this had, however, better be deferred until after we have seen what can be done with the broader facts in settling the affinities of this highly puzzling group of creatures.

It is to be feared that nothing can be done except, and that vaguely, to suggest an Ungulate-like ancestor. In them we have in some forms, at least the Ruminants, a highly complex stomach and a rather simple liver. But there is really nothing else of first-rate importance to make the comparison stronger. As undoubted whales occur back to the Eocene they have possibly come off from some earlier stock still, and Professor Albrecht has advanced and ingeniously supported the view that the Cetacea are the nearest thing now existing to the necessary, but unfortunately hypothetical, "Promammalia," the race which gave rise to all mammals. His arguments will be partly gone into here; for at any rate they give some colour to a primitive ancestry of our whales, a result to which other considerations—chiefly the failure to tack them on even with probability anywhere else—seem to drive us.

Unfortunately, as a general rule, it is by no means easy to distinguish between simplicity which is the effect of degeneration and simplicity which may be fairly interpreted as a retention of earlier and simpler conditions of structure. Sometimes it seems to be obvious enough to which category to refer an apparently primitive state of affairs in an organ. For example, while everyone admits nowadays that the Amphibia are close to the fishes, no one would probably suggest that the total absence of lungs in certain Salamanders is due to the final disappearance of the air bladder of the fish-like ancestor, whose disappearance is commencing to be indicated by the loss of a connection with the œsophagus in many fishes. It is a question of simplification and degeneration within the tribe of newts themselves. And when Professor Albrecht* alleges the absence

* "Uber die Cetoide Natur der Promammalia," *Anat. Anzeig.*, i., p. 338.

of a sacrum in the vertebral column as a primitive character it seems impossible to accept his view, and to do otherwise than regard this simplification of the vertebral column as due to the dwindling hind legs, and to the consequent absence of any need for strong support from the vertebral column. Again, whales have not only not an external ear (in the adult condition), but also no ear muscles, which are so highly developed in terrestrial mammals with mobile ears. In criticising Professor Albrecht's statements and suggestions Professor Max Weber* points out that some time since Professor Howes showed in the fœtal porpoise rudiments of external ears and of a muscle, which can hardly be regarded as a beginning of these structures, so essential to an ear which plays an important part in the life of terrestrial mammals. For they are only found in the embryo; if commencing structures they should be more apparent in the adult. Vestiges, remains of former structures, indicate their earlier existence by appearing for a brief time during development, and then fading away as maturity is reached.

Some other features in the organisation of the Cetacea may, perhaps, be interpreted as really primitive.

Among the whalebone whales the two halves of the lower jaw are only united by what is termed syndesmosis, a weaker union by ligaments than the strong, bony union ("ankylosis"), which is prevalent in mammals generally. It may be urged, however,

* "Uber die Cetoide Natur der Promammalia," *Ibid.*, ii.

that this has really to do with the mode in which the Rorquals and Right whales feed. The capacity for taking in enormous gulps of water containing the minute animals upon which the majority of these whales feed would be advantaged by a distensibility of the mouth, and a consequent increase in size of the mouth cavity. Of more importance in connection with the anatomy of the lower jaw is the discovery by Professor Albrecht of a separate supra-angular bone. It is a distinguishing feature of the mammals, as contrasted with the reptiles lying beneath them in the series, that the lower jaw is almost entirely formed of a dentary bone alone (a small chin bone sometimes occurring also). Now in reptiles a large number of separate elements enter into its formation, so that the occasional occurrence in *Balænoptera sibbaldii* of the supra-angular is so far an archaic feature. So too, possibly, is the marked separation of the sternum into two hemisterna. This is particularly apparent in the Cachalot and in the Ziphioids. Now the sternum is developed from the ends of the ribs on both sides, and in the embryo it is always double; later the fusion of the two halves takes place, and the apparently median-sternum arises. In lower vertebrates the double condition often survives.

That there is often a seventh cervical rib in whales is a remnant of a former state of affairs; for in reptiles there are a series of ribs depending from the neck vertebræ. But after all such an additional rib has been often met with in other mammals. Professor Albrecht points out that the Cetacea resemble the fishes in that the occipital bone joins the frontal. It is no doubt, as has already been pointed out, a very curious fact in their anatomy, and one not easily susceptible of an explanation. But to liken them to fishes for this reason seems to prove too much; what we want on the "promammalian" theory is rather a likeness with lowly-organised reptiles. It cannot, of course, be seriously maintained, as Professor Albrecht would have us believe, that the dorsal fin is an inheritance from a fish. Dr. Murie's comparison of it to the hump of the camel is far better.

Professor Weber has justly dwelt upon the excessively complicated brain, and upon the mode of the attachment of the fœtus to its mother, in support of the more orthodox view that the whales are not primitive Mammalia at all. If we are to place them in this position we must displace the monotrematous mammals (Ornithorhynchus and Echidna), whose organisation in so many points places them unquestionably at the base of the existing mammals. The general conclusion which best suits the facts at our disposal seems to be to look upon the Cetacea as an offshoot from an early group of the higher Mammalia. This is unsatisfactory in its vagueness, no doubt; but it is difficult to see what more can be said which is not entirely speculative and devoid of foundation in ascertained fact.

Having then attempted, and, it must be candidly confessed, failed, to place the whales accurately in the system, it remains to arrange them with reference to each other. It is easier to do this than to solve the first problem. There is, however, an initial difficulty in the great superficial likeness which the various members of the whale tribe bear to each other. It needs no arguments to prove that the Mammalia are essentially a land race other than those which have already been advanced. To inhabit the water is a mode of life entirely foreign to their organisation. It is perhaps this which, in part at least, accounts for the uniformity of structure which the large group of whales exhibits. So little divergence from the suitable structure would be just the fatal straw. We find as a support of this way of looking at the matter similar uniformities in groups which inhabit an unusual medium. The group of birds, for example, which contains an enormously large number of different species, and is yet characterised by so great a uniformity of organisation that the task of classifying them has proved insuperable, is an example of a race which has probably been modified to the aerial life from a life among the branches of trees. Here again a certain organisation is needful to live that life, and wide departures from the most fitting type of structure are not to be seen.

A slight structural divergence might easily prove fatal to the perfect fulfilment of their functions as flying animals. Everyone is agreed that the orders of birds are separated from each other by characters of far less importance than those which separate many, if not all, of the orders of the purely terrestrial mammalia. The Cetacea, it is true, form but one group equivalent to the Ungulata, the Rodentia, etc.

But it would seem that they are more alike, one genus with another, in external build and internal conformation, than are either of two groups cited. There are, for example, larger differences in the organs of digestion among the Rodents and Ungulates than are met with in the whales; the variability of external form it is hardly necessary to dwell upon. The teeth differ much more in form from one Rodent genus to another, or from one Ungulate genus to another, than in the whales, generally speaking.

Fishes, on the other hand, which are born and bred to the aquatic life, show just as many (if not more) divergences of structure as do the mammals. The expression "fish-like" is, it is true, often used to describe a certain shape; but what could be more utterly different in shape than a skate and an eel, or a sunfish and a sole? Here we have the precise converse of the case afforded by whales. The whole organisation being fitted to the marine or fresh-water life, there is ample room for much variation without affecting the necessary essentials.

Bearing in mind then the profound influence which the aquatic life seems to have had in moulding the external as well as the internal form of whales, it is not surprising that several naturalists have arrived at the conclusion that those structural differences which do exist argue the justice of dividing the group into two great orders, the toothed and the whalebone whales, which have arisen from separate ancestors, and have only come to resemble each other in various details owing to "convergence," *i.e.*, the likeness is superficial and due to similar conditions, not similar descent. This convergence is not an uncommon fact in nature. Such likenesses as there are between the seals and the whales and between the Manatees and the whales are examples. "Flying" Rodents and "Flying" Marsupials exhibit another instance of the same phenomenon.

In technical zoological parlance then, by those who believe the whales to be two groups originally distinct from each other which have come to lie side by side, they would be spoken of as "diphyletic." That there do not appear to be any annectant forms between the toothed and the whalebone whales is so far in favour of this view. But much more than that is necessary to lend even a colour of probability to the suggestion.

It is perfectly true that the two great divisions of the Mystacoceti and the Odontoceti are, as will be seen from the definitions which follow, separated from each other by exceedingly trenchant characters; so, for the matter of that, are the Archaeoceti from both. But what appears fatal to us to the idea of a double origin is the exact correspondence in certain structures, which, so to speak, need not necessarily have been the same. Among these the peculiar form of the scapula stands pre-eminent. It is only in whales, and it is in all whales, that this shape of scapula is met with.

CHAPTER V.

THE HUNTING OF WHALES

THE economic products of whales are (not in order of importance): (1) The flesh, (2) the bones, (3) the whalebone, and (4) the oil derived from the blubber.* It is for these substances that they are hunted.

The first two need not detain us long. The flesh of the Caaing whale, as noticed on page 28, is utilised by the inhabitants of the Orkneys as food, and that of various other whales is eaten, but it is not an article of at all general consumption. The bones as well as the flesh can be and are utilised, in the case of stranded whales, for manure; and the ribs have been at various times and by different peoples used to build huts with. Nearchus relates how the natives of the Mediterranean built houses of these bones, and structures of the same kind are illustrated by Olaus Magnus.

The oil of whales is derived from the blubber, which, as already said, forms a thick coating immediately underlying the skin. Besides, there is in

* Ambergris, a product of the Sperm whale only, is dealt with below on page 197. Something has already been said of whalebone. (*Supra*, p. 80.)

many whales, especially in the Sperm whale, a certain amount of clear oil contained in the head, which is solid when cold, and is known as spermaceti. But you must first catch your whale, and then extract the oil. The use of whale oil seems to be very ancient. M. Pouchet* tells of a convent mentioned in the life of St. Philibert which had run short of oil. In answer to the prayers of the inmates a large whale was found stranded the next day. This was in the year 684. M. Pouchet thinks that whales were more frequently stranded in old times than now, for the reason that—not being hunted—they were necessarily more numerous.

It seems to be hardly a matter for doubt that whales were first of all utilised only when stranded on the shore. And very numerous are the records of whales cast up upon our coasts and those of other European countries. A number of these events are collected together by van Beneden, in his *Cétacées des Mers d'Europe*, and more recently Parona† has described the whales of the Italian shores. There are numerous other scattered, and more or less elaborate, enumerations of the stranding of different species of whales. John Evelyn, in his *Diary*, records a large whale which came ashore near to his house. It seems probably, from the size and other suggestions, to have been a Rorqual. Here is his description :—

"A large whale was taken betwixt my land butting

* *Comptes Rendus Soc. Biol.*, 1890, p. 686.

† *Atti. Soc. Ital.*, xxxvi., p. 297.

on the Thames and Grenewich, which drew an infinite concourse to see it, by water, horse, coach, and on foot, from London and all parts. It appeared first below Greenewich at low water, for at high water it would have destroyed all the boates, but lying now in shallow water incompassed with boates, after a long conflict it was kill'd with a harping yron, struck in the head, out of which spouted blood and water by two tunnells, and after an horrid grone it ran quite on shore and died. Its length was 58 foot, heighth 16; black skinn'd like coach leather, very small eyes, greate taile, onely two small finns, a picked snout, and a mouth so wide that divers men might have stood upright in it; no teeth, but sucked slime onely as thro' a grate of that bone which we call whalebone, the throate yet so narrow as would not have admitted the least of fishes. The extreames of the cetaceous bones hang downewards from the upper jaw, and was hairy towards the ends and bottom within side; all of it prodigious, but in nothing more wonderfull than that an animal of so great a bulk should be nourished only by slime thro' those grates."

In Holinshed's *Chronicle* we read that in 1531 "the five and twentieth of Maie, between London and Gravesende were taken two great fishes called whorlepooles, male and female." These were presumably either *Balænoptera*, or perhaps more likely Sperm whales. The expression "whorlepoole" for large whales was very common at that period.

Earlier still, and also in the Thames, we hear from Fabyan's *Chronicle* that in the year 1472 "were taken at Eryth within XII miles of London iiii wonderful fysshes whereof one was called Mors Maryne, the second a Sworde fysshe and the other ii were Whales, which after some exposytors were pronostycacions of warre & trouble." The Mors Maryne of this description, one would think, could hardly be a Walrus; it was very possibly an *Orca*, of which three individuals came up the Thames so lately as 1890. The notion of the appearance of these huge whales being a portent of dire trouble is common. In Stowe's *London* is recorded the stranding in the Thames, at Blackwall, of a "Parma-Ceti whale," the Sperm whale of course. A curious variant in the spelling of this word occurs in Baker's *Chronicle*, where the stranding of a Sperm whale is recorded, and the writer goes on to remark, "The Oyl being boyled out of the head was Parmacitta."

For the following account of a whale hunt in olden times, and also up the Thames, I am indebted to the Rev. William Hunt. The story comes from the *Chronica Majora* of Matthew Paris; the date is 1240:—

"Balaenae circiter undecim praeter alias beluas marinas in litore maris Angliae contermino mortuae, et quasi in aliquo certamine laesae . . . sunt projectae . . . Unde nautae et seniores maris confinia habitantes . . . asserebant bellum fuisse inauditum inter pisces beluas et monstra marina, quae sese adinvicem mordentia et collidentia alterno impetu interemerunt, unde mortua ex illis ad litora sunt projecta. De quorum piscium (numero) unus, monstrosae immanitatis belua, in Tamensem veniens, vix inter pilas pontis illaesus pertransierit. Ad manerium autem regio quod Mortelac (Mortlake) dicitur, insequentibus multis navigatoribus cum funibus et balistis et arcubus, perveniens, ibidem jaculorum ictibus vix est peremptus."

No season passes without the record of a few whales stranded upon the shores of Great Britain, and it is to this fortunate circumstance that our knowledge of whales is so largely due.

The discovery of the economic value of many parts of these huge monsters led naturally to their pursuit, either from the shore or in the open sea. As to the actual date of the first active hunting of whales there is dispute, the real date of the origin of this pursuit being difficult to ascertain. Some say that the Basques were the earliest race to engage in the pursuit of whales as a commercial enterprise; others hold that the Norwegians were the pioneers in this branch of industry. Probably whales were first of all hunted from the shore, as, indeed, they are now in the case of the Californian grey whale off the Pacific shores of North America. As to the Norwegians, the following passage may be quoted from J. Ross Browne:—*

"'As early as 887,' according to Anderson (in his *Historical and Chronological Deduction of the Origin*

* Quoted by SCAMMON (*Marine Mammals*, p. 186).

of Commerce), or, as Hakluyt thinks, about 890, 'our excellent King Alfred' received from one Ochther, a Norwegian, an account of his discoveries northward on the coast of Norway; a coast which appears to have been before very little, if at all, known to the Anglo-Saxons. There is one very remarkable thing in this account; for he tells King Alfred 'that he sailed along the Norway coast, so far north as commonly the whale hunters used to travel,' which shows the great antiquity of whale fishing, though undoubtedly then and long after the use of what is usually called whalebone was not known; so that they fished for whales merely on account of their fat or oil."

This story seems to show not merely a great antiquity for the pursuit of whales, but that the fishery was carried on from the shore. No doubt as soon as the value of stranded whales was ascertained they would be hunted in this fashion, and then as the shore-coming whales got scarcer they would be pursued by the whalers further and further into the ocean.* Anyhow, whatever may be the actual date of the first practising of whaling as an industry, it is clear that it was known in this country as early as before the year 1000, for there is an

* The shore fishery, however, has been up to recent times and is still largely pursued in various quarters of the globe. In New Zealand the Hon. W. Pember Reeves (*The Long White Cloud*, 1898) informs us this industry commenced in the last decade of the eighteenth century. In the "forties" it became important, and in 1843 there were more than thirty shore stations, employing 500 men. The value of oil and whalebone of that year was £50,000.

interesting dialogue preserved, written by one Aelfric, Abbot of Ensham, in which the subject of whaling is dealt with.* This is in the form of a conversation between the master and his pupils, written in order to familiarise the pupils with Latin conversation. The master begins by inquiring what is to be caught in the sea. The pupil then enumerates the following curious assortment of "marketable marine fishes": "Aleces et isicios, delphinos et sturias, astreas et cancros, musculos et torniculos, neptigallos, platerias et platessas et polypodes et multa alia." Then the master: "Vis capere aliquem cetum?" "Nic." The reason is then demanded. The youth is supposed to reply: "Quia periculosum est capere cetum. Tutius est mihi ire ad amnem cum nave mea quam ire cum multibus navibus in venationem balaenae." "Et tamen," the master goes on to say, "multi capiunt cetos et evadunt pericula." It is plain, therefore, that whaling was practised, presumably in this country, at that date. It should be explained that the word *cetus* alone means whale; *balæna* means a sea monster generally. This is rather remarkable considering the derivation of Cetus from the Homeric word, which seems to mean a sea monster generally. Balæna usually definitely means whale. But the words "hwael" and "hranes" seem to put the matter beyond a doubt. The American whale fishery began at any rate as early as the year 1614. At first the animals were pursued from the shore; and the island of Nantucket was the headquarters of the industry.

* For this I am also indebted to the Rev. W. Hunt.

The whales were watched for from a "tall spar," and when the animal was seen to spout the boats immediately set out in pursuit. The whale when captured was towed in shore, and the flensing carried out on the beach. Shore-whaling, however, was after no great a period abandoned, for the reason that the whales had begun to get scarce. Ships were then fitted out for long voyages, and in 1790 a ship fitted out at New Bedford doubled Cape Horn, and really inaugurated the South Pacific whale fishery. The names of the ships are characteristic of the date. Captain Scammon tells us that one of the first vessels to cross the Atlantic in search of whales (in the year 1770) was named the *No Duty on Tea*. The whale trade went on increasing for many years in leaps and bounds; in 1775 there were as many as 300 vessels engaged in the industry, and by 1846 the total number of ships had increased to about 730, representing an aggregate tonnage of 233,189 tons. At this period the "investments connected with the business are said to have been at least $70,000,000, and 70,000 persons derived their chief support from the whaling interests." That year, according to the statistics given by Captain Scammon, was apparently the culmination of the whale trade in America, for we observe a gradual diminution in the number of vessels until the year in which the statistics end, viz., 1872; in this year the number of ships was altogether only 218, representing a tonnage of 52,701. That there should be this decrease is not surprising, when we learn from the same table of statistics that during the years 1835–1872 about 292,714 whales must have been either captured or destroyed!

To write an adequate account of the whaling industry would need a volume to itself. We can only give a few facts. There is no doubt that here as in other countries the pursuit of whales has fallen off enormously in the last fifty years. This is to be partly explained by the increasing rarity of the more valuable kinds, and partly to the replacement of the substances for which whales are hunted by cheaper substitutes. Captain Yule, harbour-master of the port of Dundee, has been good enough to give me some valuable information with regard to the state of the whaling industry at that town for incorporation into the present volume. Writing to me in June, 1898, Mr. Yule stated that in that year the whaling vessels equipped at Dundee had met with but scant success; this fact, "coupled with the great fall in the price of oil, and the enormous expense of the voyage, has reduced the industry to such a point that only five vessels have left this season." The following table (also kindly supplied to me by Captain Yule) shows the number of ships and the number of whales caught in a series of years commencing with 1859. The decrease of both sets of figures is most noteworthy. Moreover, the heaviest decrease is in the number of whales. Whereas in 1861 eight vessels captured between them 121 whales, the same number of ships in 1897 only secured nine whales. This tells its own story. For some further details of whale fisheries the reader is referred to the sections dealing with the Greenland whale and the southern whalebone whale.*

DUNDEE SHIPS AT DAVIS STRAITS AND GREENLAND, WHALING.

Year.	No. of ships.	Whales caught.	Year.	No. of ships.	Whales caught.
1859 . .	6	71	1879 . .	15	72
1860 . .	7	27	1880 . .	14	92
1861 . .	8	121	1881 . .	15	53
1862 . .	8	82	1882 . .	15	79
1863 . .	8	19	1883 . .	13	17
1864 . .	8	31	1884 . .	15	79
1865 . .	7	50	1885 . .	16	27
1866 . .	11	30	1886 . .	15	17
1867 . .	12	2	1887 . .	10	9
1868 . .	14	108	1888 . .	9	6
1869 . .	11	9	1889 . .	10	14
1870 . .	10	61	1890 . .	10	18
1871 . .	10	133	1891 . .	9	15
1872 . .	11	105	1892 . .	10	10
1873 . .	12	158	1893 . .	4	29*
1874 . .	11	190	1894 . .	8	19
1875 . .	12	79	1895 . .	7	14
1876 . .	12	65	1896 . .	8	9
1877 . .	13	81	1897 . .	8	9†
1878 . .	15	7			

* Four ships at Antarctic and one at Nfld. only, and four at Davis Straits in 1893.
† 1897. One ship at Nfld. only, and eight at Davis Straits and Greenland.

* See for details of whale fishery in recent years a series of papers by Mr. Southwell in *The Zoologist*.

CHAPTER VI.

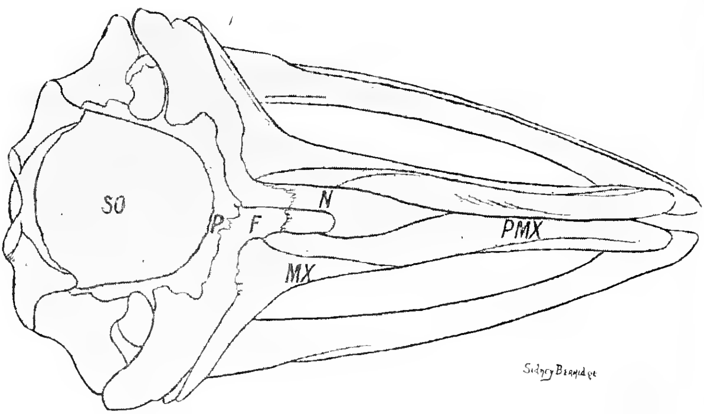
THE RIGHT WHALES

THE whalebone whales (Mystacoceti) are separated by all naturalists from the toothed whales as a distinct division, which is characterised by the possession of whalebone. This is not, however, the only feature which distinguishes the whalebone whales from the Odontoceti or toothed whales.

The skull is nearly symmetrical; in fact, it is not perceptibly asymmetrical. The nasal bones are equal or sub-equal in size, and in their characters more like those of ordinary mammals. They are placed side by side, have truncated ends, and roof over the nasal passage to the extent of their length. The frontal bones are not overlapped by the maxillæ as they are in toothed whales. There is a distinct lacrymal bone. The two rami of the mandible meet only at the very end and for a very short space; they are, moreover, as a rule connected at their junction by ligament only. They are much bowed outwards, and enclose a spoon-shaped area. The skull as a whole is more or less arched, most so in the Right whales. This structural peculiarity is obviously connected with the presence of whalebone and is less developed in the Rorquals, where the whalebone is shortest.

The ribs are never attached to the vertebræ by more than one head, which is the tubercular head, *i.e.*, that articulating with the transverse process of the vertebræ. The sternum is always in one piece, and only a single pair of ribs articulate with it. It

FIG. 19. Skull of *Balæna australis*, dorsal view.
(From van Beneden and Gervais.)

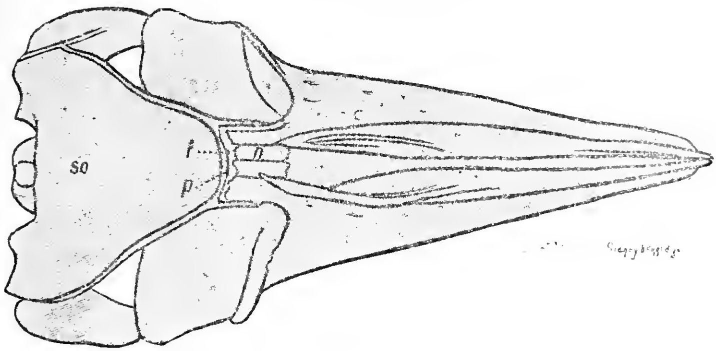


SO, Supra occipital. *P*, Parietal. *F*, Frontal. *N*, Nasal.
(N.B., the left nasal is represented as absent.)
MX, Maxilla. *PMX*, Premaxilla.

is always very small in proportion to the size of the body and does not represent a fused sternum of several segments, but the manubrium only.

It is usual, perhaps, to divide the Mystacoceti into two families: the Balænidae and the Balænopteridae. This arrangement is that followed by Gray in his Catalogue. It is the arrangement found in many text-books of zoology. In his "Supplement," however, Gray laid still greater emphasis upon the structural divergences to be seen among the whalebone whales, and arranged them thus: Sub-order I., Balænoidea, containing but a single family Balænidae; and Sub-order II., Balænopteroidea, containing the families Agaphelidae, Megapteridae, Physalidae, and Balænopteridae. The other extreme is accepted by most writers, who

FIG. 20. Skull of *Balænoptera sibbaldii*, dorsal view.
(From van Beneden and Gervais.)



SO, Supra occipital. *P*, Parietal. *F*, Frontal. *N*, Nasal.

allow but a single family Balænidae. I am disposed to allow the two families Balænidae and Balænopteridae; but there is something to be said for but a single family, chiefly on account of the characters of *Rhachianectes* and *Neobalæna*. It is rather curious that Dr. Gray with his liberality in the manufacture of families did not dignify the last named by creating a special family for it. Especially as he divided the Rorquals into two families.

Both *Rhachianectes* and *Neobalæna* to some extent interfere with the naturalness of the families Balænidae and Balænopteridae; and so does that less-known genus *Agaphelus* (if really distinct) with which Cope at first united *Rhachianectes*. *Rhachianectes* has the general outline of a Rorqual; but there is no dorsal fin, and the throat plaits of *Balænoptera* are reduced to two. The baleen, however, is short as in the Rorquals. The skeletal characters are also to some extent intermediate. The cervical vertebræ are free, as in Rorquals; the sternum is as in that group; and so on the whole is the form of the skull. But when the skull is seen from the side, the pre-maxillaries are as obvious as in the Greenland whale, and the fore part of the skull is narrow as in that cetacean. The scapula, moreover, is not so elongated as in the Rorquals, but has more the shape of that in the genus *Balæna*.

Neobalæna is placed by Gray among the Balænidae; but it has several Balænopteroid characters. It is, however, a true *Balæna* in the length of the baleen and in the consequent arching of the skull.

But the frontal bones, or rather the processes of those bones, which cover over the orbit are broad, as in *Balænoptera*, and not so narrow as in the Right whales. The skull, as a whole, is not so disproportionate to the body as in the genus *Balæna;* it is more like a Rorqual in this particular. Finally, the scapula is Rorqual-like in its antero-posterior elongation; it is not nearly so high as in the Right whale. On the other hand, the sternum marks the affinities of *Neobalæna* with *Balæna*.

I should be disposed to describe *Neobalæna* as a *Balæna* with affinities to *Balænoptera*, and *Rhachianectes* as a *Balænoptera* with affinities to *Balæna*.

Concerning *Agaphelus* we have less information. Of the two genera just mentioned there are skeletons in the British Museum, which I have been able to study. *Agaphelus** has no dorsal fin, and is said to be without throat plaits; but this has been stated of *Rhachianectes*, which is figured by Scammon as having two of those plaits. On the other hand, the baleen is like that of *Balænoptera* in being short. The scapula is like that of the same genus. Further information is required before this genus can be placed with an approximation to accuracy.

FAMILY, *BALÆNIDAE*

Skull very much arched, and narrow anteriorly; lower jaw without marked coronoid process. Cervical vertebræ fused. Baleen very long. Pectoral limbs short. No grooves on throat.

The last character may prove to be not applicable to *Neobalæna*, which is, as already explained, somewhat intermediate between the Right whales and the Rorquals. This family of whales contains but two genera, and these include between them probably not more than three species, of which two are referable to *Balæna*.

* According to Van Beneden and Gervais (*Ostéographie des Cétacées*, p. 236) *Agaphelus gibbosus*, the "Scrag whale," is a young form probably of *Balæna australis*.

Genus, *BALÆNA*

Size large, 50–60 feet. No dorsal fin. Head more than one-fourth the length of the body. Orbital process of frontal not wider than downward process of maxilla. Scapula rather high; 12–15 pairs of ribs, hind limb consisting of a pelvic bone, femur, and tibia.

The "Right whales," as it is usual to term the Greenland whale and the southern whalebone whale, are so termed on account of the fact that they are the "right" kind of whale for the whaler to attack; their whalebone is finer and longer than that of others, and the oil is more abundant and of a superior quality. These whales are characterised, in addition to the characters given in the definition which are not found in the allied genus *Neobalæna*, by the enormous head and the peculiar form of the mouth, which is shown in the accompanying illustration. (Fig. 21.) The skull is mainly distinguishable from that of *Neobalæna* by the characters of the frontal and maxilla given in the diagnosis; this character is very plain on an examination. It is an interesting fact to note from Professor Huxley's figure of a fœtal southern Right whale, given in his *Anatomy of Vertebrates*, that in the fœtus the frontal in its proportions more approaches that of *Neobalæna* and the Rorquals. This is so far confirmatory evidence of the view that this genus is the most modified of whalebone whales. On the other hand, it must be remembered that the greater perfection of the hind

PLATE VIII.

FIG. 21. *Balæna australis.*

(From cast in Nat. Hist. Museum.)

[To face page 122.

Fig. 21: Balaena australis

Plate VIII

limb points to a less modified condition than that which is exhibited by *Balænoptera*, where the limb is still further reduced.

And furthermore, the ribs point to a more primitive stage in *Balæna*. In the Rorquals and in *Neobalæna* very few have capitular processes. In a specimen of *Balæna biscayensis* at the British Museum, of the fourteen ribs present the first two had no capitulum; but the ten following on each side were provided with capitular processes.

There would seem to be some little vagueness about the number of ribs in this genus. Vagueness is, however, readily produced by deficient specimens; and this fact may easily account for some of the discrepancies. But there would not seem to be any method by which a less number of ribs should be converted into a greater. The Greenland whale is characterised by Mr. Lydekker as possessing but twelve ribs, and thus distinguished from its southern congener, which has fifteen. The skeleton of *Balæna mysticetus* at Brussels is described by Sir W. Flower as having fourteen pairs of ribs, though the "usual" number is stated at thirteen.

The sternum of *Balæna* is not cross-shaped as in Rorquals; it is oval, decreasing in diameter behind, or somewhat heart-shaped in contour. The scapula is high, thus contrasting with the more elongated scapula of the Rorquals.

It is, or perhaps rather has been, a matter of dispute as to how many species of whale are embraced in the general expression "Right whale." It is the prevailing opinion at present that there are but two properly established forms, *i.e.*, the Greenland whale and the southern Right whale, *Balæna australis.* But it may be that there are others. Scoresby writes of "tribes" of whales inhabiting different regions which are to be distinguished by different proportions of head and trunk. "Those inhabiting southern latitudes," he observes, "have commonly long heads and bodies, compared with their circumference, moderately thick blubber, and long whalebone; those of the mean fishing latitude, that is, 78–79, have more commonly short, broad heads, compared with the size of the body. In some individuals the head is at least one-third of the whole length of the body, but in others scarcely two-sevenths."

Inasmuch as whalebone whales, undoubtedly belonging to this genus *Balæna*, occur in all the oceans from north to south, from east to west, it is at least possible that there are different races. But on the other hand, the facts which have been gathered in support of such a contention are not convincing. Certainly it does not appear justifiable to erect, as has been done, a large number of distinct genera for the inclusion of these Right whales. Thus the late Dr. Gray allowed in his Catalogue—besides *Balæna*—*Eubalæna*, *Hunterius*, *Caperea*, *and Macleayius*. *Neobalæna*, on the other hand, which will be dealt with presently, is clearly entitled to generic rank.

As to *Macleayius*, it appears to have been founded "on a mistaken impression gathered from an imperfect photographic representation." At best it depends entirely and only upon the cervical vertebræ, of which the altas was at first thought by Gray to be distinct. This would be if it were true a difference; but though that character is dropped by Dr. Gray in his "Supplementary Catalogue" from further information received, the genus is valiantly retained!

Hunterius temminckii was based upon a young and incomplete skeleton in the Leyden Museum, described also by Schlegel and Flower. Its chief character is that "the first rib is very broad with two heads attached to the transverse processes of the first and second dorsal vertebræ." As a matter of fact the statement itself is inaccurate. For Sir W. Flower pointed out that the attachment was in all probability to the last cervical and first dorsal, the apparent position being due to a mistake on the part of the articulator of the skeleton. This character may surely be dismissed as an abnormality, for in the figure which is given the rib is clearly two ankylosed ribs; it is bifid not only at the head, but at the other extreme. And, moreover, the same state of affairs was found by Sir W. Flower in an example of the southern Right whale *B. australis*. Furthermore, in the Finner, *Balænoptera rostrata*, a similar "double" rib has been recorded, and in the British Museum the skeleton of *Rhachianectes* shows an identical state of affairs. Van Beneden asserts the same as an occasional character of the Porpoise and *Globicephalus*.* The only other char-

* "La première côte des Cétacées," *Bull. Ac. Roy. Belg.*, xxvi., 1868, p. 7.

acter of importance mentioned in the diagnosis of the genus is the existence of fifteen pairs of ribs, a character which exactly fits in with the assumption that this whale is nothing but a specimen of *Balæna australis*.

Caperea, the New Zealand whale, has even less claims—if possible—to be considered a valid genus. It is practically based upon a slight difference in the form of the tympanic bone. The slight development of the acromion is apparently a question of age and deficient ossification.

Finally, there is *Eubalæna* to be considered. The main characters of this are that it has fifteen pairs of ribs, of which the first is not bifid. It seems to be merely a "variation on the theme" of *Balæna australis*. As to species of this genus *Balæna*, there can be no question of the existence of two, the Greenland whale *B. mysticetus*, and the southern Right whale *B. australis*. The former is extremely limited in range, being entirely confined to the polar seas; the latter is world-wide, and probably includes all the whales already spoken of under the various generic names already criticised.

Balæna mysticetus. The species may be thus characterised:—Length, 50–65 rarely 70 feet; head $\frac{1}{3}$ of the length of the body; whalebone, 10–11 rarely 13 feet in length; colour, black, under part of jaw white; 13 pairs of ribs; about 54 vertebræ. This, the Greenland whale, Right whale or whalebone whale, is a purely polar species, never descending as far as our coasts; the reputed occurrences of Right whale in British seas seem to concern *Balæna australis.*

This great creature, bulky though it undoubtedly is, has been very much over-rated as to its size. Scoresby, whose experience was large, says, in his *Account of the Arctic Regions*, that such dimensions as 80 or 100 feet are quite absurd; of 322 individuals, in the capture of which Scoresby was himself concerned, not a single one exceeded 60 feet in length. The largest ever measured by himself was only 58 feet. An unusual specimen caught off Spitzbergen at the beginning of the century was barely 70 feet in length, though its whalebone was as long as 15 feet. Even the older observers, who had a tendency to exaggerate the size of these sea monsters, were not always unreliable upon this point. Edge, at the beginning of the seventeenth century, contented himself with describing the Greenland whale as "a sea beaste of huge bigness, about 65 foot long." The head of this whale is about a third of its total length. There is a slight hairy covering in the form of a few scattered, short, white hairs at the extremity of both jaws.

Though the whale is usually black, Scoresby relates that he has seen specimens that were piebald all over—an exaggeration of the occasional white tracts that are normal for the species.

This whale has no voice, though they make a loud noise in spouting. It swims slowly, usually at the rate of four miles an hour; but when diving they reach a velocity of seven to nine miles an hour. This velocity is so great that whales have been found to dive to the bottom of water a mile in depth and to break the lower jaw by the violence of the impact. The time which whales can remain under water has been also exaggerated. It has been asserted that they can endure submersion for "many hours"; as a general rule five or ten minutes is the period, varied by two minutes' breathing space. But when feeding, fifteen or twenty minutes is not unusual. Scoresby mentions a harpooned whale as having dived for a period of forty minutes, and Scammon assigns one hour and twenty minutes as the limit of endurance.

The Greenland whale produces a single foal or "sucker" at a birth; the young creature, when born, is 10 to 14 feet long. The mother does not desert it until the expiration of a year or so, and the amount of maternal affection exhibited has been often commented upon. Scoresby, who was compelled to mingle commercial enterprise with due regard to the sentimentality of the twenties, remarks that "there is something extremely painful in the destruction of a whale when thus evincing a degree of affectionate regard for its offspring that would do honour to the superior intelligence of human beings; yet the object of the adventure, the value of the prize, the joy of the capture, cannot be sacrificed to feelings of compassion"!

This whale is not really gregarious; when a number are seen together it is an accident due to their having congregated at the same feeding-spot. There are various thrilling stories of adventures with harpooned whales; but it seems that the dangers are not due to any ferocity on the part of the animal itself, which is one of the most timid of beasts, so much so, indeed, that "a bird alighting upon its back sometimes sets it off in great agitation and terror." It is in this respect markedly unlike the fierce and malicious Californian whale. (See p. 170.) The accidents that have happened to the whalers are simply due to the struggles of the great beast when harpooned; they are not purposely directed at its enemies at all. But it is said that a Greenland whale cannot throw up into the air, in the way that Scoresby depicts in an oft-copied picture, a boat and its crew. Since a whale of 60 feet in length would weigh one hundred tons, it is not at all surprising that the lashing of its tail and its terrified rushes may prove extremely dangerous.

It has been mentioned that there are slight variations in the Greenland whale, chiefly concerning the proportions of the head and trunk.

Scammon distinguishes the "Bowhead" or Great Polar whale from the Right whale of the north-western coast, *Balæna sieboldii* of Gray. But this latter whale is probably *B. australis*, which will be dealt with on another page. This whale has the longest whalebone of all the whalebone whales. In a whale of 47 feet long the "bone" was as much as 10 feet 6 inches long. The length may even reach 12 feet, and the colour is black, not piebald or white, which is met with in other whales. There may be three hundred and fifty or more of the laminæ of whalebone on each side of the mouth. Scammon relates that three hundred and seventy layers of whalebone is the largest number that he ever counted. The typical "Bowhead," which Scammon does not differentiate from the *Balæna mysticetus*, occurs chiefly in the vicinity of Behring Strait. In the sea of Okhotsk there is to be found, in addition to the typical Greenland whale, a smaller variety, called in the vernacular of the American whalers "Poggy." This creature yields but a small quantity of oil as compared with its larger relatives. They yield per whale from seventy-five to two hundred barrels; the "Poggy" only furnishes from twenty to twenty-five barrels.

"Many whalemen," proceeds Captain Scammon, "are of the opinion that this is a different species. There is little doubt, however, of this being a young whale of the same species, as its blubber is close and fine, producing but little oil in proportion to size of body, as is the case with all calves or young whales of every description." Nevertheless, Scammon is of opinion that this sea does contain a distinct variety of the common Greenland whale which he terms and figures as Roy's "Bunchback." Its most characteristic feature is a small hump or bunch a little in front of the tail, a structure which resembles the series of low humps found on the back of the Sperm whale, and is no doubt the vanishing equivalent of the strongly-marked dorsal fin of other whales. It is said that these whales yield a larger amount of bone in proportion to oil, and that the blow holes are situated higher up.

The Right whale—and the following statements apply, of course, to the southern as well as to the polar Right whale—feeds, as is well known, upon minute pelagic creatures. The minuteness of the food led the ancients to the belief that they lived upon water only. Pteropods and Crustacea form the bulk of its food, which it has not, therefore, to laboriously collect. The Arctic seas are often dyed for acres with these small floating animals, and thus (as Dryden accurately observes in the *Annus Mirabilis*) the whales need "give no chase, but swallow in the fry, which through their gaping jaws mistake the way." But when engaged in feeding the whale hardly lies "behind some promontory," as another poet suggests, but, as Scammon better puts it, "moves through its native element, either below or near the surface, with considerable velocity, its jaws being open, whereby a body of water enters its capacious mouth, and along with it the animalculæ (termed by the whalemen 'Right whale feed' or 'Brit')."

The whale's mouth is enormous, and its capacity is enlarged by the outward sweep of the rami of the lower jaw, which have together a spoon-like contour. The plates of whalebone act as strainers, and the method of their action has been elaborately described by the late Captain Gray.* The following

* In *Land and Water* for the year 1878.

account, an abridgement of his, is borrowed from Sir William Flower:—*

"How these immensely long blades depending vertically from the palate were packed into a mouth, the height of which was scarcely more than half their length, was a mystery not solved until a few years ago. Captain David Gray, of Peterhead, at my request, first gave us a clear idea of the arrangement of the baleen in the Greenland whale, and showed that the purpose of its wonderful elasticity was not, primarily at least, the benefit of the corset and umbrella makers, but that it was essential for the correct performance of its functions. . . . The length and delicate structure of the baleen provides an efficient strainer or hair sieve, by which the water can be drained off. If the baleen were, as in the rorquals, short and rigid, and only of the length of the aperture between the upper and lower jaws when the mouth was shut, when the jaws were separated a space would be left beneath it through which the water and the minute particles of food would escape together. But instead of this, the long, slender, brush-like ends of the whalebone blades, when the mouth is closed, fold back, the front ones passing below the hinder ones in a channel lying between the tongue and the bone of the lower jaw. When the mouth is opened their elasticity causes them to straighten out like a bow that is unbent, so that at whatever distance the jaws are separated the strainer

* Essays on Museums, etc. *Macmillan's*, 1898, p. 221.

remains in perfect action, filling the whole of the interval. The mechanical perfection of the arrangement is completed by the great development of the lower lip, which rises stiffly above the jawbone, and prevents the long, slender, flexible ends of the baleen being carried outwards by the rush of water from the mouth, when its cavity is being diminished by the closure of the jaws and raising of the tongue."

The food thus filtered off by the action of the whalebone and the raising of the tongue and shutting of the jaws is left stranded upon the gigantic tongue and then swallowed down the narrow throat. It is accordingly not advantageous that this tongue should be mobile and muscular; it is, as a matter of fact, mainly formed of "a mass of spongy fat intermixed with sinewy flesh."

The second species, *Balæna australis*, Desmoulins,* must probably include the following rather formidable list of synonyms:—

B. biscayensis, Gray; *B. sieboldi*, Gray; *B. japonica*, Gray; *Hunterius temminckii*, Gray; *B. antipodarum*, Gray; *B. antarctica*, Schlegel; *B. mediterranea*, Gray; *B. angulata*, Gray; *B. nordcaper*, Gray; *B. capensis*, Gray; *B. cisarctica*, Cope; *B. eubalæna*, Flower; *Hunterius swedenborgi*, Liljeborg; *Macleayius australiensis*, Gray; *M. britannicus*, Gray; *B. tarentina*, Capellini; *B. alutiensis*, van Beneden; *B. kuliomoch*, Chamisso; *B. cullamacha*, Chamisso.

* *Dict. Class. d'Hist. Nat.*, ii. (1822), p. 161.

It may be thus defined:—Head relatively smaller than in *B. mysticetus* ($\frac{2}{7}$–$\frac{2}{8}$ of body length); whalebone also shorter; ribs 15; 57 vertebræ.*

This list of synonyms includes the names given to whales which are probably—at most no more than —local races of but one species. But with all of them it is by no means easy to be certain of the justice of this view. Thus since *Macleayius britannicus* is only known by its cervical vertebræ, it is conceivable, though not in the least likely, that it is a different form. But of those whales with different names that much is known about, there seems to be but little doubt that they are all one and the same species. To believe in the existence of twenty species of Right whales in addition to the Greenland Right whale is too large a draft upon credulity to be honoured at present.

At every page in describing the natural history of whales it is necessary to make statements with great care, and to allow a due amount of qualification. It may be that the large number of synonyms, which it appears to me to be necessary to include in the description of this species, are really proper varieties at least, or even distinct forms. As has before been stated, there does not appear much reason to accept the numerous genera which Gray allowed. But as to species the affair is different. Since these whales do not live, or at least are not common, in the tropics,

* See GULDBERG, "Zur Kenntnis des Nordkapers," *Zoolog. Jahrb.*, vii., p. 8.

but prefer the temperate waters both north and south of the equator, it might be urged that the northern were distinct from the southern species. And this is and has been the opinion of many. On the other hand, Sir William Flower is inclined to believe in the existence of but a single *Balæna* besides the Greenland whale, and with this opinion I associate myself.

The most marked characteristics of this whale have been given in the above diagnosis of *Balæna australis*. But the number of the ribs appears to be a character that is not absolutely fixed. As a rule *Balæna mysticetus* has but thirteen ribs, while *B. australis* has as many as fifteen. Sir W. Flower,* however, described some years since an undoubtedly Arctic whale with fourteen ribs, the last being rudimentary and only eighteen inches in length. Still, here are fourteen ribs. With this fact must be compared the figure of *Balæna japonica*, here regarded as a synonym of *B. australis*, which, according to a Japanese artist,† has also fourteen pair of ribs; the accuracy of the Japanese is so well known that we must hesitate before rejecting the fact.‡

Neither apparently can the length of the plates of baleen be absolutely relied upon as a character diagnostic of *Balæna australis*. Generally the baleen is coarser and shorter than is that of *Balæna mysticetus*.

* *Proc. Zool. Soc.*, 1864, p. 416.

† MOEBIUS, *Ueber den Fang und die Verwerthung der Walfische in Japan*, *SB. k. preuss. Akad. Wiss.* Berlin, 1893, p. 1065.

‡ GULDBERG (*loc. cit.* on p. 134) also gives fourteen for the Nordcaper.

It is figured, for example, by Scammon as rather more than one-fourth less in length than that of its ally. Six feet is the length assigned by Gray to the baleen of "*Eubalæna australis*"; but of "*Eubalæna sieboldii*" the baleen is stated by the same author to be "nearly as long as the Greenland, varying from seven to twelve feet long, and slender." The difference, therefore, is in the latter instance not great.

A very singular feature of *Balæna*, especially of the present species, is the so-called "bonnet." This is a horny, irregular mass growing on the snout. The irregular shape and pitted appearance of the bonnet gives one the impression that it is a pathological structure, a kind of corn, perhaps produced by the animal rubbing itself against rocks, as this species has been observed to do in order to get rid of the barnacles which are apt to infest it. It is not large, eleven inches being about the length of a large one, and this was eight inches in width. It is spoken of as a "rudimentary frontal horn" by Gray, and a comparison with an Ungulate horn, especially that of a rhinoceros, is highly interesting in view of the disputed affinities of whales. We cannot, however, press this comparison at present.

As to the habits of this whale, they seem to be much those of its nearest ally. They go about singly, in pairs, or three together. Towards the end of the season Scammon tells us that they congregate in herds, which are technically known as "gams." This is previous to migration, and the whales of the southern hemisphere are also migratory.

Balæna australis has the same strong maternal affection that characterises *Balæna mysticetus.* This is illustrated by the recital of the capture of a whale in the Bay of St. Sebastian, quoted by M. Fischer* (to whom science is indebted for a great deal of collected information about this and other whales): "When the mother whale saw her young captured, instead of flying she made unheard of attempts to free it, describing a circle round the boats without hurting them. Sometimes she pressed the cub under her great fins, and tried to drag it away; sometimes she dived with it, disappeared, and reappeared at some distance. But the enterprise was not easy; the ropes were strong, and the three harpoons well embedded." Later on the cub escaped through the mother breaking, by a stroke of her powerful tail, the ropes attached to the harpoons; but the young one died, and the mother followed and remained near its dead body regardless of musket shots fired at her, and only went away on the following day.

This whale, which was once more abundant on the coasts of Europe than it appears to be now, has been much hunted, especially by the Basques, who have left their mark upon the whaling industry by the very word harpoon. Of this industry a number of important observations on the spot, and

* "Cétacées du Sud-Ouest de la France," *Actes Soc. Linn. Bordeaux* 1881.

references to the literature, have been collected by M. Fischer in the memoir just referred to, and at nearly the same time by Mr. (now Sir Clements) Markham.* It would seem that they were fished upon the shores of Flanders so long ago as the year 875, but in these remote periods it is by no means always certain that whale is meant by the descriptive expressions used. Even *Balæna* itself does not always apply in these early records to the whalebone whale, and the term "crassus piscis" is clearly even more vague in its possible significances. We learn that in old times the habits and customs of the Basques resembled those of their not very distant neighbours, the Normans. They lived along the shores, and, as a rule, picked up a living there. When the fishery was not productive they occupied themselves in pillaging inland. The whales were attacked when they approached the shore to bear their young; they were driven on to the shore and despatched there. The earliest document relative to this fishery is dated from the year 1150. It is in the shape of privileges granted by Sancho the Wise to the city of San Sebastian. A little later, in 1197, John Lackland, King of England, "gave to Vital de Biole and his heirs to take fifty Angevin pounds on the two first whales captured each year at Biarritz in exchange for the fees which King Richard his brother had given him on account of the fishery of Guernsey." The pursuit of the Biscayan

* "On the Whale Fishery of the Basque Provinces of Spain," *Proc. Zool. Soc.*, 1881, p. 969.

whale was at its height at this period, and for some time afterwards. Its importance is shown by the fact that a whale is incorporated into the coats-of-arms of many cities lying upon the Bay of Biscay. "This charge," remarks Sir C. Markham, "is in the arms of Fuentarrabia. Over the portal of the first old house in the steep street of Guetaria there is a shield of arms consisting of whales amidst waves of the sea. At Motrico the town arms consist of a whale in the sea, harpooned, and with a boat with men holding the line. The same device is carved on the wall of the townhall of Lequeito. The arms of Bermeo and Castro-Udiales also contain a whale." Other traces of the former prevalence of this industry are to be seen in the remains of "vigias," or look-out towers, whence the whales were first espied and the fleet of boats sent out in pursuit. In the sixteenth century the trade was still important. We find Rondeletius (1568) remarking upon Bayonne as a centre of the trade, and the flesh, especially the tongue, was eaten, being exposed in the markets of Bayonne, Biarritz, and other towns. A curious example is given by Sir Clements Markham in proof of the importance of the industry, even so late as 1712. In the records of a marriage at Lequeito the bride and bridegroom between them possessed all the necessary outfit for a whaling voyage.

Ambroise Pare (quoted by Fischer) has given an elaborate account of whale fishing in the Bay of Biscay in the year 1564, a part of which we shall quote here as serving to illustrate how the Biscayan whale was hunted at that period: "It is taken at certain times of winter in many places, including the coast of Bayonne, near a little village distant three leagues or about from the said town, and named Biarris. . . . Opposite that village there is a hill upon which, from a long time back, has been built a tower" (one of the vigias already referred to) "entirely for this pursuit, day and night, to discover the 'Balaines' which pass, and perceiving them coming partly by the loud noise they make, and partly by the water which they throw out by a conduit which they possess in the middle of the forehead. And when they perceive them to come they ring a bell, at the sound of which promptly all those in the village run with their apparatus which is requisite to take these animals. They have several boats and skiffs, in some of which there are men whose only duty is to fish up those who may have fallen into the water. The others are used for the combat, and in each of them are ten men, strong and capable of rowing well, and several others with barbed darts, which are marked with their mark to recognise them again, attached to cords, and which are thrown with all their force at the whales." After the whale is killed the whalers feast ("font gode chere") and depart, each with his share, which is calculated by the harpoons already in the body, and, of course, known to their possessors. This author from whom we have just quoted remarks upon the affection of the females for their young, and the comparative ease, therefore, with which they are captured. After the beginning of the eighteenth century the industry seems to have decayed, on account of the growing rarity of the whales. In the nineteenth century but two or three records of its occurrence in the Bay are to be found.

The genus NEOBALÆNA may be thus characterised:—

Size small, 20 feet about. Head not large. No throat grooves. A small falcate dorsal fin. Frontals broad. Seventeen pairs of ribs, very broad and flat. Vertebræ C. 7 (fused) D. 18, L. 2, Cau. 16. Whalebone long. Scapula broad, not high.

This very remarkable genus of whalebone whales bears the same kind of relation to the great *Balæna* that *Kogia* does to its equally gigantic ally *Physeter*. In both cases also the dwarf form is to some extent intermediate in its characters, thus illustrating a generalisation applicable to a good many groups—that archaic characters are not usually coupled with extremes of size.

To Dr. Gray may have been justly allowed some jubilation concerning this whale. He separated it as distinct on account of its whalebone, and, as it has turned out, very rightly. As *Neobalæna* is represented by but a single species it is clearly impossible to disentangle from each other the characters which belong to *Neobalæna* as a genus from those which should be held to distinguish *Neobalæna marginata* as a species. Indeed, the two skeletons of this whale in the fine collection of Cetaceans in the British

Museum show certain differences which may be specific, if they are not sexual. It is from an examination of those two skeletons that the following notes have been drawn up.*

Neobalæna has a very short vertebral column, the total number of vertebræ being only forty-three. The complete fusion of the cervicals allies the genus to the Right whales. The most noteworthy point that I observed concerning the dorsal vertebræ was the fact that the first dorsal apparently bears no rib. As this was the case in both specimens it seems unlikely that it has dropped off. The number of the dorsal vertebræ is therefore one in excess of the number of ribs. This number was not constant in the two specimens; the larger had eighteen, the smaller whale seventeen dorsal vertebræ. In any case *Neobalæna* has more dorsals than any other Cetacean. It has also fewer lumbars; there are two in one and one in the smaller specimen. The only other Cetacean in which anything like so small a series of lumbars occurs is *Inia* (see p. 297), and there the number is three.

The ribs of this Cetacean are remarkable for many reasons. Their number (seventeen) is in excess of that known elsewhere. In one specimen, it is true, there are but sixteen—a number which occurs in the largest whalebone whale *Balænoptera sibbaldii*. As already observed, the first rib is attached to the

* The principal osteological features are also noted in FLOWER and LYDEKKER'S *Mammals, Recent and Extinct*. A more detailed account by HECTOR, *Trans. New Zeal. Inst.*, 1875, p. 251.

second dorsal vertebra, a remarkable state of affairs upon which I have commented elsewhere. The ribs are attached only to the transverse processes of their vertebræ, and there apparently not very firmly. The second to the fifth ribs, however, have a neck and head produced beyond the tuberculum towards the centrum, which, however, they do not seem to reach. If *Neobalæna* is an especially diving whale capable of longer submersion than some others, the lax attachment of the ribs may conceivably be explained as furthering this capability, for it would allow of a greater expansion of the contained lungs. (See p. 55) Another feature in which the ribs are remarkable is their great breadth and flatness. This brings them close together into a thick armature for the protection of the underlying viscera. The condition of the ribs is suggestive of the Sirenia and of many Ungulates.

Neobalæna marginata, of Gray* (perhaps *Caperea antipodarum*, Gray, *ib.*, p. 101, in part), is the only species of the genus.

* *Cat. Seals and Whales*, 1866, p. 90.

CHAPTER VII.

THE RORQUALS

Family, *BALÆNOPTERIDAE*

THIS family may be distinguished from that of the Balænidae by the following definition :—

Head less than quarter of the length of the body. Dorsal fin usually present. Throat with longitudinal plaits more or fewer in number. Bones of skull but slightly arched. Tympanic bones more elongated. Coronoid process of mandible more or less developed. Cervical vertebræ usually free. Hand narrow and tetradactylous. Baleen plates short. Cæcum present.*

This family of whales comprises at least three well-marked genera: the Rorquals, genus *Balænoptera;* the Humpbacks, genus *Megaptera;* and finally the recently-known California Grey whale, *Rhachianectes.*† We shall commence with a consideration of the Rorquals, which will be here included within a single genus. This is probably

* The above classification and definitions are chiefly founded upon Sir W. Flower's paper in *Proc. Zool. Soc.* for 1864, p. 384.

† Whether Professor Giglioli's *Amphiptera pacifica* with two dorsal fins (see p. 14) is an abnormality or not remains to be seen. (*Cetacea of the "Magenta."*)

the prevailing opinion at present, though many naturalists—even Sir William Flower in his earlier memoirs—have divided the existing Rorquals into three or even more genera. We shall clear the ground by defining this genus, of which of course the definition will be, in the opinion of some, applicable to a sub-family.

Genus, *BALÆNOPTERA*

Dorsal fin present and falcate. Throat plaits numerous. Scapula low and broad, with long acromion and coracoid process.

In considering whether or not it is advisable to divide the only four really definable species into different genera we may at once discard *Benedenia*, founded upon an immature specimen, *Rudolphius*, which is the same as *Sibbaldius*, the two names having been given to identical species.

Sibbaldius and *Flowerius* again have both been applied to what we term here *Balænoptera borealis;* so that one of them at least may be discarded, and that one must obviously be *Flowerius*, as it is the newer name. *Balæna* is clearly to be left out of consideration, as it is or rather has been in the hands of older authors of wide applicability, embracing all the whalebone whales. *Physalus* is an older name than *Pterobalæna* for the same species, and the same applies to *Ogmobalæna*. So we may in this way weed down the generic names of the Rorquals to *Balænoptera*, *Sibbaldius*, and *Physalus*. These three genera were accepted by Flower in his paper on "The Skeletons of Whales in the principal Museums of Holland and Belgium" (in *Proc. Zool. Soc.* already referred to). If we add to these *Cuvierius* for the fourth species, described in the present work as *Balænoptera sibbaldii*, we shall have exhausted the possible generic names for the only four species known.

But are they wanted? It seems to be a reasonable procedure in zoological nomenclature to invent generic names for the due pigeon-holing of a group which embraces a large number of species. It facilitates memory, and expresses a notion of classification. But when a group is so restricted as is that of the Rorquals, this procedure seems to be superfluous, especially since the utmost differences between the recognised forms are so small. All these great creatures are so much alike that their confusion one with another is almost inextricable. When species has been so confounded and confused with species, it seems to be a deliberate sarcasm to attempt generic definitions. Besides, now that the group has emerged from the complexity in which the labours of Dr. Gray involved it, we are able to see clearly how slight are the anatomical differences which distinguish the different forms.

We think, therefore, that the best plan will be to give some sketch of the external characters and osteology of the Rorquals, and to mention the differences which enable the different forms to be distinguished from each other.

The number of vertebræ differs, and the following table shows the numbers for a series of individuals :—

B. musculus	C. 7	D. 15 *	L. 14 or 15 †	Ca. 26.
B. borealis	C. 7	D. 13 or 14	L. 13, 14, or 16	Ca. 19.
B. rostrata	C. 7	D. 11	L. 12	Ca. 17.
B. sibbaldii	C. 7	D. 15	L. 15	Ca. 28.

It is the rule for the whales of this genus to have all the cervical vertebræ free from each other, not ankylosed in the typical whale fashion. But occasionally two or three are partially fused. This is described by Flower as occurring in *B. rostrata.* Nor is this occasional peculiarity confined to the species *Rostrata.* It has been mentioned as occurring in *B. borealis.*

As to the number of vertebræ, it is noteworthy that it bears some relation to the size of the creatures. Thus the smallest species *B. rostrata* has the smallest number of vertebræ, and the largest species *B. sibbaldii* the largest number of vertebræ.

It is a feature of this genus for the first rib to be bifid. This structural feature, as has been pointed out, occurs in other Cetacea, and has been made use of for systematic purposes. The late Professor van Beneden, however, observes that it is wrongly that "zoologists have thought it their duty to attach a certain importance to this arrangement, which is purely individual." But it is very general. Thus

* I have seen only 14 lumbars in a specimen at the British Museum, but 15 on another.

† A sixteenth rib has been described (by Sir J. Struthers).

van Beneden remarks that it has been found to characterise all the examples of *B. borealis* that have been examined from this point of view, with the exception of a specimen studied by Sir W. Turner in 1882.

This state of affairs characterises the two specimens in the British Museum, and therefore the number of ribs allowed in the table on p. 147 must be increased by one. For there can be no doubt that this two-headed rib represents two, as it is articulated with the transverse processes of two vertebræ. As is the case with all Mystacoceti, except *Rhachianectes*, the first few ribs have capitular processes; but these processes do not articulate directly with the centra of their respective vertebræ. In *B. musculus* the first three ribs have these processes; in *B. borealis* I noticed four; in *B. sibbaldii* there were again only three, the last two of which were so much longer that they may perhaps articulate directly with the centra. Professor Delage* has directed attention to the fact that the only rib (the first) which articulates with the sternum does so by two heads; it is first of all attached by an articular surface, and then by a "pseudo-articular" fibrous surface. This double attachment is, it seems, paralleled in Edentates.

The sternum of *Balænoptera* is usually a somewhat cruciform bone such as is displayed in the figure on p. 44. The cross-like outline is not always so well marked, and differences in the proportions of the limbs of the cross are evident, and are certainly in

* "Histoire du *Balænoptera musculus*," *Arch. Zool. Experim.*, 1885, p. 1.

some cases due to varying conditions of maturity. Thus Sir W. Flower has figured a sternum of *B. borealis*, in which the ossified portion consisted only of a roundish piece of bone, the cruciform shape of the entire sternum being, however, shown in the surrounding cartilaginous regions.

As to the number of phalanges in the hand of various species of *Balænoptera*, the following table from Kükenthal* gives the ascertained facts :—

B. sibbaldii	I, 1	II, 5	III, 7	IV, 7	V, 4.
B. borealis	I, 1	II, 4	III, 7	IV, 7	V, 4.
B. musculus	I, 1	II, 4	III, 7	IV, 6	V, 4.
B. musculus	I, 0	II, 5	III, 6	IV, 7	V, 4.
B. musculus	I, 1	II, 4	III, 6	IV, 6	V, 5.
B. rostrata	I, 1	II, 4	III, 8	IV, 7	V, 4.
B. rostrata	I, 0	II, 4	III, 7	IV, 6	V, 3.

But these tables, according to Kükenthal, have to be corrected by his discovery of a rudimentary finger (Fig. 2, p. 9) lying between the third and the fourth of the above enumeration. This consisted in an embryo of *Balænoptera musculus* of three slender phalanges lying at the upper (free) end of the interspace between the digits already mentioned. In this case the reputed thumb will be a prepollex, and the missing digit will be No. III. An obvious conclusion with regard to this rudiment is to regard it as a division of a digit, such as has been described in the Beluga. But certain considerations derived from the distribution of the nerves in the hand of this

* *Op. cit.* (on p. 31).

whale seem to negative this view, and to establish the theory that it is really digit III which has thus nearly disappeared.

The whales of the genus *Balænoptera* have a much more elongated form than those of the genus *Balæna*. They are also to be distinguished by the presence of a dorsal fin—not large in proportion to the body—which is situated quite at the posterior end of the body. The elongated form conduces towards a greater swiftness of movement; and for this among other reasons the "Finners," as these whales are termed, are not such profitable creatures to pursue as are the more lethargic Right whales. Besides, the whalebone is short and the blubber less in amount and inferior in quality. Some two feet is the average length of the whalebone, which contrasts with the twelve or thirteen feet in length of the "bone" of the Greenland whale; more accurate measurements of the whalebone of the Rorquals is given under the definitions of the four species below. Nevertheless, the Rorquals are hunted, particularly from the coasts of Norway; and an interesting account of some facts in this fishery has been recently communicated to the Zoological Society of London by Professor Collett.* It is a curious thing that these whales are sometimes pursued with poisoned harpoons; the poison consists in the decaying flesh of a dead whale, and its effect is to set up septicæmia. The simplicity of this mode of poisoning the prey is curiously paralleled by the poisoned arrows of certain African

* *Proc. Zool. Soc.*, 1886, p. 243.

tribes, who use the decaying mud of marshes—the effect in this case being tetanus.

The Rorquals are among those whales that have preserved a trace of the primitive hairy covering. There are a few hairs present in the adults of these whales, and in an embryo of *B. sibbaldii* van Beneden figures eleven hairs on each side of the upper jaw and four on each side of the lower.

A highly characteristic feature of the Rorquals is the series of longitudinal folds in the throat region. They share these with the genera *Rhachianectes* and *Megaptera* alone among whalebone whales; but the Ziphioids have a few folds in the same region, which are possibly comparable.

The number of these folds in species of *Balænoptera* varies somewhat. *B. rostrata* has been stated to possess 54–60; in *B. sibbaldii* Turner counted 60. A larger number, according to Murie, characterises *B. musculus*, for in a specimen of that whale he estimated the total number at about 100. These folds, although spoken of as throat folds, really reach further back than the throat region—indeed, to a point considerably behind the attachment of the pectoral fin. Kükenthal, as well as—long before him—Eschricht, have pointed out that these folds are not found in the youngest embryos—a fact which renders their comparison with the apparently corresponding folds of the Ziphioid whales unlikely. In *B. musculus* they were first visible in an embryo of more than 60 cm. long. The meaning from a physiological point of view of these folds is to be sought from the fashion in which the whale takes in its food. Like the genus *Balæna*, *Balænoptera* takes in huge masses of Crustacea and other minute organisms, which are swallowed after the accompanying water is strained off through the whalebone; but in *Balæna* the mouth is especially huge, owing to the arched form of the skull, a feature so characteristic of that genus and one which distinguishes it from *Balænoptera*. To make up for the reduced size of the mouth cavity, the equally colossal *Balænoptera* can expand this cavity by means of the said folds, which then enable the skin to be puffed out; when the need for the increase in mouth capacity is passed the folds form again.

A *Balænoptera* without throat grooves has been mentioned by Olafsen and Povelsen (quoted by F. Cuvier), but the veracity, or at least powers of observation, of these two writers* is discounted by the fact that they assign a length of 200 feet to the Right whale, and speak of the Marmenill or marine man as an existing fact. But perhaps after all they had seen *Rhachianectes*, unknown of course to Cuvier.

As to the different species of *Balænoptera* there are, as it appears, certainly four. We shall therefore deal with these four, and then say a few words about "Finners" which have got different names.

Dr. Collett, in a paper already alluded to in relation to the fishery of these whales, has in a convenient

* *De l'Hist. Nat. Cétacées*, p. 307.

way summed up the specific characters of these four northern whales—we say northern, though, as will be pointed out, it is probable that the southern forms are really of the same species.

Balænoptera sibbaldii, Gray* (=*B. latirostris*, Flower, and has probably other synonyms), has a length of 70–85 feet. Robust in form (for a Rorqual), proportions of height and length being as 1 : $5\frac{1}{2}$. Colour dark bluish grey. Dorsal fin at commencement of last quarter of body. Vent situated in front of vertical line from anterior margin of dorsal fin. Pectoral fins large, $\frac{1}{7}$ of total length of body. Baleen and bristles black. Number of plates up to 400; their length 930 mm.

This, the greatest of whales, and indeed of all animals living or extinct,† is named in honour of Sir Robert Sibbald, author of the *Phalainologia nova* and inventor (?) of the "High-finned Cachalot."

It is to be distinguished from other Rorquals‡ by its superior size, and by the various other characters given in the above description of its essential features. The whalers know it by its large size and by the height to which it spouts. Its speed too, when going rapidly, is great. Something like twelve miles an hour are accomplished by a *Balænoptera sibbaldii* when putting its best foot foremost. It is a species

* *Proc. Zool. Soc.*, 1847, p. 92. Sir W. Turner has described the anatomy. (*Trans. Roy. Soc., Edinb.*, 1872.)

† Unless the recently-described 130-foot Dinosaur turns out to have been accurately measured.

‡ It obviously comes closest to *B. musculus.*

that feeds upon Crustacea, mainly, it appears, upon a species of *Euphausia*, known to the Scandinavian whalers as "Krill." These Crustacea have been discovered in vast numbers in the stomach of captured whales. *Balænoptera sibbaldii* is a species that lives mainly in pairs, and reproduction seems to take place every three years, more slowly than in the case of the smaller species of *Balænoptera.*

Balænoptera borealis, Lesson* (= *B. rostrata*, Rudolphi; *B. laticeps*, Gray); is in length 40–52 feet. Height to length as 1 : $5\frac{1}{2}$. Colour bluish black above, below white; upper surface with oblong light spots. Dorsal fin high, a little in advance of last third of body. Vent exactly below hinder edge of dorsal fin. Pectoral fins small, $\frac{1}{11}$ of total length of body. Baleen black with white bristles; number of plates 330; greatest length 650 mm. (See Fig. 22.)

Of this species, known as Rudolphi's Rorqual, and by the Norwegians as Sejhval, a very complete account of external characters and habits is given by Professor Collett.

As will be seen from the dimensions given in the above definition, this is a moderately-sized Rorqual. It seems clear, therefore, that even allowing for the inevitable exaggeration that seems to have accompanied most descriptions of whales, at any rate in the past, it cannot be identical with the "Ostend whale"

* *Hist. Nat. Cetac.*, 1828, p. 342. "On a Specimen of Rudolphi's Rorqual (*Balænoptera borealis*) lately taken on the Essex Coast," *Proc. Zool. Soc.*, 1883, p. 513.

PLATE IX.

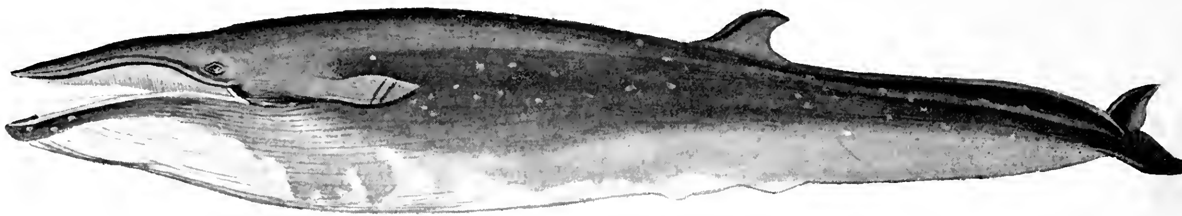


FIG. 22. *Balænoptera borealis.*

(From Collett.)

[*To face page* 154.

referred by Gray under this specific heading. For the latter measured 102 feet (!!); it is probably a *B. sibbaldii.* As to colour, I give Professor Collett's statements under this head as a part of the specific definition. But Sir William Flower, in describing a specimen stranded near the mouth of the river Crouch, in Essex, quotes Mr. Carrington to the effect that the whale within two days of its capture was "a rich glossy black, which shaded into a brilliant white on the underparts."

But little of this whale was known until the establishment of a whale factory at Sorvaer, near Hammerfest, in 1882. The main object of this establishment was the capture of the great *Balænoptera sibbaldii*, which, as the largest, is the most valuable of the Rorquals. But the present species proved to be the commoner of the two. It had been thought to be a rare whale. Up to and including 1884 but nine individuals had been stranded on the European coasts. When the actual fishery began as many as forty whales were taken in 1883, and forty-four in 1885. The intervening year produced but three. This whale goes about in shoals; Collett mentions thirteen and five as numbers of individuals in such companies. But it appears that as many as fifty is the limit in size of these shoals. *Balænoptera borealis* is inoffensive in character, and accidents are the result of "accident," as is generally the case with whalebone whales, excepting only the fierce *Rhachianectes.* Under the description of the Right whale the time that it can remain under water is given as a little over one hour at most. But as to the present species—and the remarks appear to fit all the species of *Balænoptera*—Professor Collett says: "All the whalers are unanimous in opinion that *B. borealis* (as well as *B. musculus* and *B. sibbaldii*) can remain under water for a far greater time than is generally supposed. The duration of this time is estimated to be from eight to twelve hours." This is, if true, a most extraordinary fact. The whales are fished from the shore, and the best period is from the 24th June to the 8th July; after this they leave the shore on the advent of *B. musculus* and *B. sibbaldii*. *B. borealis* seems to feed entirely on Crustaceans, chiefly the little Copepod *Calanus finmarchicus*.

This species may be recognised by its very high dorsal fin. The two sexes show no difference in size. The furrows on the throat are about 38–58 in number. The adult female has twenty-six hairs on each side of the lower jaw. In the fœtus there are more; thirty-four were counted on the lower and eleven on the upper jaw.

The baleen plates are usually black and the bristles white. But there is sometimes a mottling, or even a few of the foremost plates may be white. The blow holes lie in two long furrows, between which is a shorter furrow.

Balænoptera rostrata, Gray.* Length 25–33 feet. Proportion of height to length as 1:5. Colour greyish

* *Zool. Er. and Terror*, 1846, p. 50. For the structure of this species see TURNER, *Proc. Roy. Soc., Ed.*, 1892, p. 36. CARTE and MACALISTER, *Phil. Trans.*, 1868, p. 201; J. B. PERRIN, *Proc. Zool. Soc.*, 1870, p. 805.

black above, white below. Dorsal fin high at commencement of last third of body. Vent below hind edge of dorsal fin. Pectoral fin $\frac{1}{8}$ of total length of body. Plates of baleen about 325. Greatest length 200 mm.

This is much the smallest of the Rorquals. It is particularly to be distinguished from other Rorquals by the white band which crosses the pectoral limb, and by the sharp snout—hence the specific name of "rostrata." The "bone" too is always of a pale colour, and there are but eleven ribs. Hence this species of *Balænoptera* is exceedingly easy to characterise.

This whale, which appears to have a liking for the society of the larger *Balænoptera*, pursues fishes; and Hunter noted the discovery of dog-fishes in the stomach of an individual which he dissected. It has been noted too that the stomach contains pebbles. This is curious, for in other whales and in sea-lions the same observation has been made; possibly in both cases the stones were taken up accidentally while in pursuit of fish. One can hardly believe that any idea of ballast entered into the mind of the Cetacean.

Balænoptera musculus, Linnæus* (known also as *B. physalus*, Fabricius; *B. rorqual*, Lacepède; *Physalus antiquorum*, Gray), is in length 60–70 feet. Height

* For anatomy see MURIE, *Proc. Zool. Soc.*, 1865, p. 206; HEDDLE, *ibid.*, 1856, p. 187 (called here *Physalus duguidi*, but probably the same species really); and DELAGE, *Arch. de Zool.*, 1885, p. 1.

as to length as $1:6\frac{3}{4}$. Colour grey-slate above, white below. Dorsal fin low with straight margins; placed slightly in front of last fourth of body. Vent corresponding in position with its anterior margin. Pectoral fin $\frac{1}{9}$ of total length of body. Plates of baleen dark bluish black, also bristles. Number of plates up to 370. Length 950 mm.

This is perhaps, speaking from stranded examples, the commonest species of Rorqual. "Specimens are stranded," remarks Mr. Lydekker, "on the British coasts, more especially those of the southern parts of England, almost every year, generally after stormy weather and very frequently during the winter." Dr. Murie, who described many points in the structure of a sixty-foot long individual which was killed at Gravesend in 1859, describes the number of throat plaits as "somewhere about one hundred." In this individual the dorsal fin measured only 15 inches in height.

A curious asymmetry in the coloration of this species has been noted by more than one observer—"a sort of pleuronectism," van Beneden terms it. The body is sometimes paler upon one side than upon the other; apparently there is no constancy as to which side is the paler or the darker. This *Balænoptera* devours fish, and as many as 800 individuals of *Osmerus arcticus* have been found in the stomach of a whale. It is chiefly herrings that it pursues on the coasts of Norway and Great Britain.

The four species just characterised are the only

PLATE X.

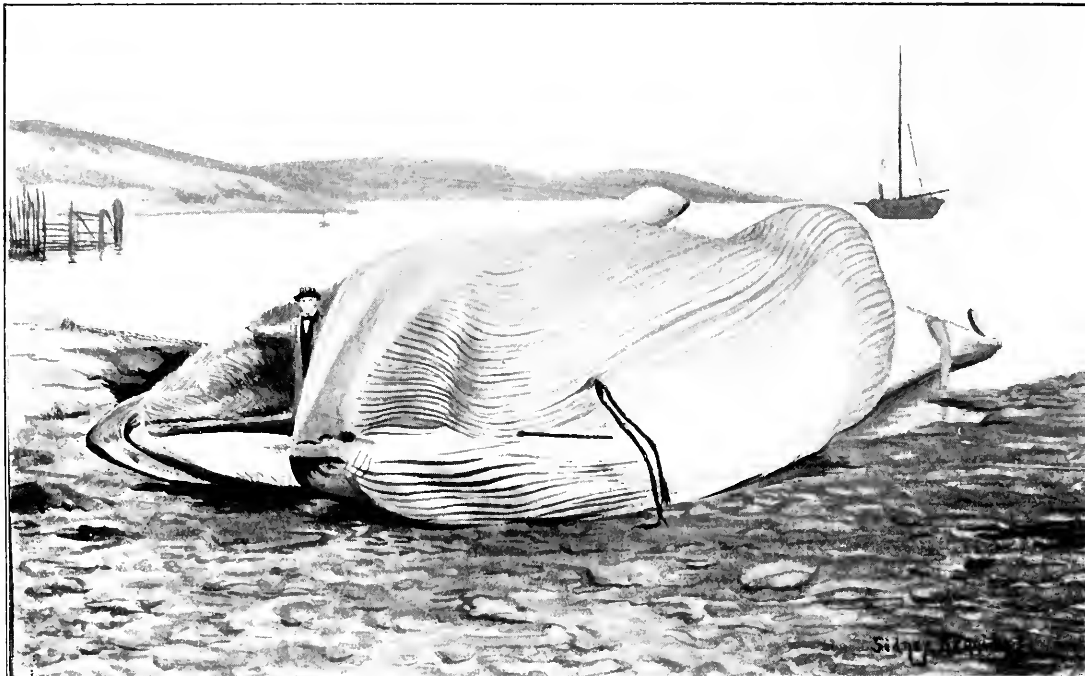


FIG. 23. Stranded Rorqual.

(From a photograph lent by E. J. Garwood, Esq., F.G.S.)

[To face page 158.

species that are really known to exist. But the genus is by no means confined to the northern hemisphere, whence the individuals have been found whose study has allowed of the compilation of the above diagnoses. There are plenty of *Balænoptera* in the southern hemisphere, off the coasts of Patagonia, Kerguelen, in the Indian ocean, and elsewhere. These whales have been placed in different species by Gray and others. It may be that such a placing is correct; and, at any rate, we have before us an instance of a large whale which has an extremely restricted range in the true Greenland whale; possibly also *Rhachianectes* is another. But notwithstanding this *a priori* consideration there seem to be no substantial grounds for retaining such species as *B. indica*, *B. patachonica*, *B. schlegelii*, etc. As to external characters, the bulk of these extra European *Balænoptera* are not known, and it is always possible that there may be such characters which would justify their separation specifically. But as to such parts of the skeleton as are known there is no such justification. Sir W. Turner, in his account of the Cetacean remains collected by the *Challenger*, had no hesitation in referring these bones to some of the four known species of Rorquals. Two Pacific whales are known by different names; and as observation upon some of their characteristics are mentioned by Scammon, some little account will be given here; but it is probable that *B. suphureus* is nothing more than *B. sibbaldii*, while the white band upon the flipper of *B. davidsoni* seems to show its identity with *B. rostrata*.

Balænoptera davidsoni of Scammon, the "sharp-headed Finner whale," is a small species of which only one example, measuring 27 feet, was examined. It was full grown, as is evinced by the fact that from it was withdrawn a fœtus of 5 feet 6 inches in length. It had very pointed pectorals with a white band above and near the bases. The baleen is pure white, 270 laminæ on each side of the mouth, the longest lamina measuring 10 inches. The colour of the animal was dull black above, white below, and the under side of both pectoral and caudal fins was also white. The throat had seventy longitudinal folds. The blubber of this whale averaged three inches in thickness, and the yield of oil was about 300 gallons. This whale goes about singly, and when it spouts it makes "a quick, faint spout," like that of a calf, which accounts for its having been considered to be the young of some other species.

The "Sulphur-Bottom whale" (*Balænoptera* (*Sibbaldius*) *suphureus*, Cope) is a huge creature, of which an example has been measured and found to be 95 feet in length with a girth of 39. In this individual the baleen was four feet in length, and the yield of oil 110 barrels. The animal weighed 147 tons. It derives its name from the yellowish colour of the underparts; the back is lighter in colour than is usual, and is sometimes very light brown, approaching to white. This whale occurs in the Atlantic as well as in the Pacific. As other whales are wont to do, the Sulphur-Bottom will often follow ships. Dr. Stillman relates how a whale of this species followed the ship in which he was a passenger for no less than twenty-four consecutive days. In spite of "volley after volley" of rifle shots and missiles of all kinds the whale adhered to the ship, which caused some anxiety, as it was feared that he might unship the rudder or do other damage. The only harm that happened was that the whale rose to "blow almost into the cabin windows."

Balænoptera australis, the "Sulphur-Bottom" of Antarctic whalers, is, according to von Haast,* nothing more than *B. musculus*. A specimen which he describes was thrown up about five miles from Christchurch, New Zealand, and 67 feet in length. As the creature was much injured by sharks, the external characters could not be given with even an approach to precision. But the skeleton seemed to show clearly that there were no recognisable differences from *Balænoptera musculus*. But then, as already said, two quite different species might conceivably have a quite similar skeleton, showing their specific difference only in colour and other outward features.

The genus *MEGAPTERA* is distinguished by the following assemblage of characters: Dorsal fin not very prominent; throat plaits fairly numerous; scapula with no marked acromion or coracoid process; pectoral fin very elongate.

* "Notes on a Skeleton of *Balænoptera australis*, Desmoulins, the Great Southern Rorqual or 'Sulphur-Bottom' of Whalers," *Proc. Zool. Soc.*, 1883, p. 592.

Megaptera is not widely removed in its structural characters from *Balænoptera*. Externally it is to be distinguished by its more ungainly form, its very long pectoral limbs which are fringed along the anterior margin, and by the low dorsal fin. The tail is also fringed with numerous serrations; but they are unconnected with deeper lying parts. In the case of the flipper the rounded processes of the margin are the outward expression of the bulging of the interphalangeal cartilages.

The skeleton of *Megaptera* has been described by many; the most elaborate account of it with which I am acquainted is contained in a paper by Sir John Struthers.* Generally speaking the differences from *Balænoptera* are neither numerous nor important.

The seven cervical vertebræ are not united;† there are fourteen dorsals, ten lumbar, and twenty-one caudals.

The sternum of *Megaptera* is not widely different from that of *Balænoptera*. It has a somewhat cruciform shape. The first rib (and that only) is attached to it by a single continuous ligamentous connection; there are not two distinct attachments as in *Balænoptera musculus*, as described by Struthers and Delage (quoted on p. 157).

The scapula is peculiar in the practical absence of both acromion and coracoid process; it is moreover

* *Journ. Anat. Phys.*, vols. xxii., xxiii. More recently Gervais (*Nouv. Arch. Mus.*, 1888, p. 199) has dealt with and figured the osteology of a form from the Persian Gulf which he calls *M. indica*.

† Occasionally, to a variable extent, they are in later life.

higher, and not so long as in *Balænoptera*, having more the shape so far of the sternum of *Balæna*. The differing proportions of greatest length and height of the sterna of *Megaptera* and of *Balænoptera* can be appreciated from the following measurements:

Megaptera. Length, 42 inches; height, 30 inches.

Balænoptera musculus. Length, 39 inches; height, 22½ inches.

The pelvic bone is provided with a small femur, a feature in which the present genus resembles certain species of *Balænoptera*. There is, however, apparently no trace of a tibia such as occurs in the Greenland whale.

The head is often studded with tubercles,* and so is the margin of the flipper. The throat has the longitudinal grooves so characteristic of the family Balænopteridae. These, however, vary in number considerably, and species seem to have been partly characterised by their numbers. Some of the numbers given by Scammon, and the sex and total lengths of the whales in question, are as follows:—

No. 1. Male. Length, 49 feet 7 inches; gular folds, 26.
No. 2. Female. Length, 48 feet; gular folds, 21.
No. 3. Female. Length, 48 feet; gular folds, 18.
No. 4. Female. Length, 52 feet†; gular folds, ?

* These tubercles are of about the size of an orange. They suggest the hair bulbs found in the Balænopteras, and remains of hairs have been found in them. There is probably some connection between these "tumours" and the otherwise missing hairs.

† It is said that this whale grows to a length of 75 feet; but, as observed in the case of the Sperm whale (see p. 200), such measurements have to be received with caution.

They are never so numerous, it will be noted, as in *Balænoptera*. Scammon has found that this whale varies more than others in the production of oil, a circumstance which would seem to be dependent on the condition of the animal at the time of capture. It also depends upon sex and the period of breeding, for the female, when accompanied by a cub to whom she is giving suck, has less blubber than at other times. The baleen of this whale, as in the case of the Rorquals, is not longer than two to three feet.

The only species of the genus that can be safely allowed at present is *Megaptera longimana*, Rudolphi,* of which the following must then be regarded as merely synonyms:—

Balæna boops, Fabricius; *B. poeskop*,† Desmoulins; *B. lalandii*, Fischer; *Balænoptera capensis*, Smith; *Balænoptera leucopteron*, Lesson; *Megaptera novae zelandiae*, Gray; *Megaptera burmeisteri*, Gray; *Megaptera americana*, Gray; *Balæna antarctica*, Temminck; *M. kuzira*, Gray; *M. versabilis*, Cope; *M. osphyia*, Cope.

Notwithstanding the immense variety of names given in the above synonyms, Sir W. Flower and most others think that there is but a single Hump-backed whale of universal range. As to a goodly

* *Abh. Ak. Berlin*, 1829, p. 133.

† This is not, as perhaps might be imagined, a classical word significant of the possible affinities of the Cetacea, and meaning "one who gazes upon the grass." It is Dutch in origin, obvious in meaning, but untranslatable here.

number of the late Dr. Gray's "species" Captain Scammon observes: "We have frequently recognised upon the California coast every species here described, and even in the same school or 'gam.' Moreover, we have experienced the greatest difficulty in finding any two of these strange animals externally alike, or possessing any marked generic or specific differences." If there are differences of colour, Scammon goes on to remark, the number of species must be quite indefinite, as every combination and permutation of black, white, and grey are to be found in their colour.

It is pointed out, however, by MM. van Beneden and Gervais (in their *Osteographie des Cétacées*) that the southern form of *Megaptera*, which has been termed *M. lalandii*, differs from the northern by certain features in the scapula. In the former animal there is a distinct though small projection from the margin of the bladebone in front, which occupies the place of an acromion, and, what is more remarkable, an acromion like that of *Platanista*, that is, a rising from the edge of the scapula. Of this process there is no trace in the northern *Megaptera*, but, on the other hand, a faint process not so well marked, and lying lower down on the bone, occupying in fact rather the position of a rudimentary coracoid process.

The name "Hump-backed" applied to this Cetacean is due to the low dorsal fin, in the relative size of which, however, there seems from the various figures published to be some differences. It is, however, to be distinguished from the Rorquals proper by its ungainly form and the great length of the pectoral fins (13 feet or so). Its colour is usually black, pure white on the under surface of tail and flipper.

"In disposition," observes Mr. Lydekker, "it is neither very timorous nor very fierce, and is consequently easy to capture." It seems thus to have an intuitive knowledge of the poorness of its oil and the shortness of its "bone." Acting upon this it will swim fearlessly round boats, and when these whales are in herds, as is sometimes the case, some caution has to be exercised to avoid a collision with them. The Humpback is much addicted, remarks Captain Scammon, to "breaching," "bolting," and "finning," which vices mean, it should be explained, leaping out of the water, shooting out diagonally, and striking the water with its flukes. During the breeding season *Megaptera* is remarkable for "its amorous antics." At such times their caresses are of the most amusing and novel character, and these performances have doubtless given rise to the fabulous tales of the sword-fish and thrasher attacking whales. When lying side by side of each other the megapteras frequently administer alternate blows with their long fins, which love-pats may, on a still day, be heard at a distance of miles. "They may also be seen to roll about in the water and beat themselves with their long flippers; but this seems to be due to an anxiety to rid themselves of the parasites which infest them." These whales, like others, are also to be noted for their affection towards their young. The fact that they will leap clean out of the water appears to distinguish the whales of this genus from any other whalebone whale. Guldberg* states that this whale carries its young for 10–12 months. Only one (rarely two) are produced at a time. There is some relation between size and time of gestation, for *Balænoptera sibbaldii*, a larger species, carries its young over a year. Other Balænopteras have the same period of gestation as *Megaptera*. The foal, as in whales generally, is when born $\frac{1}{3}$–$\frac{1}{4}$ of the length of the mother.

Dr. Gray thinks that *Balænoptera jubartes* of Lacepède † (=*Balæna boops* of Linnæus) is the same whale as the common Rorqual, *Balænoptera musculus*. It seems, however, to be likely from the figure, bad enough, it is true, that Lacepède gives of it, especially on account of the "warts" upon the face, that the animal is really the Humpback. It is related by Lacepède that the animal was in his time let alone by the Icelanders. Probably the real reason is that which protects it at the present time, *i.e.*, the inferiority of its valuable productions. But the author whom we quote observes that the whale was held to be the friend of man, like the Amazonian dolphin referred to on p. 271. It is related that, when the frail barques of the natives are surrounded by the ferocious and carnivorous Cetacea of the north which

* *Zoolog. Jahrb., Syst. Theil*, 1887, p. 127.

† *Histoire naturelle des Cétacèes.* Paris. XIIth year of the Republic (1804).

threaten danger, the *Megaptera* will endeavour to rescue its friends from the danger which environs them, and will accompany them until they arrive close to shore and have escaped the Sperm whales, of whose real ferocity Lacepède is so fully convinced.

The genus *RHACHIANECTES* may be thus defined: Dorsal fin none; throat plaits reduced to two. Scapula high.

This genus was described some years since by Cope. I am able to write the following brief notice of the principal characters of the skeleton, after examining a complete skeleton in the British Museum.*

The skull of the whale is, on the whole, Rorqual-like. It is, however, narrower anteriorly than in Rorquals; and this is accounted for on a lateral view by the fact that the pre-maxillaries are, as it were, pinched up in the middle line by the maxillaries and are quite visible from the side. In this feature the skull of *Rhachianectes* resembles that of a Right whale. In *Balænoptera* those bones are hardly visible on a lateral view of the skull. In other respects the skull of *Rhachianectes* differs but slightly from that of *Balænoptera*.

In the vertebral column the atlas was missing; the remaining vertebræ are quite independent of each other as in the Rorquals; and they have the wide

* See for notes on Osteology v. BENEDEN, *Bull. Ac. Belg.*, xliii (1877), p. 92, and MALM, *Bik. Svensk Akad.*, viii. (1883).

lateral foramina formed by the transverse processes, which is so conspicuous a feature of those vertebræ in *Balænoptera* and *Megaptera*. I counted 14 dorsal vertebræ, 14 lumbar, and 21 caudals.

The ribs are also fourteen, and the first two are incompletely soldered together, not so completely as in the "*Hunterius temminckii*," figured by Gray in his Catalogue. The mode of fusion was different on the two sides of the body; but as this feature is probably a mere variation, and not distinctive of species or of genus, it is not worth while to give a detailed description of the arrangement.

The sternum is like that of a Rorqual; it is cross-shaped, but the arms of the cross are very short, and the posterior termination is almost a fine point. The pelvis consisted of but a single bone, but a rudimentary femur may have disappeared.

The one species is *Rhachianectes glaucus*, Cope * (? = *Agaphelus*).

As is the case with so many whales, this species varies somewhat in colour. It varies from a mottled grey to black. The length of a full-grown example is from 40 to 44 feet, but individuals somewhat larger than this have been met with. Such individuals would yield some twenty barrels of oil, but as many as seventy barrels have been obtained from a larger specimen. The baleen reaches a length of 14 to 16 inches, and is light in colour, sometimes nearly white. The Gray whale is limited so far

* *Proc. Acad. Nat Sci., Philadelphia*, 1868, p. 225.

as is known to the Pacific coasts of North America. In the summer it is found in arctic regions; in the winter it descends to warmer latitudes, but does not migrate below 20.0 N. It is essentially a coast species, frequenting shoal waters, and has been observed to lie and play among the breakers in water not more than 13 feet deep. During the season of gestation they will even lie in water of two feet, waiting aground until the rising tide floated them off. Aelian also stated that whales bask on the shore in the rays of the sun! The pursuit of this whale is distinctly dangerous.* For the animal will, if her young be injured, pursue the boat and overturn it or stave it in with a stroke of the flukes. Apart from such danger, owing to the deliberate attacks of the whale, the whalers undergo much risk on account of the fact that the whales are pursued in shallow water, which naturally gets turbid through the struggles and rapid movements of the whale, and thus renders it difficult to see the exact position of the creature, and to escape from its rushes or the strokes of its ponderous tail. The pursuit of this whale only dates from the year 1846, and from that year to 1874 or 1875 Scammon thinks that about 10,800 must have been destroyed.

* A "cunning, courageous, and vicious" animal, says Mr J. D. Caton ("The California Grey Whale," *American Nat.*, xxii., p. 509). The same author has also stated that an individual of this species actually pursued a boat's crew on land and "treed them all"!

EXTINCT BALÆNIDS

There are three important facts with regard to the extinct representatives of the whalebone whales. Firstly, none are known from an earlier period than the Miocene; secondly, the earliest forms appear to be Balænopterids; and lastly, the more ancient whales were not larger than existing forms. On the contrary, this is a group which has increased considerably in size.

One of the best known forms, as it is represented by a nearly complete skeleton, is the Miocene and Pliocene *Plesiocetus*. *P. cuvieri* was a smallish whale, not more than 21 feet long, and distinctly belongs to the Balænopterid type. The chief interest attaching to this whale is the length of the frontal, so very abbreviated in other recent whales, and the share which the parietals take in the formation of the roof of the skull. In the living whalebone whales these bones are covered in by the supra-occipital. Like the modern *Balænoptera* this genus comprises both large and small species. Cope states that *Plesiocetus brialmonti* was some 60 feet in length.

Mesoteras of Cope was thought by him to be somewhat intermediate between *Balænoptera* and *Balæna*. It has "the characters of the Finner whales (*Balænoptera*), with the narrow maxillary bones of the true *Balæna*." It is a large species, with a skull 18 feet long, evidently so far a *Balæna*. There is an "enormous thickening of the superciliary part of the frontal bone." The existing genera are also known as fossils.

CHAPTER VIII.

THE TOOTHED WHALES OR ODONTOCETI

THIS group contains by far the larger number of whales. It embraces all the dolphins, Sperm whales, beaked whales, etc. It contrasts markedly with the Mystacoceti, the differences being so great that more than one naturalist, as already said, is disposed to give to the two a different line of descent. The most characteristic feature of the Odontoceti, and the one which has given to it its name, is the possession of functional teeth. These are never totally absent in any member of this group, though they may be—as in the Narwhal among the true dolphins, and in the Ziphioid whales—greatly reduced in number. Correlated with the presence of teeth is the absence of baleen. The skull is always more or less asymmetrical, and this asymmetry is often greatly exaggerated, especially in the Sperm whales. The maxillæ overlap the frontal bones. The nasals share in the asymmetry of the skull, and one only is sometimes developed. In connection with this the single* blow hole, either median in position, or (Sperm

* It is said to be double in *Kogia pottsi*, but the left spiracle is ten times larger.

whale) on the left side, may be mentioned. The ribs have always either bony or cartilaginous sternal moieties, which articulate with the usually composite sternum. A fair number, moreover, thus articulate. The ribs too, more or fewer of them, have both a capitular and a tubercular head, articulating respectively with the transverse processes and with the centrum of the vertebræ.

The two rami of the mandible unite by a longer or shorter, but always definite, symphysis, not a mere fibrous union such as is met with in the whalebone whales.

So sharply defined are the Odontoceti from the Mystacoceti that intermediate types are sadly to seek; and both divisions, in fact, have each specialised on their account in the same kind of direction in parallel lines. We have great-headed Cetaceans in both groups. The Cachalot corresponds to the Right whale. There are giants and pigmies among the families of each. The small *Kogia* is a near ally of the bulky Cachalot. The somewhat dwarfish *Neobalæna* is not far off from the leviathan of the Greenland seas. There are Odontocetes without a dorsal fin, and Odontocetes with that fin. The Rorquals correspond to the latter, the Greenland whale to the former. The pectoral fin is large in *Megaptera* and *Globicephalus*, small in *Neobalæna* and *Physeter*. The throat is grooved for extensile purposes in Balænopteridae and in the Ziphiidae. All these are parallelisms, and not evidence of affinity. So, at least, it seems to us.

Broadly speaking it would seem likely that the Mystacoceti were to be derived from the Odontoceti, and not *vice versâ*, if only on account of the teeth visible in the embryos of the toothless whales. On this view we might look upon those toothed whales in which the teeth are diminishing as the nearest approach among the Odontocetes to a Mystacocete. In this case it is clear that the Ziphioids would occupy that position, for it is in that group that the teeth are poorest in their development. But there is no hint in any of them of appearing whalebone. Neither can any other definite structures be laid hold of which support considerations derived from the dwindling teeth. It seems too trivial a matter to raise the question of the nearly perfect symmetry of the skull of *Berardius*, and of the distinct lacrymal and malar bones in the Ziphioids as well as in the Right whales. The fact seems to be that the meeting-point between the two great divisions of the whale tribe, if there is such a meeting-point, and the group is not diphyletic, is to be sought for no nearer than in the Eocene period among the Zeuglodonts.

And yet there are other considerations which seem to suggest that a renewed search for affinities between the two groups among more recent forms should produce some result. In contradistinction to the Odontocetes the whalebone whales are a limited group, which, as is pointed out here (p. 119), are so closely related one genus with another, that it is really difficult to form them into more than one family. This suggests a recent origin; for in groups, which there is reason to regard as ancient, there is often greater difference between the component genera, gaps having arisen through the extinction of certain forms.

The problem may therefore be approached by endeavouring to ascertain which of existing Odontocetes is the older group or genus as the case may be.

Mr. Lydekker has recently described an exceedingly interesting fossil from the Eocene of the Caucasus under the name of *Iniopsis caucasica*.* This Cetacean is represented only "by the hinder portion of a cranium, and also by some fragments of jaws and several vertebræ." But these remains, though not abundant, seem to fix the systematic position of the animal, of which they give such an incomplete idea, and to prove that it should be relegated, as its name denotes, to the neighbourhood of *Inia*, the freshwater dolphin of South America. In this extinct animal and in *Pontistes* of the tertiaries of the Argentine the maxillary bones are more deeply excavated than in dolphins, and their posterior border is squarely marked off and extends further back. The lower jaw too of *Iniopsis* seems to have been slender, and to have possessed very numerous teeth as in the existing Platanistidae. These facts, though few, seem to point to the great age of whales most nearly allied to the existing Platanistidae. Now whalebone whales do not go back so far into time.

* "On Zeuglodont and other Cetaceous Remains from the Tertiary of the Caucasus," *Proc. Zool. Soc.*, 1892, p. 558.

It will be seen from what immediately follows that in some respects the Platanistidae are the most primitive of existing Odontocetes.

The mode of attachment of the ribs to the dorsal vertebræ has been used in the classification of the Odontocetes. As a matter of fact there is an interesting series of modifications in these attachments which does away with any hard and fast lines of classification, though to some extent the groups can be defined from the facts.

What we may consider in the meantime to be the typical arrangement occurs in Dolphins; in *Orca gladiator*, for example, the first rib has both capitulum and tuberculum; the former is attached to the centrum of the last cervical, the latter to the transverse process of the first dorsal vertebra. The next six ribs are similarly attached by two heads to the transverse process of each vertebra and to the centrum of the vertebra behind. The last five have but one head, the tubercular, which is of course attached to the transverse process of its vertebra.

Kogia, though a Sperm whale, has many delphinoid characters, upon which we shall comment later. The first eight ribs have a double attachment, the capitulum is inserted on to centrum of each vertebra, and the tuberculum to transverse process of vertebra behind. The next five are attached to processes of centrum only, each to a longish process of the centrum. But there is no real difference from what we find in dolphins, for the process to which the last ribs are attached gradually moves down the transverse process until it comes to arise from the centrum instead of from the neural arch.

Kogia belongs to the same division as *Physeter*. But there are apparent differences between the two whales in the fact now under consideration. The first rib has only the tubercular attachment; the next eight have the double articulation of *Kogia*, but the capitular head in the latter ribs of the series is partly inter-central—it articulates with both centra, the one that bears its tuberculum and the one behind.

In the case of the ninth dorsal vertebra the facet upon the centrum is raised; in the tenth it is more prominent, and the transverse process to which the tuberculum should be attached has become rudimentary and joins the raised facet already mentioned, but not so as to receive any part of the rib—which thus articulates only with the centrum. In the last rib the tubercular process has entirely disappeared and the capitular head of the now one-headed rib is alone left.

The difference between *Physeter* and *Kogia* seems to be great, and as a consequence between *Physeter* and the dolphins. But the very interesting conditions which Sir William Flower has described in *Inia* bridge over the apparent gap, and, as I shall attempt to show presently, so does *Kogia*. In *Inia* the first seven ribs have the usual two attachments, but the capitular head, at first inter-central, comes to be upon the same vertebra as that which bears the tubercular head. Moreover, the facet upon the centrum becomes raised. The two articular facets upon the eighth dorsal vertebra approach near together, and in the next become completely fused. Hereafter the ribs are attached by but one head, which is really, be it observed, produced by a fusion between the capitulum and tuberculum, not by a disappearance of one or the other.

Now in *Physeter* we have a trace of this arrangement in the case of the tenth rib, for there the transverse process is still present and fuses with the central facet, though it takes no actual share in the formation of the surface for the articulation of the rib. In *Kogia* the facet on the centrum of vertebra 7, and still more on vertebra 8, is a little raised, so that here is left a trace of the arrangement obtaining in *Inia*. In the dolphins it has totally vanished, so that the fact that in the posterior ribs of the dolphins the tubercular head alone, and in *Kogia* the capitular head alone, remains is really not a fundamental difference, but only one of degree. They are the two extremes united by such intermediate forms as *Physeter*, and the Ziphioids, both springing from some such original form as is exemplified by *Inia*. We arrive therefore at the conclusion that the transverse processes of the lumbar vertebræ of these whales are compound structures partly belonging to the neural arch and partly to the centrum, but that as a rule one of these elements preponderates, or is even the only one which enters into their formation.

This series of facts obviously leads to the inference that in *Inia* we have a primitive form of Odontocete. At any rate, the different disposition of the ribs in existing Odontocetes can be derived from some such original form.

There are other facts which point in the same direction.

Not merely is the freedom from any trace of fusion a character in which the cervical region of the vertebral column may be considered to present primitive characters—for the mere freedom of these vertebræ is found in other whales, both toothed and whalebone (*e.g.*, *Monodon*, *Balænoptera*)—but the great length of this region of the body is important. There is in this Cetacean (and in *Platanista*) a distinct neck. The atlas vertebra too is more typically mammalian-looking than in other whales, and the second vertebra has a better odontoid process than is found elsewhere.

But *Inia* is very far from being an ideal basal form, with which to commence the Odontocete series. Its teeth are extremely numerous, though possessing, indeed, an additional cusp; the sternum may be like that of the Manatee, but is not typically mammalian (it has been pointed out that the Sirenia are not ancestral whales); the reduced lumbar region is against the present view of the position of *Inia*. There are, moreover, other facts which will be found referred to under the description of this whale. Still one cannot, at any rate in the present state of our knowledge, get much nearer to the basal Odontocete.

But this seems to bring us no nearer to the origin of the whalebone whales. The most primitive type of the latter seems to be the little *Neobalæna*. (See

p. 141.) But *Neobalæna* offers no hints in the structure of its skeleton of a toothed whale ancestry; neither does *Inia* or any Platanistid show a leaning, however slight, towards *Neobalæna*. It seems, therefore, that this question is one that will have to be deferred until we come to deal with the Zeuglodonts.

As to the origin of the remaining groups of toothed whales from the Platanistidae, that does not offer so many difficulties. The family itself, it may be remarked, is not a very natural one. This comes from the fact of its age and the consequent number of extinct genera which have caused gaps. Sir William Flower thus defined it in 1866:—*

"Costal cartilages not ossified. The tubercular and capitular articulations of the ribs blending together posteriorly. Cervical vertebræ all free. Pterygoid bones thin, not conforming in their mode of arrangement with either of the other sections. Jaws very long and narrow; both with numerous teeth having compressed fangs. Symphysis of mandible very long, exceeding half the length of the entire ramus. Orbit very small. Lacrymal bones not distinct from the jugal. Pectoral limbs large. Dorsal fin rudimentary."

At the time that this was written but little of *Pontoporia* (or *Stenodelphis*, as it should really be called) was known. But with the exception of the vertebral characters, the ossified costal cartilages and the presence of a back fin, it corresponds to the definition.

* "Description of the Skeleton of *Inia geoffrensis*," etc., *Trans. Zool. Soc.*, vi., p. 87.

In fact, we may still fairly accept the family, as does Flower in his most recent expression of opinion,* and as does Kükenthal.† In several ways *Pontoporia* points towards the true dolphins, the Delphinidae of the present volume. The attachment of the ribs is purely delphinoid, the curious double attachment of the genera *Platanista* and *Inia* not being preserved. There are also five lumbar vertebræ instead of the reduced lumbar region of the genus *Inia.*

The prominent dorsal fin is moreover a characteristic of the dolphins, as indeed of other groups.

All the Odontocetes have at least a trace of the elevation laterally of the maxillæ; this is carried to an extraordinary pitch in the full-grown male of *Hyperoodon.* *Platanista* too has a pair of thin plates which arch over the front of the head at the base of the snout, which are extensions of the maxillae, and may be referred to the same category. This genus moreover, and *Inia*, agrees with the Sperm whales and the Ziphioids in the permanently cartilaginous ribs; in the dolphins the sternal ribs are ossified. The length, both of the lower jaws themselves and of their symphysis, has led to their being described as miniatures of the lower jaw of the Cachalot; in fact, there are many resemblances between the Platanistidae and the Physeteridae. The connection of both seems to be plain.

* In *Mammals, Recent and Extinct.* London, 1891.

† "Vergleichend-anatomische u. Entwickelungsgeschichtliche Untersuchungen an Walthieren," *Denkschr. med.-nat.-Ges.* Jena, 1889.

As the Sperm whale is the most familiar form, perhaps, among the toothed whales we will commence with an account of it and its family.

Family, *PHYSETERIDAE*

This family may be thus characterised :—

All or most of the cervicals ankylosed. Costal cartilages not ossified. Pterygoids thick and meeting in middle line; lacrymal bones distinct and large; symphysis of mandible long. Teeth found in both jaws, but those of lower jaw alone functional,* often very reduced in number. Pectoral limb smallish. Throat furrowed by two or more furrows.†

These whales form a small assemblage of forms which are again divided by Sir William Flower into the Sperm whales and the Ziphioids. Van Beneden is in favour of uniting them rather more closely. The chief anatomical characters which ally the Sperm whales to the Ziphioids and the fewer characters which separate them are given below on p. 213.

The whales of this group are for the most part, if not altogether, social, the solitary and stranded individuals being as a rule males. Probably these males are, like "rogue" elephants, fierce bulls which

* In *Kogia simus* Owen figures a pair of apparently functional teeth in the upper jaw near to its anterior extremity. This fact, moreover, has been recently confirmed by Cope in his "Fourth Contribution to the Marine Fauna of the Miocene Period of the United States" in *Proc. Amer. Phil. Soc.*, 1895, p. 135.

† ? as to *Kogia*.

have been expelled from the herd. All the members of this division of the toothed whales range widely. None are really restricted in range, except the *Berardius*. They are equally at home in the calm seas of the tropics, amidst the ice floes of the north, and in the stormy waters of the antarctic ocean. They all possess functional teeth in the lower jaw, and there only. Their food seems to be chiefly, if not invariably, cuttlefish; and this circumstance accounts for their greater abundance in the tropics, for those animals more abound in those latitudes. Van Beneden reminds us that all, or at any rate most, of the Physeteridae produce spermaceti. Originally known, and once solely obtained, from the Sperm whale itself, the late Captain Gray commenced at one time to pursue *Hyperoodon* for the same substance; he found it to be by no means inferior in quality to that of *Physeter*, and to be of the same composition. From *Berardius* spermaceti has been also obtained. The grooving of the throat which characterises, indeed appears to be universal in, these whales may have some relation to the extensility of the gorge required by the enormous quantity of cuttlefish devoured. It may be in fact a structure developed by similar needs to those which have produced the grooves upon the *Balænoptera*, and to be therefore no evidence of affinity. Ten thousand beaks of the Molluscs were obtained from the stomach of a *Hyperoodon*.

We may associate the "Sperm whales" *sensu stricto* in the sub-family Physeterinae, which is quite as far as they ought to be separated from the Ziphioids. This sub-family will contain two genera, viz., *Physeter* and *Kogia*. These two genera agree to differ from what may be termed the Ziphiinae by two characters of some little importance; these are the presence of numerous teeth in the lower jaw, and the existence of only a lacrymal bone; there is at any rate only one bone, which may of course conceivably represent a fused lacrymal and malar. There are two in Ziphiids. To these two characters, which Sir William Flower uses to ally the "Sperm whales giant and pygmy," we may add the single lateral (left) blow hole. Sir R. Owen at least figures a single blow hole* in *Kogia simus*, which is longitudinal as in *Physeter*, but not S-shaped as in that creature. Of the two genera of Physeterines, *Kogia* is in many ways the least specialised form. It has the blow hole in what is (for a whale) a more normal position. We cannot, it seems reasonable to suppose, regard the terminal blow hole of the Cachalot as primitive because it is so far away from the shrunken nasal bones; it must be at most a return to a primitive state of affairs. The falcate dorsal fin of *Kogia* may be considered in the same light, and also generally the more delphinoid form of the head and body; the form of the Cachalot with its disproportionate head is surely a secondary acquisition. In the skull too there are features which seem to point to the same conclusion. The elongated rostrum of the Cachalot contrasts with the short snout of the Pygmy Sperm

* A rudimentary second one exists in *Kogia pottsi*.

whale. And it has been shown that the fœtal Cachalot is so far more like the *Kogia*. In the fœtal Cachalot it has been pointed out by Sir R. Owen that the lacrymal is only united to the squamosal by ligament; the bone is thus independent of the squamosal as is the case in the adult *Kogia*. In *Kogia* the pterygoids are not so completely united in the middle line as they are in *Physeter*, a character in which the former genus seems to be at a lower level than *Physeter; Kogia* seems to have (at any rate in the species *K. simus*) a pair of functional teeth in the upper jaw. In *Physeter* there are small teeth apparently non-functional in the upper jaw as in the Ziphiids generally.

There is one feature in the vertebral column which seems to point to the more basal position of *Kogia* in the series. The posterior dorsal vertebræ are not supported by special outgrowths of the centra to which they are attached; in *Physeter* such processes exist in the case of the last two ribs, as has been explained in detail already.

On the whole then these various considerations, drawn from different organs of the body, lead us to consider *Kogia* to be the most primitive of the Sperm whales. It is the most dolphin-like of those aberrant Cetacea. For this reason we shall commence the survey of the sub-family with a description of *Kogia* and its species.

This genus, *KOGIA*, consists of at most three species, all of which are small whales 9–13 feet in length. Dorsal fin falcate; form delphinoid. Cervical vertebræ ankylosed. Jugal not joining squamosal. Snout short. Blow hole at forehead.

This genus of "Pygmy Sperm whales" comprises a number of varieties from very various parts of the world, which have been much divided up into species and even genera. Allowing for the present that there is but one genus, a conclusion which it will be attempted to justify later, we may begin by contrasting it with the giant Sperm whale *Physeter*.

As to outward form the present whale has a delphinoid aspect, produced by the small head and the backwardly situated blow hole, the well-developed and falcate dorsal fin, and the small size. A peculiarity of the genus, more strongly marked than in its ally *Physeter*, is the inferior position of the mouth. This gives to the creature, as seen in the figure of Owen,* a curiously shark-like aspect. Some little time since a marine monster was stranded on the Welsh coast, and the newspapers reported that it was undecided by the local zoologists, or their own reporter, whether the beast was a shark or a whale. In spite of the superficial resemblance which the ventral mouth of a *Kogia* † gives it to a whale, it would be probably only a newspaper reporter who would be in doubt on the matter.

* *Trans. Zool. Soc.*, vi.

† Kogia or Cogia, as it is variously spelt, is a "barbarous" word, said to be a Latinised form of "codger"! But it might be a tribute to a Turk of the past surnamed Cogia Effendi, who observed whales in the Mediterranean!

The skull is short, and has not the prolonged anterior portion so characteristic of the Sperm whale. It is, however, very asymmetrical. The pre-maxillary bones are shorter than in *Physeter*, and diverge anteriorly on account of the vomer. The lacrymal bone is not in contact with the squamosal; indeed, a very considerable gap is left between the two.

The cervical vertebræ are all ankylosed together. The ribs vary in number, between 12 and 14. The sternum is in three pieces, and at any rate four ribs are attached to it. The scapula has not the concave outer face that it has in *Physeter*. The vertebræ are rather more numerous, but not much more so. The phalanges also are more numerous than are those of the manus of *Physeter*.

The above are the principal generic characters of *Kogia*, and they are clearly sufficient to distinguish it generically from *Physeter*. But the question of species is not so easy a one to decide, in view of the small amount of material that can be and has been examined. The greatest possible number is six, which—adding the recently described *Kogia pottsi* to those enumerated by Gill—are *K. breviceps*, *K. grayi*, *K. macleayi*, *K. floweri*, *K. simus*. The latter is elevated by Gill into a distinct genus, *Callignathus*, on account of the form of the lower jaw mainly, and the presence of two teeth in the upper jaw in addition to the series in the lower jaw. I believe that this is a distinct specific form from the others, but see no advantage in retaining generic rank for it. The whales of this genus are found all over the world, but especially abound in the antarctic half of the globe.

Kogia breviceps of de Blainville,* probably the same as *Euphysetes macleayi*, Krefft, has 13 pairs of ribs. Teeth confined to lower jaw, 14 or 15 on each side; not long.

There is a complete skeleton of this whale at the British Museum. The vertebral formula is C. 7; D. 13; L. 9; Ca. 25. The first rib articulates with the last cervical vertebra and the first dorsal. There are seven pairs of ribs which have both capitulum and tuberculum. The capitulum, it may be remarked, is not situated between two adjacent centra, but is entirely confined to the vertebra lying in front of that which bears the tuberculum. I found four ribs to join the sternum. The sternum is composed of three pieces, not divided at all longitudinally. The first sternal rib articulates with the expanded front of the manubrium, which is rather cross-shaped, the two arms being anterior. The second rib is attached between the first and second pieces of the sternum, the third between this and the next, while the last of the sternal ribs articulates at the end of the terminal piece of the sternum.

The scapula is not so high as is that of *Physeter*, but more fan-shaped as in the dolphins. It is not concave externally; it is practically flat. The number of phalanges is as follows: I, 2. II, 8. III, 8. IV, 8. V, 7.

* *Ann. Anat. Phys.*, 1838, p. 337.

The skull appears to agree with de Blainville's figure. The V-shaped lacrymal was especially plain, and characteristic as compared with Owen's figure of "*Physeter simus*."

Gray suggests that this species is perhaps the same as *Euphysetes macleayi* of Krefft.* I think that this determination is correct. Krefft gives the same number of vertebræ, save for the addition of a twenty-sixth caudal, a difference obviously of no importance. But it must be admitted that the number of phalanges in the hand are not the same. But the figure illustrating this point in his whale is of a young whale, a fact which may account for some discrepancies.

Kogia simus, Owen,† has nine teeth on each half of lower jaw; two in upper jaw. Vertebral formula: C. 7; D. 14; L. 5; Ca. 24 = 50.

This species, which inhabits the Indian Ocean, where it was first observed by Sir Walter Elliot, has been by Dr. Gill relegated to a distinct genus, largely on account of the peculiar swollen appearance of the mandibles. The name which he proposed for this genus is *Callignathus*. This does not seem to be at all necessary, as the whale is so definitely a *Kogia*, and as the genus contains at the most so very few species. However, it seems to be a distinct species, and cannot, I think, be confounded with *K. grayi*, with which species Dr. Gray united it.

* *Proc. Zool. Soc.*, 1865, p. 708

† *Trans. Zool. Soc.*, vi., p. 30.

Sir R. Owen pointed out that it is even shorter snouted than that species; the outline of the occipital behind is, if anything, convex, while the same outline in *K. breviceps* is concave; the occipital condyle too stands out more in *K. simus*. The peculiar upturned snout suggested the name. Furthermore, the fewer teeth in the lower jaw and perhaps the two teeth in the upper jaw are marks of specific distinction which cannot be overlooked. As to the latter it is possibly not a valid specific character. *Physeter* itself has a series of somewhat rudimentary teeth in the upper jaw, and it is therefore possible that its near ally *Kogia* has the same structural feature. However, in any case the vertebral formula is quite different; the small number of lumbars distinguishes the present form from all others. As in *K. breviceps* the first rib articulates with the last cervical (but by ligament only) and the first dorsal; after this come seven ribs which similarly are possessed of both capitulum and tuberculum. The capitulum, it should be noted, lies between the centra of adjacent vertebræ. Four ribs reach the sternum, which is made up of three pieces partly divided in the middle line.

The phalangeal formula is as follows:—I, 2. I, 5. III, 4. IV, 4. V, 2.

Mr. Gill* created a species, *Kogia floweri*, for a Pygmy Sperm whale from the shores of California. It was an individual of some nine feet in length with

* "Sperm Whales, Giant and Pygmy," *American Naturalist*, 1871.

a very low dorsal fin. Nothing of its osteology is known except a portion of the lower jaw. The teeth in this are rather long and curved back, but it would be rash to allow the species to be a certainly settled one in the absence of further information.

It seems to be very doubtful whether *Kogia grayi* can be regarded as a distinct species. It is identified by Gray with *K. simus* of Owen, an identification with which I cannot agree (assuming, of course, that the descriptions of Macleay and of Owen are to be depended upon). It seems to be much more likely that the supposed *K. grayi* is merely *K. breviceps*. Dr. Gray made a great point of the marked ridge which divides the postnarial region of the skull, utilising its marked or less marked character to separate the two "genera" *Kogia* and *Euphysetes*. The difference does not seem to exist between *K. breviceps* and *K. grayi*.

There might appear at first sight to be one more rib in *K. grayi* than in *K. breviceps*. But that this is actually the case does not seem to be perfectly clear. After mentioning "dorsal vertebræ 14" Macleay goes on to write to the following effect:—"The first rib, etc. . . . the seven following, etc. . . . the next five." This looks as if thirteen were the total number, as in *K. breviceps*. The fact that in *Kogia grayi* the first rib is only attached to the first dorsal and not to the last cervical also may be perhaps explained by the existence of a ligamentous connection and by youth. The smaller number of phalanges too is not a difference of importance, as these bones are known to vary in other whales.

A small species, *Kogia pottsi*, has been recorded by von Haast* from the shores of New Zealand which only measured 7 feet 2 inches in total length. Its colour was black, with a greyish white belly. The chief reason for distinguishing it from *K. grayi* is the vertebral formula: C. 7; D. 12; L. 11; Ca. 20. There are thus two pairs of ribs less, and besides this there are only eight chevron bones.

The genus *PHYSETER*† may be thus defined:—Head enormous; blow hole single, on left side; dorsal fin represented by a series of low humps. Atlas separate from rest of cervicals, which are fused. Snout long; jugal joining squamosal.

"In no mammal," remarks Sir W. Flower,‡ "does the cranium depart from the ordinary type to such

* "On the Occurrence of a new Species of *Euphysetes* (*Euphysetes pottsii*), a remarkably small Catodont Whale, on the coast of New Zealand," *Proc. Zool. Soc.*, 1874, p. 260.

† *Meganeuron* is an additional generic name introduced by Dr. Gray for the sake of a set of cervical vertebræ from the Australian seas.

This seems to have been quite an unnecessary proceeding, for in the first place the creation of a new species, let alone a new genus, upon a set of vertebræ is a highly risky proceeding, especially when those bones might, as I believe in the present case they do, belong to a young animal. They are in fact about half the size of the same bones in a full-grown Cachalot, therefore the different shape of the foramen for the spinal cord may be accounted for by incomplete ossification of the bone.

‡ "On the Osteology of the Sperm Whale," *Trans. Zool. Soc.*, vi., p. 314.

an extent as in the Cachalot. The expansion, elongation, flattening, and distortion of many of the cranial bones, met with in a certain degree in all Cetaceans, is here carried so far as to render it by no means easy, at least in the adult animal, to recognise their homologies."

In the first place the skull is enormously large in proportion to the rest of the body, larger than in any whale (and *a fortiori* than in any mammal). The Greenland whale does not really form an exception. It is certainly rather longer in proportion, but it is not so massive. The skull is raised into a great crest behind the vertex, being occupied by the maxilla and frontals. The asymmetry is chiefly shown in the pre-maxillae and the nasals. The *right* pre-maxilla is very much the larger. The *left* nasal alone is present.

The parietal bone, if not suppressed, is represented merely by a wedge-shaped piece of the supra-occipital. The orbit has unusually solid margins, more so than in any toothed whale; this is due to the large size and solidarity of the jugal, which, however, is not, as it is in the Ziphioids, divided into two pieces. The entire bone apparently represents the separate malar and lacrymal of the Ziphioids.

The pterygoids meet for a considerable distance in the middle line; the vomer is entirely exposed in front of the palatines. The two rami of the lower jaw do not appear to be united at the symphysis by ankylosis; the length of the symphysis recalls the Platanistidae.

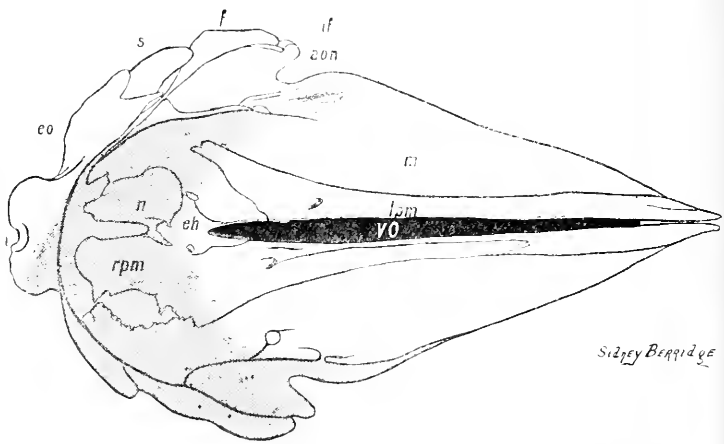
The vertebral formula of the Sperm whale is :—

C. 7; D. 11; L. 8; Ca. 24 = 50.

The atlas alone is distinct, the other cervicals being united with each other, and even sometimes with the first dorsal. In the freedom of the atlas and the fusion of the remaining six *Physeter* is unique

FIG. 24. SKULL OF PHYSETER FROM ABOVE.

(From Flower.)



eo, Ex-occipital. *s*, Squamosal. *f*, Frontal. *n*, Nasal. *m*, Maxilla. *eh*, Ethmoid. *rpm*, Right pre-maxilla. *lpm*, Left pre-maxilla. *vo*, Vomer.

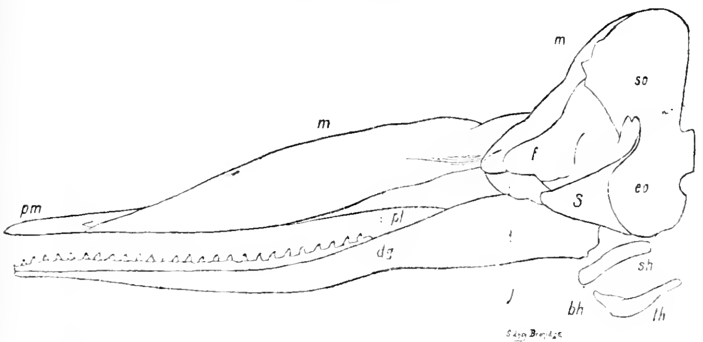
among whales. Another characteristic feature of the atlas is its quadrangular outline.

As to the dorsal vertebræ (eleven in number if we include the one at the end of the series much resembling the lumbars, but bearing a rudimentary rib), the first nine have somewhat rudimentary post-zygapophyses—"rough processes, which can be hardly called articular surfaces." The prezygapophyses are smooth-surfaced.

The heads for the articulation of the ribs are highly characteristic of the Sperm whale, and differ in detail from those of other whales. The first vertebra bears a strong transverse process of the neural arch for the articulation of the first rib, and

FIG. 25. SKULL OF SAME FROM THE SIDE.

(From Flower.)



p, Parietal. *so*, Supra-occipital. *pl*, Palatine. *pm*, Pre-maxillary. *sh*, *bh*, *th*, Hyoid. *f*, Jugal. Other letters as in Fig. 24.

also a small facet on the hinder edge of the centrum, where articulates the head of the second rib. The eight following vertebræ have similar processes, arising from their neural arches, for the articulation of the tubercula of their respective ribs. But the corresponding articular facets upon the centra for the capitula of the ribs are not arranged in so uniform a fashion, but vary as follows: The first four vertebræ have facets upon their centra posteriorly for the reception of the heads of ribs II–V. The fifth vertebra has, in addition to the posterior facet, one small one upon the anterior edge of the centrum, so that the capitulum of the fifth rib is inter-central, articulating, as it does, with two centra.

In the sixth vertebra it is the anterior of the two centrum-facets which is the larger. In the case of the next vertebra the posterior facet is still further reduced, while the anterior facet is borne upon a tubercle. The characters of the eighth vertebra are an exaggeration of those of the seventh, and in the ninth there is no trace at all of the posterior facet. The tenth vertebra is peculiar by reason of the fact that the large tubercle which arises from the centrum and carries the capitular head of the rib bends back above and nearly joins the transverse process of the neural arch, a canal, nearly complete, being formed between the two. The rib of this vertebra is in consequence only provided with a capitulum. The last dorsal vertebra has a very long lateral process arising from the centrum, bearing at its extremity the rudimentary eleventh rib. The transverse process has completely disappeared. The eight lumbar vertebræ are keeled below. There are fourteen chevron bones.

A curious matter concerning the ribs was asserted by Wall. He stated that the ribs of the left side are of larger dimensions than those of the right. The asymmetry of the head is thus alleged to be extended to the trunk. Sir W. Flower so far supported this view by stating that the total weight of the ribs of the right side was 163 lbs. 9½ ozs., as against 164 lbs. 5½ ozs. for those of the left side.

The sternum of the Cachalot is a roughly triangular bone, made up of three pieces. Two of these are paired and anterior, and enclose (in the dried skeleton) a foramen between them; the third piece is posterior and smaller, and shows some indications of a longitudinal division into two. Four (cartilaginous) ribs seem to be attached to the sternum.

"The scapula is higher in proportion to its breadth than in any other Cetacean." It is remarkably concave on the outer and convex on the inner side.

There are six separate carpals (if we include the pisiform), and the phalangeal formula is as follows:—
I, 1. II, 5. III, 5. IV, 4. V, 3.

AMBERGRIS

Ambergris is a well-known product of this whale. Though the name has obviously no connection with this quality ambergris is a somewhat greasy substance, found floating in the sea or more generally washed ashore. It is a secretion of the intestine of the Cachalot, comparable apparently to bezoar stones. The fact that the substance was found to contain the beaks of cuttlefish suggested its origin, which was confirmed by finding it actually in the alimentary canal of a Cachalot. When taken from the alimentary canal the substance is greasy and of a disagreeable smell. After exposure it hardens and acquires its "peculiar sweet earthy odour." From certain chemical facts it has been inferred that ambergris is a biliary concretion, closely resembling cholesterine. But its appearance in the whales is pathological and not natural; for those individuals in which it was found were dead or in a sickly condition. Ambergris has been used as a medicine, even as an aphrodisiac; it is now solely used in perfumery. It is mainly used as a vehicle for various perfumes, and is worth from 15*s.* to 25*s.* per ounce. A piece of ambergris has been found worth no less than £500; it weighed 130 lbs. A larger piece even than that has been stated to have been in the possession of the Dutch East India Company; it weighed 982 lbs.*

The origin of ambergris was known more or less definitely so long ago as the middle of the sixteenth century. That is to say, it was known to be the product of a whale, though not known to be confined to the Sperm whale. A section of Olaus Magnus' *Historia de Gentibus Septentrionalibus* is headed, "De Spermate Ceti, quod Ambra dicitur, et ejus medicinis." He describes it as found floating in the sea, as being of a blue colour with a whitish tinge, *i.e.*, grey. It is held to be the sperm of the whale, and is set down as an excellent remedy for syncope and epilepsy. But in 1672 the Hon. Robert Boyle transcribed the contents of a manuscript found on board of a Dutch vessel, which asserted that this substance "is not the scum or excrement of the whale, but issues out of the root of a tree, which tree howsoever it stands on the land, alwaies shoots forth its roots towards the sea, seeking the warmth of it,

* Van Beneden and Gervais, *Ostéographie des Cétacées*, p. 304.

thereby to deliver the fattest gum that comes out of it, which tree otherwise by its copious fatness might be burnt and destroyed."

A curious mingling of truth with inaccuracy is shown in the views upon this substance of Sir Thomas Brown. He describes in the *Philosophical Transactions* (vol. xxxiii., p. 193) a Sperm whale cast up on the shore of Norfolk. "In vain," he writes, "it was to rake for ambergriese in the paunch of this leviathan, as Greenland discoverers, and attests of experience dictate, that they sometimes swallow great lumps thereof in the sea—insufferable fetor denying that inquiry!" It appears, therefore, that the author of *Religio Medici* knew that ambergris was found in the alimentary canal of the Sperm whale, but thought that it was swallowed by the creature. From this perhaps were derived two alternative views of the nature of ambergris given in *Johnson's Dictionary* (edition of 1818). It is described as the excrement of birds washed off rocks and swallowed by birds, or honeycombs that have fallen into the sea.

Physeter macrocephalus, Linnæus* (with probable synonyms: *P. catodon*, Fabricius; *P. gibbosus*, Schreber; *P. trumpo*, Gerard; *P. polyclystus*, Couch; *Catodon australis*, MacLeay; *C. colneti*, Gray; *P. polycyphus*, Quoy and Gaimard), is really the only species that can be satisfactorily allowed.

The above list of synonyms shows that there were held to be several species of Sperm whales. But

* *Systema Natur.*, 12th ed., i., p. 107.

we may safely follow Sir William Flower in holding that there is but one species properly definable, which is of wide range, and may be also of certain variability of outward form. The mysterious "High-finned Cachalot" will be considered a few pages further on. This single species ranges from China to Peru, in fact it is a denizen of all the oceans; and as a rule it is found far from land, preferring the deeper waters.

This whale cannot be confounded with any other; its thick, blunt head, a third of the length of the body, distinguishes it at once. The muzzle, however, is not so abruptly truncated as is often figured (*e.g.*, by Scammon); it slopes forward two metres beyond the front end of the jaw.* The skull, however, does not correspond in form to the head. The whole upper surface of the head is occupied by the "case" in which lies the spermaceti fluid during the life of the animal. The males of the whale are considerably larger than the females. The size of the former appears, however, to have been exaggerated. Beale gives from actual measurements 84 feet as the length. But Sir W. Flower thinks that this measurement and similar ones are not always trustworthy, from the fact that there is no indication whether they refer to actual length or are taken along the curves of the body. From a com-

* POUCHET and CHAVES "Des formes extérieures du Cachalot," *Journ. de l'Anat.*, 1890. See also (for internal anatomy) POUCHET and BEAUREGARD, "Recherches sur le Cachalot," in *Nouv. Arch. du Mus.* (3), vols. i. and iv.

PLATE XI.

FIG. 26. Stranded Sperm Whale.
(From Pouchet and Chaves.)

[*To face page* 200.

parison of various skeletons of old animals it seems that 55 feet, possibly 60, is the outside total length of a male Sperm whale.

The colour of the whale is black, getting grey beneath.

The blow hole is single, and is described as being of the shape of an italic *f*; it is placed near the front end of the snout. Underneath the blow hole is a longitudinal groove, the nature of which is obscure. This whale has no definite dorsal fin, but a series of lowish humps, of which the first is the most prominent. The throat has two grooves, like those of Ziphioid whales. The tail is very deeply cleft terminally, and one flap lies over the other.

The Sperm whale feeds mainly upon cuttlefish; but fishes have been found to be also eaten. It is said to feed by dropping the huge lower jaw,* "thereby exhibiting its polished white teeth, which attract within its reach the swimming food, while the creature moves along through the ocean's depths." Its food is never apparently composed of larger creatures than bonitos and albicores; but the throat is said to be large enough to swallow a man, and naturally the Cachalot† has been identified with the whale of Jonah, and also with the Leviathan of Job.

The pectoral fins are not large, measuring about six feet in a full-grown whale.

* But MM. Pouchet and Chaves (*Journ. de l'Anat.*, 1890) think that this is impossible.

† Cachalot is a Bayonne word, and is said to come from the Catalan quichal or from the Spanish quixal (tooth or jaw). The Italians call it capidoglio = oil-head.

The Cachalot will remain under water from fifty minutes to an hour and a quarter. When it spouts it does so for the space of about three seconds, and the column of vapour ejected can be seen from the masthead at a distance of three to five miles. The spouting of the Sperm whale can be readily distinguished from that of other whales from the fact that the blow hole is single, and the column of breath condensed is also a single fountain, not a double jet, as in other whales. Moreover, as the blow hole is situated further forwards than in other whales the jet is not directed upwards but forwards; these characters serve the spouting of the Sperm whale to be clearly distinguished.

This whale is intertropical in range,* and is only an accidental visitor to the arctic regions. It travels in "schools." When solitary individuals are seen, such as those which have been rarely cast up on our shores, they seem to be generally old males.

This great "sea-should'ring whale" indulges in a variety of antics; it will leap completely out of the water, coming down with a heavy splash that can be seen from the masthead at a distance of ten miles. These active leaps are said to be indulged in by the whale for the purpose of ridding itself of certain external parasites. The whale will also poke its head out of the water to look or listen, assuming then a perfectly upright position.

The great strength of the whale is indicated by

* Mr. Beale's work upon the Sperm whale is the classic in its habits and pursuit.

its capability of throwing itself out of the water. Mr. Aflalo relates the circumstance of having seen an individual hurl itself out three or four times running.

This great strength is sometimes disastrous to the whale fishers. "It has been the general belief," remarks Captain Scammon, "that the Sperm whale is excessively timid; but if this is its general character there are many exceptions among the larger males, for when attacked they have in repeated instances turned upon their pursuers in the most defiant manner, and their own disfigured jaws, which are their principal weapons of defence, prove that they either engage in desperate contentions with their kind, or with some unknown leviathan inhabiting the deep. Moreover, it is we believe a well-established fact that ships have been sunk by the deliberate assaults of vicious, grey-headed, old Cachalots."*

Captain Scammon gives several instances of such assaults. The creatures butt at the vessel with their massive forehead, and have been known to stave a vessel in; but it does not always seem clear whether this is accidental or due to mere confusion on the part of the whale, or is a deliberate attack. But there is one instance related where the whale

* Marco Polo (*Travels of Marco Polo*, Yule) explained such events otherwise: "for when the ship in her course by night sends a ripple back alongside of the whale, the creature seeing the foam fancies there is something to eat afloat and makes a rush forward, whereby it often shall stave in some part of the ship." Mr. Bullen, in his recently-published *Cruise of the Cachalot*, figures a Sperm whale about to bite a boat in two; it has turned over on its back for the purpose.

attacked one after another a number of boats which had left the vessel for its capture, giving chase to each. Captain Scammon thinks that in some cases vessels which have been mysteriously lost at sea have been sunk by Cachalots. The at least occasional ferocity of Cachalots is emphasised by a name given to such whales; they are spoken of as "eating whales."

FIG. 27. SPERM WHALE (?) ATTACKING A SHIP.
(From Olaus Magnus.)

It may be that the males, as in so many other kinds of animals, fight for the females, and that the black bulk of a whaling vessel may be mistaken for one of their own kind; the solitary males which are thus ferocious may further be comparable to "rogue" elephants driven out of the herd by their companions.

A species, called by Dr. Gray *Physeter tursio*, and with many other names, must be mentioned as an appendix to our account of *Physeter macrocephalus.* Considering that "there is not a bone, nor even a fragment of a bone, that can be proved to have belonged to a specimen of this gigantic animal to be seen in any museum in Europe," it may seem somewhat unnecessary to devote any space to its consideration. Yet so much has been written about this mysterious creature that it cannot be passed by in silence. The species was established on the good faith of Sibbald, who was certainly accurate in his accounts of other whales; thus there would be a *primâ facie* reason for accepting his dicta, improbable though they may sound. This creature, according to him, is a great whale not inferior in size to the Cachalot, but differing from it in the presence of a large falcate dorsal fin, and also apparently by the presence of numerous teeth in both jaws of equal size. One view is that Sibbald was deceived by a Killer whale into forming this new variety. But though Orca* grows to a large size, none have been recorded of the length of over 50 feet, which is the length assigned to *Physeter tursio.* The "High-finned Cachalot," as this dubious whale has been termed, is a native of our coasts if of anywhere, and an example was stated to have been thrown ashore in Orkney in 1687, and other observers have increased the mystery by saying that it often comes ashore in those localities. Since so good a naturalist as the late Mr. Thomas Bell admits

* The Orca of Pliny appears to have been a Cachalot.

this whale into his book of British Mammals, we shall allow it a place in the present book.

As to this fin, it has been described as presenting the appearance of the mast of a ship, so long and straight is it. In addition to this fin, there are said to be a few low bosses or humps; this perhaps is the secret of the mystery. In a stranded Cachalot which I saw at Birchington some months since it appeared to me that the commencement of the dorsal fin was rather higher than is generally represented; a little exaggeration and we have the High-finned Cachalot at once. As to its ferocity, etc., that is just as suitable, according to many, to the ordinary Cachalot.

Lacepède prefers to call it *Physeter mular*, and says that it grows to a length of 33 metres! He further remarks that it travels in herds with a leader, the largest of the gamme. This beast leads to the attack or retreat, and, "according to a sailor quoted by Anderson, it gives the signal by a terrible cry, of which the echo travels far along the surface of the water, of victory or of a precipitate flight."

Under the name of *Physeter microps* Lacepède has described a whale no doubt really identical with the Cachalot, but which Dr. Gray regards as a "High-finned Cachalot." "It is," remarks Count Lacepède, "one of the largest, most cruel, and most dangerous inhabitants of the sea." The suggestion is made that the story of Perseus and Andromeda is based upon a ferocious Cachalot, and that the Orca described by Ariosto, which was to devour Angelica chained to a rock upon the coast of Brittany, is referable to this creature. There is a story told of the Emperor Claudius who engaged in battle with his pretorian guards a monster of this species at the port of Ostia. It can hardly be right to refer this animal to anything but the species *Physeter macrocephalus*, for there is no suggestion, except by native Greenlanders, that there are teeth in the upper jaw, and probably these teeth are the rudimentary ones so common in the Sperm and Ziphioid whales. Still it is alleged to possess the hypothetical dorsal fin of the mysterious species to be described later. Of this whale in December, 1723, seventeen examples were thrown up on the shores of the Elbe. A more remarkable stranding of Cachalots occurred on the coast of France in the year 1784. "On the 13th March," writes Lacepède, "were seen with great surprise a quantity of fishes throwing themselves out of the water on to the shore, and a great number of porpoises enter the harbour of Andierne. The 14th at six o'clock in the morning the sea was high, and the wind blew from the south-west with violence. Extraordinary bellowings were heard towards Cape Estain, which were audible in the country at a distance of more than four kilometres. Two men who were coasting along the shore were seized with terror when they saw at a little distance some enormous animals, which were struggling with violence and attempted to resist the foaming waves which rolled them over and hurled them towards the shore. . . . The fright of the spectators increased when the first of these Cetaceans, struggling uselessly with the waves, were thrown on the sand; the terror redoubled when they saw them followed by a very large number of these colossal and living Cetaceans." There were altogether thirty-two of the monsters stranded on that occasion. It is a curious fact that the majority of these individuals were females. They had probably sought the shore for breeding purposes. This whale, as is related of so many others, is said to possess a great tenderness for its offspring. As with other whales but one is born at a time, but occasionally there are two.*

EXTINCT ODONTOCETES

We shall refer here to two extinct Cetaceans from the Miocene of Patagonia, of which one at any rate —*Physodon*—is apparently a Physeterid. As to the other, its systematic position is not so plain. *Physodon*, when it is more fully known, will probably have to be placed in a distinct family, Physodontidae. The general outline of the skull is much like that of *Physeter*. It is crested, as in that whale, but the rostrum is shorter, and so comes to resemble that of *Kogia*. As *Kogia* appears to be a more ancient type of Physeterid than *Physeter*, this likeness is perhaps of some significance. Its most salient feature is the existence of teeth in both upper and lower jaws. In the upper there are some 22 teeth on each side, and 24 on each ramus of the mandible. A noteworthy

* See also for stranded Sperm whales TURNER, "Notes on some Rare Prints of Stranded Whales," *Journ. Anat. Phys.*, xii., 1878, p. 593.

point is that some of the upper jaw teeth are implanted in the pre-maxillæ. The total length of the skull is about 10 feet, so that it falls short of that of the Sperm whale.

Argyrocetus patagonicus is mainly known from a skull. This shows that the animals were about as big as the dolphin genus *Steno.* It shows several archaic characters. In the first place the occipital condyles, whereon articulates the first vertebra, are in shape more like those of terrestrial mammals instead of being adpressed to the skull, as in the Cetacea generally. The nasal bones too are large and well developed; the rostrum is long and slender; the skull generally is bilaterally symmetrical. It has been pointed out by Mr. Lydekker* that the fossæ upon the maxillary bones are squared and flattened like those of *Pontoporia.* As in the Platanistids, moreover, the cervical vertebræ, or at any rate cervicals found in association with the skull, are all free, and longer than is the rule among more modified Cetacea. The end of the mandible is upturned, smooth, and without teeth, and is unlike that of any existing Cetacean.

* *Ann. Mus de la Plata,* 1893.

CHAPTER IX.

BEAKED WHALES

Family, *ZIPHIIDAE*

ANOTHER group is formed by the Ziphioid whales, which should perhaps be only regarded as a sub-family Ziphiinae. The whales of this sub-family or family are of moderate size, not exceeding —so far as we know from actual measurement—a little over thirty feet. They are also fairly rare, and seem for the most part to live singly, so that their bodies have been but rarely thrown up upon the shore. Moreover, they seem to be most prevalent in the southern hemisphere; hence their occurrences would be far likelier upon the great stretches of desolate coasts which abound in the southern half of the globe to go unnoticed. Their rarity at present contrasts with the relative abundance which once obtained on the surface of the earth. This leads, remarks Sir W. Flower, "to the belief that the existing Ziphioids are the survivors of an ancient family which once played a far more important part than now among the Cetacean inhabitants of the ocean, but which have been gradually replaced by other forms, and are themselves probably destined ere long to share the fate of their once numerous allies or progenitors." Since the words just quoted were written (in the year 1871) more has been discovered and written about this group of Cetaceans; but they still remain a group or family that requires much further study before they are as well known as some other families of Cetaceans. Their rarity is emphasised by the fact that almost every individual seen or captured has received a different name. *Berardius* is only known by three specimens, *Mesoplodon grayi* by two or three. The late Mr. P. H. Gosse thus wrote of a mysterious "*Delphinorhynchus*" (= *Mesoplodon*) observed by himself in the Atlantic:—"During my voyage to Jamaica, when in lat. 19 N., and long. from 46 to 48 W., the ship was surrounded for seventeen continuous hours with a troop of whales, of a species which is certainly undescribed. I had ample opportunity for examination, and found that it was a *Delphinorhynchus*, thirty feet in length, black above and white beneath, with the swimming paws white on the under surface, and isolated by the surrounding black of the upper parts—a very remarkable character. This could not have been the Toothless whale of Havre, and there is no other with which it can be confounded. Here, then, is a whale of large size, occurring in great numbers in the North Atlantic, which on no other occasion has fallen under scientific observation." The Toothless whale of Havre, it may be remarked, named *Aodon dalei*, seems to be merely a toothless, probably aged, example of *Mesoplodon bidens*.

Apart from *Hyperoodon*, which has been long known, and which is fairly abundant, the Ziphioid whales were entirely unknown to science until the beginning of the present century; and up to the year 1871 only some thirty individuals had been caught or stranded.

The Ziphioid whales agree in the following assemblage of characters:—

1. The functional teeth are limited to one or two pairs, which are only developed in the mandible. In addition to these there are a number of small teeth in both jaws, which are not recognisable in skulls, as they come away with the gums, and are hidden by them during life.

2. The skull is characterised by the marked prominence behind the nares, by an elevation of the maxillæ (exceedingly developed in *Hyperoodon*), by the long rostrum, by the large solid pterygoids which meet in the middle line, and by a distinct and separate malar bone.

3. The vertebræ are not more than fifty in number; their spines (in the dorsal and lumbar regions) are very long; the transverse processes of the neural arches of the dorsal vertebræ, as a rule, cease abruptly near to the end of the series, and are replaced upon the succeeding vertebræ by similar processes which arise from the bodies of the vertebræ (*Hyperoodon* is exceptional).

4. The ribs are not more than ten pairs; the sternal ribs are permanently cartilaginous.

5. The blow-hole is crescentic, with the concavity forwards.

6. The pectoral fin is rounded, and not large. The phalanges are not numerous.

7. There is a dorsal fin, falcate in form.

8. The throat is marked by at least one pair (? as to *Berardius*) of gular grooves, similar to those of *Balænoptera* and *Physeter*.

All the Ziphioid whales present these characters.

They agree with the Physeterinae in having no functional teeth in the upper jaw; in the general form of the skull; in the characters of the transverse processes of the dorsal vertebræ; in the cartilaginous sternal ribs; and in the throat grooves.

But the Ziphioid whales differ from the Cachalots in the fewness of their functional teeth and in the existence of a distinct malar bone; in the latter point they agree with the Mystacoceti.

It is possible that the Ziphioids also agree to differ from other whales in a small character, which has been noticed at any rate in *Hyperoodon*, in *Mesoplodon*, and *Ziphius* (by Scott and Parker); that is in the rounded projection between the flukes of the tail.

The genus *MESOPLODON** consists of moderately-sized whales, 15–17 feet or so in length. Skull with mesethmoid ossified; the nasals are sunk between the upper ends of the pre-maxillæ; single pair of larger or smaller functional teeth in lower jaw, embedded in

* W. H. FLOWER, "A further contribution to the knowledge of the existing Ziphioid whales, genus *Mesoplodon*," *Trans. Zool. Soc.*, x., p. 415. See also AURIVILLIUS, in *Bihang. Svenk. Acad. Handl.*, xi., 1887; and TURNER in *Journ. Anat. Phys.*, 1886, p. 144.

mandible at or near middle. Vertebral formula: C. 7; D. 9 or 10; L. 10 or 11; Ca. 19 or 20 = 46 or 48. Atlas and axis fused, sometimes also third. Sternum of four or five pieces. Eight ribs two-headed. Phalanges: I, 1. II, 6. III, 6. IV, 3. V, 2.

The most elaborate account of the skeleton of *Mesoplodon* is contained in Sir W. Flower's description of the osteology of most of the species. The skull agrees with that of *Ziphius*, and differs from that of *Hyperoodon* and *Berardius* in the thorough ossification of the mesethmoid, and its coalescence with surrounding bones to form the very solid rostrum, which in the adult has the density of ivory. The tympanic bone of this genus differs from that of *Ziphius* in having a well-marked groove at the posterior end between the lobes. In this matter *Mesoplodon* agrees with *Berardius*, and differs from *Hyperoodon*, which in its turn agrees with *Ziphius*. *Ziphius* and *Hyperoodon* are nearer in this particular to *Physeter*, and the two other Ziphioid genera to the dolphins.

In these "beaked whales" the breadth of the base of the rostrum and the relative positions of the two foramina for the exit of the two branches of the second division of the fifth nerve offer characters, which are made use of, following Sir W. Flower, in the characterisation of the species of the genus. The maxillæ have the characteristic ridges of the Ziphioid whales, especially in *M. hectori*. The nasals are sunk between the extremities of the pre-maxillæ. The relations of the palatines and pterygoids differ somewhat, and are made use of to distinguish the species *M. australis* and *M. densirostris.*

The vertebral formulæ of several individuals are as follows:—*M. grayi*: C. 7; D. 10; L. 11; Ca. 20 = 48. *M. australis*: C. 7; D. 9; L. 11; Ca. 20 = 47. *M. bidens*: C. 7; D. 10; L. 10; Ca. 19 = 46. Another individual of *M. bidens*: C. 7; D. 10; L. 9; Ca. 20 = 46; *M. layardi*: C. 7; D. 10; L. 10; Ca. 19 = 46. There are thus no specific characters at all obvious to be deduced from the numbers of the vertebræ.

In both *M. australis* and *M. grayi* the atlas and axis alone were united, the least amount of union existing in any Ziphioid whale; and one of the skeletons was that of an adult animal. The same

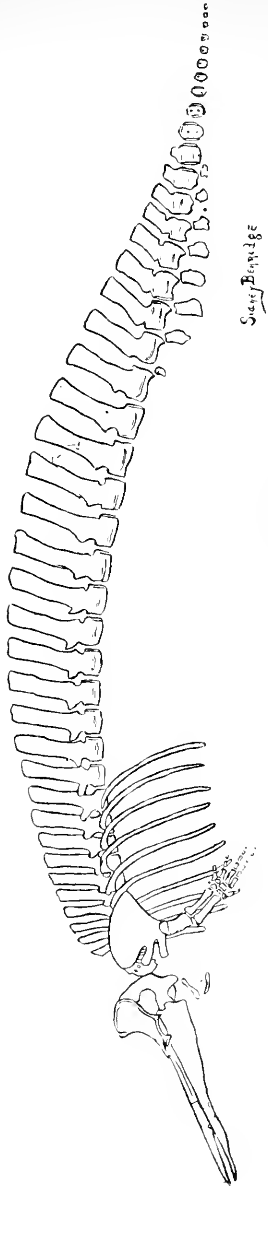


FIG. 28. Skeleton of *Mesoplodon.*
(From Flower.)

amount of union has been observed in two specimens of *M. bidens.* In *M. layardi* the first three vertebræ were united, the rest free. The high spines of the dorsal and lumbar vertebræ, and the absence of a slope backwards in those vertebral spines allies the present genus to *Ziphius* and *Hyperoodon*, and distinguishes it from *Berardius.* Zygapophyses extend to about the sixth vertebræ (dorsal) in *M. australis*, further back to the tenth in *M. grayi.* The lumbar vertebræ are strongly carinate below. There are eleven chevron bones, judging from the presence of articular facets. The sternum has five distinct pieces in the immature *M. grayi*; only four in the adult *M. australis.* In both there are notches between the successive elements, which are naturally converted into foramina.

While there is a great uncertainty about the species of *Ziphius* more is known, thanks to the studies of Sir W. Flower, concerning the species of this genus *Mesoplodon.* Eight species, at any rate, can be clearly recognised, mainly by the position and the characters of the teeth.

These eight species, with their synonymy,* are as follows :—

Mesoplodon bidens, Sowerby ;† (=*Delphinus* (*Heterdon*) *sowerbiensis*, Blainville ; *D. sowerbyi*, Desmarest ; *Delphinorhynchus micropterus*, Cuvier ; *Mesoplodon sowerbiensis*, van Beneden ; *Micropteron bidens*, Malm ; *Aodon dalei*, Lesson).

* This synonymy only relates to the *specific* names.

† *British Miscellany*, p. 1.

This, the first species of the genus, is Atlantic and North Sea in range. It is thus to be characterised: Rostrum broad at base; no basirostral groove; foramina for exit of two branches of second division of fifth nerve on a level. Tooth near hinder edge of mandibular symphysis; its apex directed forwards.

This species is the only one that has ever been stranded on the shores of this country; and not very many examples have been thus seen or acquired. Mr. Lydekker, in *British Mammals*, in "Allen's Naturalists' Series," records ten individuals. Of these the first is the one from which the species was originally described. It was stranded on the shores of Elginshire, and its skeleton is now in the Oxford Museum. The very last specimen, which the present writer had the pleasure of seeing in the flesh, is now at Tring in the Hon. Walter Rothschild's Museum. This whale reaches a length of from fifteen to eighteen feet.

A specimen of this whale was captured at Havre in August, 1828, and lived for two days out of the water. It was offered "soaked bread and other alimentary substances"! "It emitted a low cavernous sound like the lowing of a cow." This specimen had no teeth, and was named in consequence *Aodon*.

Mesoplodon europæus, Gervais;* (= *D. gervaisii*, Deslongchamps). Rostrum broad at base; no

* *Zool. et Palaeont. Franc.*, first ed., t. ii.

basirostral groove; foramina of second division of fifth nerve as in *M. bidens*. Tooth at middle of mandibular symphysis.

This species is not to be regarded as certainly distinct from the last. The only point, it will be observed, in the above definition relates to the position of the teeth. Dr. Gray, however, erected it into a separate genus, *Neoziphius*. It is based upon a single individual found floating in the sea at the entrance of the British Channel about 1840. The skull is now in the Museum at Caen. There is really nothing more to be said about this animal.

Mesoplodon densirostris, Blainville;* (=*Ziphius sechellensis*, Gray). Rostrum narrow at base; basirostral groove present; foramina for fifth nerve one behind the other. Tooth with vertical apex, near hinder edge of mandibular symphysis.

This species has been taken at the Seychelles, on the coast of South Africa, and at Lord Howe's Island. The species is based upon a skull and the skeleton of another animal.

Mesoplodon grayi, Haast.† Rostrum narrow at base; basirostral groove present; foramina of fifth nerve one behind the other. Tooth vertical, near hinder end of jaw symphysis.

* *Nouv. Dict. Hist. Nat.*, 2nd ed., t. ix., p. 178.
† *Proc. Zool. Soc.*, 1876, p. 457.

This whale was placed in a separate genus (*Oulodon*) by von Haast on account of the fact that the upper jaw is provided, as are the jaws of other Ziphioid whales, with a row, nineteen on each side, of small teeth entirely unconnected with bone, and without any traces of sockets on the bone of the jaw. It is doubtful, however, whether this character can be used to distinguish a genus since in *M. bidens* there are similar teeth in both jaws,* and the same may be the case with other species of the genus, although there is, according to Sir W. Flower, "no evidence of the presence of any such teeth in *M. australis* or *M. hectori*."

In *Mesoplodon australis* of Flower† (which is the same as *M. hectori* in part), the rostrum is narrow at the base; basirostral groove present; foramina of fifth nerve one behind the other. Tooth near hinder edge of symphysis.

This species was founded by Sir W. Flower upon a skeleton which Dr. Hector had referred to *M. hectori*. It would appear from the above definition to be nearer to *M. densirostris*. But there are points which serve to separate it from that species. The most obvious is the fact that in *M. densirostris* the palatines completely surround the anterior ends of the pterygoids; in *M. australis* the former lie altogether outside the latter.

* The occurrence of these teeth in the upper jaw is, however, denied by GRIEG, *Bergens Mus. Aarbog.*, 1897.

† *Trans. Zool. Soc.*, x., p. 417.

Mesoplodon layardi, Gray* (with synonyms: *Callidon guntheri*, Gray; *Dolichodon traversii*, Gray; *Mesoplodon floweri*, Haast), is provided with a rostrum, narrow at base; basirostral grooves present; two foramina of fifth nerve on a level. Tooth very large, near hinder edge of mandibular symphysis.

This *Mesoplodon* is remarkable on account of the singular growth of the strap-shaped teeth. These finally grow round the jaw so as to prevent their opening to the full extent. At first this singular arrangement was naturally regarded as an abnormality, but later it was found to characterise the species, which is in this peculiar feature of its organisation comparable to the sabre-toothed tiger. It is, like the last, a southern species.

Mesoplodon hectori, Gray;† (=*Berardius arnuxi*, Hector; *Mesoplodon knoxi*, Hector). In this species the rostrum is broad at the base; the basirostral grooves are absent; foramina of fifth nerve on a level. Tooth close to apex of mandible.

Of this species Sir W. Flower wrote that "it does certainly present some transitional characters (between *Mesoplodon* and *Berardius*); but as it is only known by the skull of a very young animal it is scarcely safe to decide its position, except provisionally." It is, of course, the apical position of the mandibular teeth that has led to its confusion with *Berardius*.

* *Proc. Zool. Soc.*, 1865, p. 358.
† *Ann. and Mag. Nat. Hist.* (4), viii., p. 115.

Mesoplodon haasti, Flower.* Rostrum narrow at base; basirostral grooves present; foramina of fifth nerve one behind the other. Tooth very large, near middle of jaw.

This species is only known from a rostrum and a mandible. But the peculiar form (triangular with a conical point) and large size of teeth seem to mark it out.

Finally, there is the species *Mesoplodon stejnegeri*, of True,† which has an unusually large brain case (half the length of the skull); no basirostral grooves, and the two foramina one behind the other. This skull, which came from Behring Straits, has no lower jaw.

The genus *HYPEROODON* may be distinguished by the following features:—Skull with enormous maxillary crests (in adult males). Mesethmoid not fully ossified. A single tooth on each ramus of lower jaw; also numerous small teeth as *Ziphius*. Vertebral formula: C. 7; D. 9; L. 9; Ca. 18=43. Cervicals fused into one mass, the last sometimes free. Sternum consisting of three pieces, the last of which is bifid posteriorly.

In more than one feature *Hyperoodon*, of all Ziphioids, comes nearest to *Physeter*. The great

* *Trans. Zool. Soc.*, x., p. 421. In a recent memoir upon *Mesoplodon* (*Proc. Zool. Soc.*, 1893, p. 216) Mr. H. O. Forbes seeks to unite with *M. grayi*, Haast, Sir W. Flower's species, *M. australis* and *M. haasti*.

† "Description of a New Species of *Mesoplodon*," etc., *Proc. U. S. Nat. Mus.*, 1885, p. 584.

maxillary crests (Fig. 29) are paralleled in *Physeter*, where, however, owing to their relative thinness, they bound, instead of diminishing through blocking up, the cavity for the spermaceti. In the vertebral column too is a striking point of likeness. The first six ribs, as in the Ziphioids, are two-headed, the capitular and tubercular attachments being in two successive vertebræ. The seventh rib, however, is exactly like the tenth rib of the Cachalot. It is attached to two processes of the seventh dorsal vertebra, which nearly join each other before they receive the rib. *Physeter*, therefore, in this particular, is more like *Hyperoodon* than it is to its nearest ally *Kogia;* and both genera retain a trace of the arrangement characteristic of *Inia.*

This genus comprises apparently but two species: one, with many aliases (*e.g.*, *H. butzkoff*, *H. borealis*), is the northern *H. rostratum;* the other, which seems to be perfectly distinct, though only known from a single water and pebble-worn skull, comes from Australian seas, and was described by Sir W. Flower as *H. planifrons.* Thus, like so many other genera of Cetaceans, *Hyperoodon* is of very wide range.*

Dr. Gray's species, "*latifrons*," made the type of a separate genus *Lagenocetus*, was undoubtedly based upon an old example of *Hyperoodon rostratum.* It has been shown that the "forehead" increases in squareness with the age of the animal, as the accom-

* The name *Hyperoodon* was given to this whale (by Lacepède) on account of the numerous rough papillæ upon the palate, which were erroneously regarded as teeth.

PLATE XII.

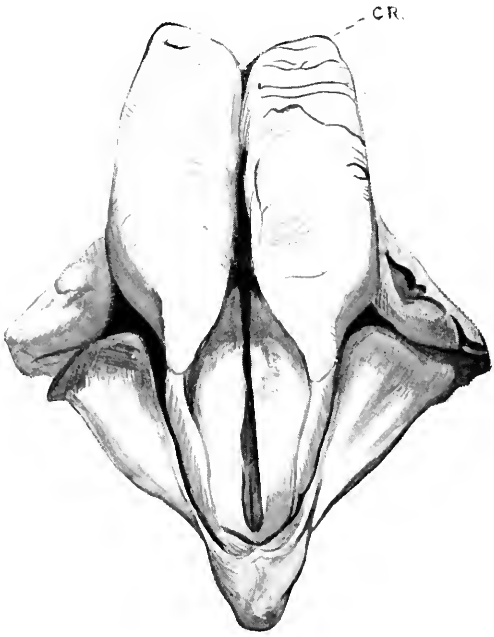


FIG. 29. Skull of Hyperoodon.

(From D. Gray.)

[To face page 222.

panying figures derived from Captain Gray's paper on the whale show. It is interesting to note that it is the males which show this peculiar form; the females nearly always* remain in the condition of young males. The square appearance of the head in front is produced by an increase in thickness of the crests of the maxillæ, which this whale has in common with *Berardius*, only more developed—even in the young.

Hyperoodon rostratum, Müller.† This whale is a common northern species, and has been often recorded on our own coasts. The first recorded occurrence was at Maldon in Essex, in 1717.‡ It varies in colour from black in the young to light brown in the old animals. Very old animals turn a pale yellowish with white about them. The under surface is always greyish white. It will be noted that this change of colour is very similar to that which takes place in Beluga. The length seems to vary between twenty and thirty feet; but Hunter described a skull (since missing) which apparently belonged to a still larger specimen "thirty or forty feet long."

Captain Gray noted that the tail of this whale, instead of being notched in the centre as is common

* Sir W. H. FLOWER "On the Whales of the Genus *Hyperoodon*," *Proc. Zool. Soc.*, 1882, p. 722. D. GRAY, "Notes on the Characters and Habits of the Bottlenose Whale," *ib.*, p. 726, and see p. 227.

† O. F. MÜLLER, in his *Zool. Dan. Prodromus*, 1776, p. 7, first gave the *specific* name; he called the whale *Balæna rostrata*.

‡ TURNER, "On the occurrence of the Bottlenosed Whale, etc," *Proc. Roy. Phys. Soc. Edin.*, ix., p. 25.

among whales, was rounded, as is shown in the accompanying figure. (Fig. 30.)

This species is gregarious, going about in herds of from four to ten, rarely more, though Captain Gray has recorded a herd of fifteen. The animal is very unsuspicious, owing no doubt to the fact that it has been until of late but little hunted; the growing scarcity of the Right whale has led to its being more actively pursued, and it has been proved that the oil derivable from the animal differs but little from that produced by the Right whale.

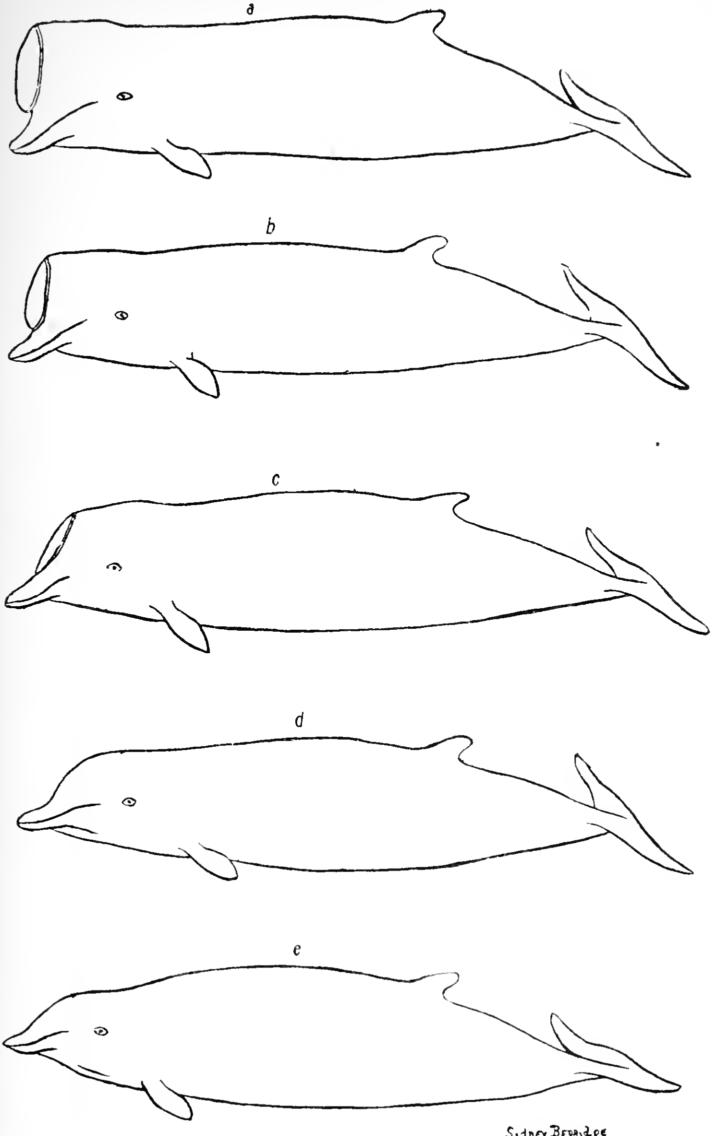
Another habit of this whale has proved its destruction; a herd will never leave a wounded comrade. Directly their companion is dead they move away, but not until. They are extremely vigorous and hard to kill; a "Bottlenose" can not merely leap out of the water—that is a capability shared by many whales—but it always takes the water on returning to it head first, and can move its head while out of the water. When harpooned this species has been known to stay under for two hours. The young when born seem to be about ten feet long; at least a full-grown fœtus of this size was cut out of a mother twenty-nine feet long.

It is rather an unusual fact, but it is the case—according to M. Bouvier*—that in this species of whale the females are more numerous† than the males.

* In *Ann. des Sci. Nat.* (7), xiii., p. 259.

† This statement is in direct conflict with that of Captain Gray, who found that out of 203 individuals killed in a single season "ninety-six were full-grown males, fifty-six cows, and fifty-one younger males."

FIG. 30. Outlines of *Hyperoodon*.
(After D. Gray.)



a, Adult male. *b–d*, Younger males. *e*, Adult female.

Q

The same writer, in describing a specimen of this species, found that the massive forehead is not a character of the male only; M. Bouvier's example was a female, and had a well-developed pair of maxillary crests like those figured on p. 223 of the adult male. It does not appear to be certain whether this specimen is to be relegated to the category of hens with cock's combs, and other instances of the old female occasionally taking on the characters of the male, or not. Another sexual difference, according to Fischer, is in the length of the pectoral fin; in the male it is $\frac{1}{7}$, and in the female $\frac{1}{12}$ of the body length. The Greenlandish name of this whale, "Anarnak," expresses in a naïve way the exceedingly purgative character of the fat of the *Hyperoodon.* But although the fat has this unpleasant effect, the flesh, according to M. Bouvier, is eatable if rather insipid.

As is the case with other Ziphioid whales, *Hyperoodon rostratum* has grooves upon the throat. But there is some dispute as to the number of these. One pair is the usual allowance, but Kükenthal found four in embryos studied by him. In an example of twenty feet long Turner found these grooves to measure nineteen inches. Another external character of importance is the presence or absence of hairs on the snout. Kükenthal saw what he believed to be indications of four hairs on each side; but a histological study did not give definite results.

In connection with the fact that a distinct voice is possessed by Ziphioid whales, I may call attention to an observation by the Rev. G. Beardsworth* that an example of *Hyperoodon* "sobbed."

The third genus of this family, *BERARDIUS*, may be thus defined:—Skull very symmetrical; nasals massive, forming its vertex; maxillæ with a rugose eminence; mesethmoid only partially ossified. Teeth two on each side of lower jaw, pointed with apices directed forward. Vertebral formula: C. 7; D. 10; L. 12; Ca. 19 = 48; first three cervicals fused. Sternum of five pieces. Eight ribs two-headed.

As this genus consists of but one species, which has been thoroughly studied, the main features in its description will be considered under the description of the species instead of here. It must be observed, however, that we do not at present know whether the rudimentary teeth present in the jaws of *Mesoplodon* are also present in *Berardius*. Attention should also be directed to the fact that a specimen in the Wellington Museum has but one tooth on each side of each mandible, hence it is clearly rash to attempt to define the Ziphioid whales by the characters of their teeth alone.

Berardius arnouxi, Duvernoy.† As is unfortunately the case with other whales, but little is known of the appearance and habits of this the largest of the Ziphioids. Indeed, there are but three records

* *Proc. Zool. Soc.*, 1860, p. 373.
† *Ann. Sci. Nat.*, 1851, p. 52.

of its occurrence, and one of these records cannot be regarded as applying without doubt to *Berardius*. The fullest account of its external appearance is given by Sir Julius von Haast.

The creature reaches a length of thirty to thirty-two feet, the specimen examined by Haast being thirty feet six inches in total length. Its colour is described by him as of a velvety black, with the exception of the lower portion of the belly, which had a greyish tinge. This agrees exactly with the account of the first specimen, upon the examination of whose skull Duvernoy based the genus *Berardius*. That individual, however, was thirty-two feet in length. It has not been noticed whether the longitudinal throat plaits present in other Ziphioid whales also exist in the species under discussion. This whale is described as bellowing like a bull. It will be remembered that *Mesoplodon bidens* was stated to low like a cow. But the most remarkable observation as to its economy was made by the wife of the fisherman who discovered the example referred to by Haast. "She told her husband that each time he put the stick into the whale's mouth she could see several large teeth in front of its lower jaw, which, however, were not observed by anybody else, and the existence of which was only revealed when the skull was cleaned, when in front of the lower jaw two large triangular and movable teeth on each side became exposed. It thus seems that the Ziphioid whales, when defending themselves from their enemies, or attacking their prey, have the power to protrude these four teeth at will." This extraordinary statement is supported by an anatomical fact discovered by Dr. Hector in another example of this species. He found that the teeth were embedded "in a tough cartilaginous sac, which adheres loosely in the socket of the jaw, and is moved by a series of muscular bundles that elevate or depress it." Sir W. Flower justly remarks that these facts "accord so little with anything hitherto known in mammalian anatomy that further observations on the subject are extremely desirable." Still, there is the statement of the woman, who would not be either prejudiced or informed, in the matter upon which her testimony is given. The whale feeds upon cuttlefish. A specimen twenty-seven feet long produced about 240 gallons of oil, and a fair amount of spermaceti.

As there is but a single known species of this genus *Berardius*, the osteological characters will be described under the present heading more in detail than was thought requisite to define the genus. These details are naturally taken from Sir W. Flower's memoir upon the whale, but I have myself verified most of them upon the actual skeleton in the Royal College of Surgeons Museum.

A striking peculiarity of this whale is the small size of the head compared to the length of the vertebral column, and the large size of the individual vertebræ, a feature which is, however, also very noticeable in *Mesoplodon*. These proportions are curiously suggestive of some of the extinct aquatic Mosasaurians, as well as of some of the Dinosaurs.

In this respect *Berardius* is at the opposite pole to the Greenland whale, where the head is so enormous as compared with the length of the vertebral column. The skull of *Berardius* is remarkably symmetrical for a toothed whale, as indeed is that of *Mesoplodon*, the nasals standing up erect, and not sunk from the vertex of the skull. The maxillæ are furnished with a strong oval tuberosity like those of *Hyperoodon*, but not so strongly developed. Since in *Hyperoodon* those convexities increase in the males from youth to old age, it may be that the skeleton of *Berardius* which Sir W. Flower has so carefully described is of a female or a young male.* That it is not a fully adult example is shown by the large persistence of the epiphyses, not only in the vertebral column but elsewhere. The mesethmoid plate is short comparatively speaking; that is to say, compared with what we find in *Mesoplodon*. The rami of the mandible are not ankylosed together. The vertebral column has the following formula: C. 7; D. 10; L. 12; Ca. 19=48.

Of the cervical vertebræ the atlas, axis, and the third vertebra are united by their bodies. The first two are also united by their neural arches. The remaining vertebræ are quite separate. Sir W. Flower observes that apart from the fusion between these vertebræ, they are much like those of the Beluga (*Delphinapterus*). The dorsal and lumbar vertebræ, especially the lumbar, contrast greatly with those of *Mesoplodon* by reason of the shortness and

* "On the Recent Ziphioid Whales, with a description of the Skeleton of *Berardius arnouxi*," *Trans. Zool. Soc.*, viii., p. 203.

slenderness of the neural spines, as well as their greater inclination backwards. Of the ten dorsal vertebrae zygapophyses are only developed until between the eighth and ninth ; there are none between the ninth and tenth. The lumbar vertebræ have their transverse processes (continuous with the lower transverse processes of the ninth and tenth dorsals, which bear the last two ribs) in a perfectly straight line from beginning to end of the series as in *Mesoplodon*. The lumbar vertebræ are distinctly keeled on the under surface. The first of the nineteen caudal vertebra is to be distinguished from the last of the lumbar series not only by the pair of facets on the hinder lower surface of the centrum for the chevron bones, but also by the absence of the keel spoken of as characteristic of the lumbars. There appear to be nine chevron bones. Of the ten pairs of ribs the first articulates with the transverse process of the first dorsal vertebræ, and with the centrum of the last cervical. As in most other Ziphioids (*cf.*, however, *Hyperoodon*) there is a sudden break at the end of the series of ribs ; the ninth and tenth have only the capitular head, which is attached to a lower transverse process springing from the centrum of the vertebræ, and not existing, even in rudiment, in the vertebræ in front.

The sternum consists of five elements not connected by bone. Between the first four of these are spacious foramina in the dried skeleton, the edges of which are bevelled and smooth, "so that it does not appear that ossification would have advanced further in this direction if the animal had lived to be older." There appear to be six pairs of cartilaginous sternal ribs.

In the manus the scaphoid and the lunar are united, though a groove remains to mark their original distinctness. The cuneiform is partly united with the unciform; the magnum and the trapezoid are completely united. So far as is known the pelvis consists of only one small bone, 5·8 inches in length.

Berardius arnouxi is one of the few whales with a really limited distribution. It has only been taken, so far, on the shores of New Zealand. Malm, however,* has given some account of a fragmentary skull, to which the name *B. vegæ* has been given, from Behring's Straits, and there is also *B. bairdi.*

The genus *ZIPHIUS* has as characteristic features: the skull with mesethmoid ossified; the nasals conjoined form an asymmetrical eminence upon the vertex. Two teeth near symphysis of mandible, besides smaller functionless teeth. Vertebral formula: C. 7; D. 9 or 10; L. 11; Ca. 21 = 49. The first four cervicals fused, or only three or six. Seven ribs two-headed. Sternum consists of five pieces. Phalanges: I, 1. II, 5. III, 5. IV, 5. V, 2. (Parker and Scott.)

Ziphius cavirostris, Cuvier,† is the only species of

* "Skelettdelar af Hval," etc., *Bihang Svensk Akad. Handl.*, viii., 1883.

† An alleged synonym of this species, *Epiodon urganantus*, of Rafinesque, is rejected by Fischer with the following contemptuous observation: "It would be wise to allow the diagnosis of Rafinesque to repose in peace; we should not accord any scientific notoriety to such labours!"

the genus that can be certainly recognised. The following names, however, have been also given :—

Z. chathamiensis, Hector; *Z. novæ zelandiæ*, Haast; *Z. indicus*, van Beneden; *Z. australis*, Burmeister; *Petrorhynchus capensis*, Gray; *Z. grebnitzkii*, Stejneger; *Hyperoodon semijunctus*, Cope; *H. doumetii*, Gray; *H. gervaisii*, Duvernoy; *Delphinus desmarestii*, Risso; *D. philippii*, Cocco; *Ziphiorhynchus cryptodon*, Burmeister; and apparently some others.

The above formidable list of synonyms is mainly after van Beneden. Considering that the species has been only known from the year 1804, the synonyms have multiplied with perhaps greater rapidity and to a greater extent than those of almost any whale. It was in the year mentioned that a skull "completely petrified in appearance" was picked up upon the Mediterranean coast of France, and regarded properly as the type of a new form, but incorrectly as a species now extinct. Forty-six years later, *i.e.*, in 1850, a second skull was found, also on the Mediterranean shore. Since then *Ziphius cavirostris* has been found in many and the most distant parts of the world.

The size of this whale varies much according to the measurements given. These naturally are from individuals of different ages. Van Beneden remarks that its size is a little inferior to that of *Hyperoodon*. It is also to be distinguished from that northern whale by the larger size of the two teeth. The grooves on the throat are possibly a character by which differences may be ultimately detected between specimens of

PLATE XIII.

FIG. 31. *Ziphius Sp.*

(From Scott and Parker.)

[*To face page* 235.

Ziphius, which are at present referred to the same species. The bulk of accounts allow only two grooves meeting, and forming a V-shaped mark upon the throat. But I quote later from another account, and of a New Zealand species or specimen.

Von Haast's *Z. novae zelandiae* was originally founded on an "aged female" twenty-six feet in length, described as being "bluish black on the upper portion of the body, white beneath, the upper portion being marked with numerous oval spots, two to three inches across, like the skin of a leopard." Two additional specimens acquired later * showed that the animal possesses a dorsal fin (which was doubted at first). One of these was a young female, nineteen feet in length; the other of the same sex, and twenty-one feet in length. The colour is the exact reverse of that first described, being white above and black beneath. The throat has a single fold on each side, and the two teeth stood out half an inch beyond the gums. No smaller teeth were detected. In the larger specimen the teeth were worn down, and could not be felt, but were revealed by incisions. The first animal was scored by numerous lacerations, due, apparently, to fighting among themselves or to attacks from the males. The spots are also healed wounds.

Messrs. Scott and Parker have described and figured † a young *Ziphius* from New Zealand, which differs in several particulars from those just referred to. But they have, perhaps wisely, abstained from

* "On *Ziphius novae zelandiae,*" *Proc. Zool. Soc.*, 1880, p. 232.

† *Trans. Zool. Soc.*, xii., p. 241.

giving it a name. The animal, a young female, was sixteen feet long all but an inch ; purple-black on the back, brown on the sides of the head, and white beneath to as far back as the genital orifice, whence it was brown. The throat is grooved by *three* grooves on each side. The middle of the caudal fin is convex as in *Hyperoodon* and *Mesoplodon*. (See Fig. 31.)

It will be noted that the colour and grooves on the throat differ from those of *Z. novae zelandiae ;* but there are no salient differences in the osteology.

CHAPTER X.

THE DOLPHINS

Family, *DELPHINIDAE*

THE family Delphinidae may be thus defined:—Of small to moderate size. Teeth as a rule numerous, and in both jaws. Anterior ribs (5–8) two-headed, posterior with tuberculum only; sternal ribs ossified. Palatines meeting for a greater or less extent in the middle line.

This family of whales comprises, as the name denotes, those Cetacea which are commonly known as Dolphins and Porpoises. There are no giants among the Delphinidae, save only *Orca*,* the Killer whale, which may grow to a length of over 20 feet; but nothing of a colossal size is attained to by any member of the family Delphinidae.

The skull of all these whales is characterised by

* The mysterious *Delphinus coronatus* of M. de Fréminville may, however, be mentioned as a possible exception. It is 30–36 feet long, with a relatively small head, which would suggest a *Mesoplodon* were it not for the numerous teeth in both jaws. The "bec fort pointu" and the dorsal fin nearer the tail than the head seem to forbid the notion that it is an Orca. What is it? It comes from Spitzbergen shores.

the form of the lacrymal bone, which is not distinct from the malar, and consists of a thicker piece, which ends abruptly in a thin bar of bone articulating behind with the squamosal. This single bone may contain the elements of the two distinct ossifications of other Cetacea. The skull is asymmetrical, as in other Odontocetes, but there is no such highly-raised crest behind the nares as in the Ziphioids or Sperm whales. The symphysis of the mandibles is of limited extent, "never exceeding one-third of the ramus."

The most salient difference perhaps which the Delphinidae display from most other whales is the presence of numerous functional teeth in both jaws. It is only the primitive Platanistidae that show agreement with them in this. But there are exceptions. In Beluga the teeth show a commencing reduction, and this culminates in the Narwhal, where the well-known tusk only (sometimes double) is left.

The vertebral column is often composed of very numerous vertebræ, as many as ninety or so having been recorded. On the other hand, it is by no means infrequently short, so that no family definition can be arrived at from a statement of these numbers. But all Dolphins agree in the mode of articulation of the ribs. At first they are double-headed, afterwards the tuberculum only is left; furthermore the sternal ribs are ossified.

The Delphinidae enumerated in Dr. Gray's Catalogues amount to over one hundred in number; and even so careful a worker as Mr. True enumerates and defines no less than fifty.* Many of these names will, however, ultimately have to be weeded out from the lists which they encumber. Everyone nowadays will agree with Sir William Flower when he observes that it is necessary to abandon "the old assumption, upon which so many new species were founded, which limited the area of each species to a small and circumscribed portion of the ocean, and placed imaginary barriers to its distribution where none really existed." It is this perversity which has confounded the whole history of whales, and especially of that family which is now under consideration. Like other animals, too, the Dolphins show some alterations in structure as they pass from immaturity to old age. And these alterations have to be taken very careful account of, as they relate to features which have been made use of for specific, and even generic, definition by Dr. Gray and others. A number of these anatomical points are brought together by Sir W. Flower in his essay† upon the generic subdivisions of the Dolphins. In the first place the length and width of the beak alters with advancing years, and it becomes longer and wider in proportion to the rest of the skull in perfectly adult animals.

Another character which is commonly made use of in the discrimination of species is the number and

* There is no doubt that there are at least some thirty to thirty-five species on the lowest estimate. In view of the scattered and imperfect character of much of the literature relating to this family, the reader will have to regard the list of known forms as only approximately true.

† "On the Characters and Divisions of the Family Delphinidae," *Proc. Zool. Soc.*, 1883, p. 466.

size of the teeth. It is, in the first place, hard to count accurately the teeth in a given skull; the smaller ones at the ends of the series are sometimes lost, or concealed in the gum. They become larger too with growth, and more widely separated owing to the growth of the beak already referred to.

As both the numbers and size of the teeth are used —and, in many cases, apparently quite properly used— in the discrimination of species, it is desirable to be cautious.

In the third place sexual differences exist which, if wrongly interpreted, might lead to the placing of the two sexes in different species, when—as has been more than once the case—a species is founded upon a single individual, even upon a single skull or part of a skull.

Fourthly, the distribution and depths of the colours of these Cetaceans are apt to show differences, not merely of age, but sheer variations which do not always depend upon differing age. The Beluga, for example, gets paler with age; the arrangement of the bars of colour upon the common dolphin, *Delphinus delphis*, seems to differ to a considerable extent. These observations obviously apply to other whales besides the Delphinidae, to which they are specially applied here. Immaturity especially has been made the basis of specific and even generic distinction. But they are particularly applied to the dolphins by Sir W. Flower, since the classification and limits of species in that group are more difficult owing to their larger numbers. In spite, however, of the numerous points in which variation of sex or age may occur and tend to obscure the possibility of accurately dividing up the family, a considerable number of definite types can be recognised, which may fairly be termed generic. To go further than this is not so easy. The most recent arrangement of the dolphins is that of Mr. True,* who attempts to distinguish the species into which the genera allowed by Sir W. Flower can be divided.

The admitted genera of dolphins are some nineteen. These will be allowed here. Seeing that there are so many types to which generic rank should perhaps be allowed, it becomes a matter of importance to inquire how far they can be grouped together; whether in fact any practical subdivision of the family into larger divisions than genera can be arrived at. Several authors are in favour of separating the Beluga and the Narwhal of the north into such a sub-family; there is no doubt that in more than one character these two northern forms approach each other to differ from the remaining forms.† The cervical vertebræ are never fused, even in perfectly adult animals, without epiphyses to the vertebræ; in other dolphins more or fewer are fused. The pterygoid bones are somewhat rudimentary, not having the involuted cavity below, which is a character of other dolphins; these two bones, moreover, are not merely widely separated, which is found in other dolphins, but are bent towards each other posteriorly, and also articulate

* *Bull. U.S. Nat. Mus.*, 1889.

† It is highly interesting to note in this connection that, according to van Beneden, the natives of Greenland and the Esquimaux regard the Beluga as the female of the Narwhal.

outwards with the squamosals, as Mr. True has pointed out. This last character is found in *Platanista;* and it will be borne in mind that the last-mentioned family is characterised among other facts by the freedom of the cervical vertebræ. *Delphinapterus* further agrees with *Platanista* in having a distinct neck. The reduction of the teeth culminating in *Monodon* is, however, met with in *Grampus* and *Globicephalus.* Finally, a larger number of ribs (eight) than in any others (seven at most), have both capitulum and tuberculum.

In the following account of the dolphins I shall for the most part admit Mr. True's species (and of course species subsequently described) where there are salient characters. Colour, exact number of teeth, phalanges, and vertebræ are so liable to variation and to wrong enumeration, owing to defective skeletons, that great care will have to be exercised.

We will commence with the genus *DELPHINAPTERUS,** which has eight to ten teeth of moderate size, occupying anterior part of jaws only. Vertebræ: C. 7; D. 11;† L. 9; Ca. 23 = 50. All cervicals free. Eight first ribs two-headed. Four reach the sternum. Pterygoids widely apart, converging towards extremity but not meeting. Phalanges: I, 1. II, 6–7. III, 4–5. IV, 3–4. V, 3–4 (in embryo 3, 9, 7, 6, 6). No dorsal fin. No hairs on the face.

* For structure see WATSON and YOUNG in *Trans. Roy. Soc. Ed.*, xxix., p. 393; and STRUTHERS, *Journ. Anat. Phys.*, x., 1896, p. 124.

† Occasionally 12.

Genus	No. of Teeth	Beak	No of Vertebræ	Pterygoids	No. of Ribs	Other characters
Sotalia	26–35	Distinct	51–55	Separate	12	
Steno	20–27	Distinct	65 or 66	Meet	12, 13	Crowns of teeth rugose
Tursiops	22–26	Distinct	64 or 65	Meet	13, 12 (5 two-headed)	
Delphinus	40–65	Distinct	73–76	Meet	14, 15	Maxillæ deeply groved
Prodelphinus	37–52	Distinct	69–76	Meet	14, 15	
Tursio	43–44	Distinct	?	Separate	—	No dorsal fin
Lagenorhynchus	22–45	Distinct	73–92	Separate or Meet	13, 15, 16 (6 two-headed)	
Cephalorhynchus	25–31	Not distinct	63–65	Separate	13, 14 (6 two-headed)	Dorsal fin rounded ; not falcate
Neomeris	18 or 19	Not distinct	63	Separate	13 (7 two-headed)	No dorsal fin ; teeth lobed
Phocæna	16–26	Not distinct	64–98	Separate	12, 13, 14, 15	Teeth lobed
Orcella	12–14	Not distinct	63	Separate	14 (7 two-headed)	
Orca	10–13	Not distinct	51 or 52	Separate	12 (7 two-headed)	
Pseudorca	8–10	Not distinct	50	Meet	10	
Grampus	2–7 (in mandible only)	Not distinct	68	Meet	12 (6 two-headed)	
Globicephalus	9–12	Not distinct	58 or 59	Meet	11 (6 two-headed)	Pre-maxillæ unusually broad
Delphinapterus	9	Not distinct	50	Separate	11 (8 two-headed)	No dorsal fin ; atlas and axis free
Monodon	1 (in upper jaw)	Not distinct	50	Separate	12 (8 two-headed)	No dorsal fin ; atlas and axis free

Both Sir W. Flower and Mr. True concur in allowing but one species of White whale, which will therefore have the following synonymy:—

Delphinapterus leucas, Pallas; *Delphinapterus beluga*, Lacepède; *Delphinus albicans*, Fabricius; *Beluga catodon*, Gray; *Catodon sibbaldii*, Fleming; *Beluga borealis*, Lesson; *Delphinus canadensis*, Desmarest; *D. kingii*, Gray; *B. rhinodon*, Cope; *B. declivis*, Cope; *B. angustata*, Cope; *B. concreta*, Cope.

The White whale is entirely northern in range. The alleged species *D. kingii* was asserted to come from the Australian shores, but the locality requires confirmation. It is so exclusively arctic in range that there are but few certain records of the occurrence of this species on the shores of England, though several specimens have been recorded from Scotland, and the species occurs off the eastern coasts of North America. It reaches a length of 16 to 20 feet. This whale is remarkable for its white colour (its name, Beluga, from the Russian, signifies white), which is, however, only characteristic of the full-grown animals. The young is blackish, the older whale is mottled, and finally a yellowish hue is arrived at, which is gradually blanched to pure white. Though the whale is marine it will ascend rivers, mainly, it is said, in pursuit of salmon. It has been said to ascend the Yukon river for a distance of seven hundred miles.

The name *Delphinapterus*, applied to this whale, signifies the peculiarity of the absence of the dorsal fin, in which it resembles its undoubted ally the *Narwhal* and the more distant *Neomeris*. It is a singular fact that these whales, unlike many Cetacea, have a distinct voice; and their vocal capabilities have earned for them the name of "Sea Canary." The Beluga lives in companies. They feed upon fish, Cephalopods and Crustacea; these they pursue at great depths in the ocean. It is said that the sand which is sometimes found in the stomach is used as ballast to enable the creature to remain below water with greater facility; but, as already mentioned in the case of the *Balænoptera rostrata*, it seems much more likely that the sand is engulphed accidentally along with their prey.

The various aliases of the one polar White whale are partly due to the occasional fusion of the cervical vertebræ, the presence of an additional rib, and a few other points, which are really within the limits of individual variation.

The Beluga has a very distinct neck—a rarity among whales, but a character of *Platanista* and *Inia*, to which genera indeed the freedom from each other of the cervical vertebræ give it an additional resemblance. A curious error, but made in good faith, was perpetrated in 1748 with regard to the systematic position of this "white fish." Anderson described a specimen which had lost the teeth of the upper jaw, and was in consequence only dentate below, as a white Cachalot. Lacepède added, apparently solely for the sake of a better filled page: "On ne peut guére douter que ce cétacée ne fournisse de l'adipocire;

et peut-être donne-t-il aussi de l'ambre-gris." It seems a belated procedure to attack Lacepède, but he has acquired so big a reputation as an historian of the Cetacea that it is perhaps permissible to quote M. Fischer's remark, that "the scientific element is not conspicuous in his book."

The Narwhal, genus *MONODON*, is externally very unlike the last genus, though they possess many structural points in common; it has but one tooth (rarely two) in maxilla, which has the form of a long tusk; in female this is rudimentary.

Vertebræ: C. 7; D. 11; L. 6; Ca. 26 = 50. Eight ribs, two-headed; four reach the sternum. Pterygoids as in *Delphinapterus*. No dorsal fin. No hairs. Phalanges: I, 2. II, 6. III, 5. IV, 3. V, 3 (embryo 2, 9, 7, 5, 4).

This genus is obviously characterised by the singular spirally-twisted "tusk" of the male, which is simply an abnormally enlarged maxillary tooth. Occasionally two teeth are fully developed, one in each jaw; there is a skeleton in the British Museum which shows this peculiarity. That skeleton has also a small twelfth rib in addition to the normal eleven. Of these ribs the first eight are-double headed; the same is the case in the Beluga. And, as also in the last-mentioned genus, four sternal ribs exist. Though the Narwhal has no dorsal fin there is a raised ridge along the back an inch in height.

There is but one species: *Monodon monoceros*, Linnæus.*

M. microcephalus, Desmarest; *M. andersonianus*, Id.; *Narwhalus vulgaris*, Lacepède; *Tachynices megacephalus*, Brookes, are some of the synonyms which really all refer to the one species.

The Narwhal or Sea Unicorn—"mighty Monoceros with immeasured tayles"—is a whale familiar to everybody, at least by name and appearance, as depicted in pictures. The creature grows to a length of about fifteen feet; such an individual would have a "horn" of some seven feet. But the length, as with other whales, has been grossly exaggerated (sixty feet!). The colour is darker above, paler below, both tints speckled in a leopardine fashion. But old animals seem to lose this character, and to become quite white. It is a purely arctic animal, and Mr. Lydekker records only three examples thrown up on our shores.† Another, however, has been since recorded by Mr. Christy.‡

The tusk of the Narwhal, van Beneden tells us, was at first—and after all naturally—thought to belong to a terrestrial creature; it is from this idea that the notion of the unicorn with the form of a horse has doubtless sprung. So lately as 1655, however, Wormius announced the real nature of this apparent freak of nature. The use of the horn or tusk to its possessor has been much discussed. As it is a sexual

* *Syst. Nat.*, 12th ed., 1766, p. 105 (of vol. i.).

† *British Mammals*, in Allen's Naturalists' Library.

‡ *Trans. Norfolk Soc.*, vi., p. 204.

character, the most obvious use would seem to be in the battles of the males with the toothless females. Scoresby observed that shoals of these animals often consisted entirely of males; these animals played with their horns, "crossing them with each other as in fencing." This is of course comparable to the use of other weapons in play by other animals, such as the teeth of young dogs, the claws of the cat, etc., etc. Another suggestion is that the long and strong weapon is useful for the purposes of breaking the thick ice of the polar regions so that the whale can rise and breathe. A third suggestion is also due to Scoresby. He captured and dissected a Narwhal which had in its stomach, besides beaks of cuttlefish, so common a food of whales, a large skate. Now an active skate, which moreover had a diameter greater than that of the whale's mouth, could hardly, thought Scoresby, have been caught alive by its devourer. He suggests indeed that with the tusk the skate was first pierced and killed, and then swallowed. An elaboration of this story is to be found in writings earlier than the two books of Scoresby. Lacepède, quoting from others, credits the Narwhal with a more ingenious use of the tusk. The animal threads its prey upon the tusk, and gradually works it down like a conjurer with a ball upon a string, until the fish can be seized with its lips and swallowed. These three views are presented for the consideration of the reader.

As to uses with which their possessor has no concern, the tusk was employed in Europe in the past and in China to-day as a drug. At Rosenborg is a throne entirely made of those tusks, and Captain Scoresby (Mr. R. Brown tells us*) had a bed made from the same material.

The genus *PHOCÆNA* (true porpoises) have the teeth sixteen to twenty-six in number; their crowns compressed, lobed. Pterygoids slightly developed and far apart; pre-maxillæ with bosses in front of nares.

Vertebræ: 64–98 in number. Phalanges: I, 2–3. II, 7–10. III, 6–8. IV, 3–5. V, 1–3. Dorsal fin with a row of tubercles along its posterior margin.

Of well-established species there would seem to be three, which are the following:—

Phocæna communis, Lesson.† The Common Porpoise may be thus distinguished from other members of the genus *Phocæna*:—Length, 5½ feet. No beak. Dorsal fin triangular, anterior margin straight. Pectoral fins ovate. Teeth, 26. Vertebræ: C. 7; D. 12, 13, 14; L. 14, 15; Ca. 30–33=64–68. First six cervicals fused. Young with 2–4 hairs.

The common porpoise is a northern form, being found in both Atlantic and Pacific. It reaches a length of five to six feet and is generally blackish, but whiter on the belly. The name of this dolphin has been variously given as Porkpisce, Porpice, Porpesse,

* "Cetaceans of the Greenland Seas," *Proc. Zool. Soc.*, 1868, p. 554.

† *Man. Mamm.*, 1827, p. 413.

Porpus, and Porpoise—the meaning of the word being especially plain from the first instance; it is of course pig-fish, a suggestion of the Ungulate affinities of whales which has been commended by naturalists. It is a gregarious whale and often ascends rivers —it has been met with in the Seine at Paris, for example; it is the commonest species of our seas.

The porpoise was once esteemed a delicacy in this country, as are other Cetaceans in other lands at the present day. It formed a Royal dish even so recently as the times of Henry VIII. The sauce recommended by Dr. Caius for this "fish" was made of crumbs of fine bread, vinegar, and sugar. Considered to be a fish, it was allowed to be eaten on fast-days!

The porpoise, like the stormy petrel, has had the reputation of presaging foul weather. Willsford (I quote from Bacon), in *Nature's Secrets*, remarks: "Porpoises, or Sea Hogs, when observed to sport and chase one another about ships, expect then some stormy weather." To the same effect writes Ravenscroft in *Canterbury Guests, or a Bargain Broke:* "My heart begins to leap and play like a Porpoice before a storm." The French word "Marsouin" applied to the porpoise is said to be derived from a corruption of the German "Meerschwein." But Scaliger's derivation from "marinum suem" seems to be more likely.

Phocæna tuberculifera was founded by Dr. Gray upon an example which was exhibited for a short time in the Zoological Society's garden. In this individual the doctor noticed the spiny margin to the fin, which has frequently escaped notice in other porpoises, and hence thought that there were two species, one with and one without these spines. It is held by Mr. True that *P. brachycium*, *P. vomerina*, and *P. lineata* (all named by the late Professor Cope) are at most varieties of the common porpoise.

But *Phocæna spinipinnis* of Burmeister* is distinct. It has a length of 5 feet 4 inches. Slight beak. Dorsal fin narrow, low, with concave anterior margin. Pectoral fins falcate. End of body ridged above and below. Teeth, 16.

This porpoise seems to be quite distinct. The specimen upon which the description of Burmeister was based was captured near the mouth of the Rio de la Plata. It is entirely black. But the most remarkable character, which distinguishes it from *P. communis*, and at the same time allies it to the next species, is the existence of a long, low ridge on both sides of the body near to the tail. This seems to be a survival of the low dorsal ridge of the embryo. (See p. 14.) And the existence of the two ridges gives some colour to older assertions that whales may possess two dorsal fins and an anal fin like the fish. The tubercles on the fin (as well as the peculiar shape of the latter) distinguish the species. They are more numerous and in more rows, on the back as well as on the fin itself.

* *Proc. Zool. Soc.*, 1865, p. 228.

Phocæna dallii, True,* is thus defined: Length, 6 feet. No beak. Dorsal fin high and falcate. Pectorals oval. Body ridged above and below at end. Teeth, 23–27. Vertebræ: C. 7; D. 14, 15; L. 27; Ca. 49=97 or 98.

The most salient difference of this from *P. communis* is the extraordinarily long vertebral column formed mainly by the large development of the lumbar region. All the cervicals are united. It is a Pacific species.

The genus *NEOMERIS* is to be characterised by the absence of a dorsal fin and the number of teeth, 18–26. The skull characters are as in *Phocæna*. Vertebræ D. 13; L. 12; C. 29=63.

This genus has been already referred to on account of the rows of tubercles which stud the back in the place of the absent dorsal fin. It is a genus which is barely to be distinguished from *Phocæna* according to most authorities. Of the cervical vertebræ the last five are free. Seven ribs are two-headed. The sternum is short and broad and has four pairs of ribs attached to it. There is but one species, *Neomeris phocænoides*, Cuvier.†

It is unnecessary to give a definition of this species, as the principal characters have been already given in the description of the genus. Its colour is entirely black, save for a purplish red patch on the upper

* *Proc. U.S. Nat. Mus.*, viii., 1885, p. 95.

† *Règne Anim.*, 2nd ed., 1829, p. 291.

lip and one on the throat. This porpoise is about four feet long, and inhabits the seas of India, Cape of Good Hope, and Japan.

Mr. True thinks that a species, noted merely from a native drawing and described as *Delphinapterus molagan* by Sir Richard Owen, is the same. "Molagan" is of course a native name for the porpoise. *Neomeris kurrachiensis*, Murray,* is but a synonym.

Mr. Murray, the describer of this last, remarks that it has eighteen teeth on each side of each jaw, besides two or three "which were scarcely visible through the gums, and situated out of the line of the other teeth in front of the jaws. In shape these teeth are quite unlike the rest, being conical instead of flattened or compressed." May these possibly be compared to the rudimentary teeth of Ziphioids? In the stomach of this whale prawns of the genus *Peneus* were found.

The genus *DELPHINUS* has the teeth small and numerous, 47–65 in number. Vertebræ: C. 7; D. 14 (15); L. 21 (22); Ca. 30 (32) = 73 or 76. Atlas and axis fused, the rest free. Palatal border of maxillaries deeply groved. Phalanges: I, 2 or 3. II, 8 or 9. III, 5–7. IV, 2–4. V, 1 or 2.† Fins falcate. Beak distinct and long.

This genus, which embraces not more than three

* *Ann. and Mag. Nat. Hist.* (5), xiii., 1884, p. 351.

† In the embryo of *D. delphis* digit II may have as many as 12, digit III as many as 9, phalanges.

ascertained species, may be termed the true dolphins. They have a long beak, and are to be distinguished from all other Delphinidae by the deep grooves on the palatal surface of the maxillaries, producing thus a separation between the alveolar border and a raised median ridge. Though there are not more than three ascertained species (according to Mr. True), an immense number of names have been given. The Common Dolphin, *Delphinus delphis*, appears to be identical with animals that have received the following names: *D. major*, *D. fulvofasciatus*, *D. forsteri*, *D. janira*, *D. pomeegra*, *D. bairdii*, *D. moorei*, *D. walkeri*, *D. novae-zelandiae*, *D. albimanus*, *D. marginatus*, *D. fuscus*, *D. souverbianus*, *D. variegatus*, *D. balteatus*, *D. algerienis*, *D. moschatus*. This lengthy list is the result of giving a new name to a dolphin captured or observed in a fresh locality. We have simply to do with a Cetacean of exceedingly wide range, or as Lacepède—who delighted more in symmetrical sentences than in a plain record of cold fact—observed: "It is met with in the favourable climes of the temperate zones, under the burning firmament of the equatorial seas, and in the horrible valleys which separate the enormous mountains of ice which time builds upon the surface of the polar ocean as so many funeral monuments to Nature who is there expiring"!*

* Goldsmith was not so far wrong in all probability in asserting that the Mediterranean dolphin was also to be found in the Red Sea, though his actual attempt at proof may have been shaky.

PLATE XIV.

FIG. 32. Dolphin (*Delphinus delphis*).

(From Flower.)

[*To face page* 255.

Delphinus delphis, Linnæus.* Length, 7 feet 5 in. Form slender. Forehead sloping gradually. Dorsal fin narrow. Teeth, 46–50. (Fig. 32.)

This is the "Dolphin" *par excellence*, the dolphin of the ancients. It is common, among other places, in the Mediterranean; hence its frequent observation. But—it is perhaps hardly necessary to mention the fact—it has been often confounded with the fish *Coryphæna*; hence the legends as to its dying colours and to many of its more purely fish-like attributes. On the other hand, regarding it as a fish, the ancients were impressed by its unfish-like intelligence. Upon this confusion were doubtless based the legend of Arion and the Dolphin and other similar stories. Scaliger speaks of it as "nobilissimus Cetaceorum."

As a matter of fact the colours of this animal are unusually variegated for a Cetacean, and liable to much variation (hence the multitude of "species"). The best figure illustrating these hues is contained in a memoir by Sir William Flower.† The usual black of the dorsal and white of the ventral surface is supplemented by two lateral areas of a fulvous or greyish tinge; a black or greenish band extends from the lower jaw to the base of the pectoral fin; there is a ring of black round the eye; one or two bands of greyish or greenish traverse the light colour of the lower part of the sides.‡

* *Syst. Nat.*, 10th ed., p. 77.

† *Trans. Zool. Soc.*, vol. xi., p. 1.

‡ Several colour variations are figured by Fischer, *Act. Soc. Linn. Bordeaux*, 1881.

The sharply marked-off "beak" of the dolphin (which it shares of course with many other Delphinidae) has given rise to such vernacular names as "Bec d'Oie," and the form of the head often repeated in ancient boats shows that perhaps a hint as to the proper form of a boat was derived from this swift creature. The ancients appear to have confused, to some extent, dolphins and sharks, for they speak of the mouth of the former being ventral in position, and say that the animal is obliged to turn upon its back before it can swallow its prey. Pliny, who always mixed up fact and fiction in one inextricable tangle, added to this imaginary portrait the further detail that the dolphin was armed with a long and spiny fin, with which it could successfully attack other creatures—possibly a confusion with the long and narrow dorsal fin of *Orca*. Its movements are rapid. It has been called "the arrow of the sea," and a proverb has emphasised this: Of those who desire something impossible it is said that they wish to catch a dolphin by the tail. The curved form in which the conventional dolphin of heraldry is exhibited is an indication of the frequency with which this Cetacean will leap out of the water. Under these circumstances the body is naturally arched. On coins, medals, and coats-of-arms of Mediterranean countries and cities the dolphin takes the place that the Biscayan whale does along the northern shores of Spain. A dolphin forms the arms of the eldest son of the King of France, who was styled in consequence "Dauphin." This seems to be a curious reversal of the "Canting Crest." The Dauphin took his style from the arms of Dauphiné; in other cases (*e.g.*, Luces=pike, the Luceys) the arms were from the name of the individual.

So many tales dating from antiquity have been told concerning the intelligence and usefulness to man of the dolphin, that the following modern one may be not without interest:—

"In Moreton Bay," relates Mr. Fairholm,* "the natives use to aid the men in the capture of 'Mullet,' a kind of 'Porpoise.'† When a shoal of the fish comes into the bay the natives, with their spears, make a peculiar splashing in the water. Whether the porpoises really understand this as a signal, or think it is the fish, it is difficult to determine; but the result is always the same. They at once come in towards, driving the mullet before them." The relator of this incident thinks that the whales really understand and assist.

The dolphin when born is one of those species which have a few hairs; 5–7 have been counted on each side, forming the "moustache."

Delphinus longirostris, Cuvier,‡ may be a distinct form. It is thus defined: Teeth, 58–65. Rostrum very elongated, about 67·9 per cent. of whole length of skull.

This species is only to be defined by the above

* *Proc. Zool. Soc.*, 1856, p. 353.
† No genus or species is given.
‡ *Règne Anim.*, 2nd ed., 1829, p. 288.

characters, and its external characters are unknown. It is therefore not very satisfactory, but is retained in deference to Mr. True's researches. It may be, thinks Mr. True, identical with Gray's *Delphinus capensis.* It comes from Malabar.

The third and last species, *Delphinus roseiventris*, Wagner,* is in length barely four feet. Form stout. Forehead abruptly sloping. Beak long. Dorsal fin broad. Teeth, 48.†

The characteristic feature of this species, whence it derives its name, is the rosy ventral surface, more usual in fresh-water dolphins; the back is black or dark grey. It is a native of the Molucca seas and of Torres Straits. Gray placed this species in the genus *Steno* because it had *not* a grooved palate. But this appears to be wrong.

The genus *PRODELPHINUS* is carefully to be distinguished from *Delphinus.* It has a distinct beak; dorsal and pectoral fins falcate. Vertebræ: C. 7; D. 14 (15); L. 22 (19, 21); Ca. 29–38=69–81. Pterygoids in contact. Phalanges: I, 2. II, 9. III, 7. IV, 3. V, 1.

Of this genus Mr. True remarks:—"The chief character which has been brought forward as

* SCHREBER'S *Saügeth.*, Pl. ccclx., fig. 1 (*fide* TRUE).

† The description is derived *not* from Wagner, but from the *Voyage de l'Astrolabe.*

separating it from *Delphinus* is a negative one—the absence of deep lateral palatine grooves." It also comes near to *Tursio;* the main features here which distinguish the two genera are the fewer teeth and more numerous vertebræ. The three genera are quite close together. Some twenty-three species have been assigned to this genus; but these may be reduced, according to Mr. True, to eight. It is pretty well universally distributed. There seems to be nothing of interest to record in the habits of these dolphins.

Prodelphinus plagiodon, Cope,* is seven feet in length. Dorsal fin falcate. Colour spotted. Teeth, 37. Vertebræ, 69, of which 14 dorsal.

This dolphin comes from the Atlantic coasts of North America and from the Gulf of Mexico.

Prodelphinus malayanus, Lesson.† Length about seven feet. Colour uniform ashy. Teeth, 39.

There is so little either to identify with the genus *Prodelphinus*, or to differentiate it as a species (the skull was not described by the original describer of the species but by Schlegel), that it is with great hesitation that it is here included. It is an East Indian species.

* *P. Acad. Nat. Sci. Philadelphia*, 1866, p. 296.

† *Voy. de la Coquille*, vol. i., 1826, p. 184.

Prodelphinus attenuatus, Gray.* Colour dark above, ashy grey below. Teeth, 35–44. Vertebræ, 81, of which 15 dorsal.

The very large number of vertebræ distinguish this species so far as is known. It appears to be identical with the following three species: *Delphinus pseudo-delphis*, Wiegmann; *Steno capensis*, Gray; *Clymene punctata*, Id.

It is widely distributed: Cape Horn, Cape of Good Hope, Bay of Bengal, North Atlantic.

Prodelphinus cœruleo-albus, Meyen,† has the dorsal fins not deeply emarginate. Fourteen dorsal vertebræ. Teeth, 50. Hab., South America.

This dolphin has the lateral strip which is found in many of the species of *Prodelphinus*.

Prodelphinus euphrosyne, Gray‡ (with probable synonyms: *D. styx*, Gray; *D. tethyos*, Gervais; *D. marginatus*, Duvernoy; *Tursio dorcides*, Gray; *Clymene dorides*, Gray; *Clymenia euphrosynoides*, Id.) has a length about 8 feet. Dorsal fin high and falcate; pectoral fins small. Vertebræ, 76; 15 dorsals. Teeth, 45.

Like the preceding species this has a long, narrow,

* *Zool. "Erebus" and "Terror,"* 1846, p. 44.
† *Nova Acta Nat.-Curiosorum*, 1833, xvi., p. 609.
‡ *Zool. "Erebus" and "Terror,"* 1846, p. 40.

black stripe proceeding from the eye to the vent, with a branch given off to the pectoral fin and another behind it. Hab., Europe to South Africa.

Prodelphinus lateralis, Peale.* This species, of which the name was altered to *Lagenorhynchus* in the second edition of the *Mammalia of the U.S. Exploring Expedition*, may be thus defined from the imperfect existing knowledge of it:—Length, 7 ft. 6 in.; form stout; snout small. Teeth, 41. Hab., Pacific; lat. 13°, long. 161°.

It seems to be mainly the lateral black line which justifies the inclusion of this species in the present genus, for its cranial characters are not known.

Of *Prodelphinus frænatus*, F. Cuvier,† not a great deal is to be said. It is in length up to six feet. Teeth, 38. Vertebræ, 70; 14 dorsals. Atlantic and Indian Oceans.

The following reputed species seem to be in all probability synonyms:—*D. frontalis*, Dussumier; *D. doris*, Gray; *D. clymene*, Gray; *Clymenia normalis*, Gray.

D. alope, Gray; *D. microps*, Gray; *D. stenorhynchus*, Gray, are probably not allied species, but merely synonyms.

The only two of the names given in the list of synonyms which applies to anything more than a

* *Mamm. U.S. Explor. Exped.*, 1st ed., 1848, p. 35.

† *Mammalogie*, t. iv.

skull is *D. frontalis* and *D. frænatus*, which has the characteristic dark band from the angle of mouth to pectoral limb.

Prodelphinus longirostris, Gray.* Length, nearly 7 feet. Vertebræ, 73; 14 dorsals. Teeth, 52. Palate with traces of lateral groove (cf. *Delphinus*). Rostrum very long. Japan, Malabar, Cape, Coast of Brazil, Cape Horn, Galapagos, Australia.

Genus *LAGENORHYNCHUS*. This genus may be defined in the following terms:—Head with short, not very distinct, beak. Dorsal and pectoral fins falcate. Teeth small, 22–45 in number on each jaw. Vertebræ, 73–92. Pterygoid bones in contact or separate. Rostrum not exceeding, or scarcely exceeding, length of cranium.

This genus is another to which quite a large number of species have been referred. But a number of them are barely definable, and it is a difficult—at present perhaps impossible—task to discriminate them with accuracy. I give some description here of nearly all the species that are allowed by True, a number—be it observed—in excess of the probable species of Sir William Flower's enumeration. In addition to the features of the genus mentioned in its definition, *Lagenorhynchus* is characterised by the length of the neural and transverse processes of the lumbar vertebræ.

* *Spicilegia Zool.*, 1828, p. 1.

PLATE XV.

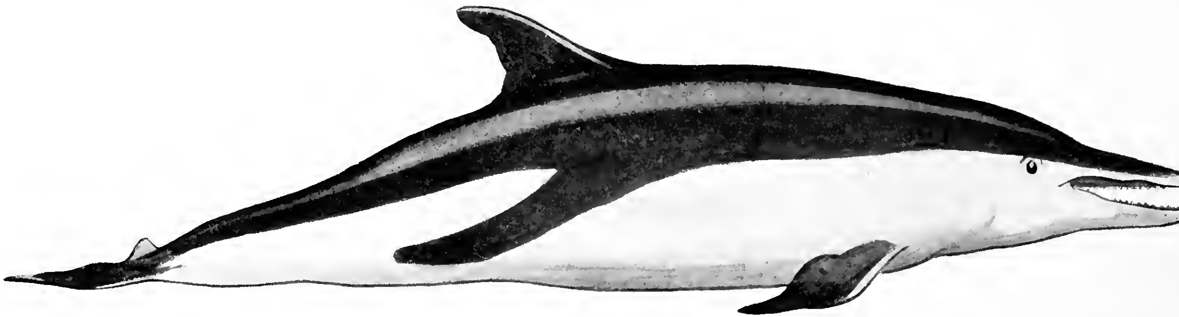


FIG. 33. Dusky Dolphin (*Lagenorhynchus obscurus*).
(From cast in Nat. Hist. Museum.)

To face page 263.

Mr. True also comments upon the "presence of an area of bright colour rather high up on the side between the dorsal fin and the flukes" as a mark of *Lagenorhynchus.* It is, according to the last-mentioned observer, nearest to *Prodelphinus* (*Clymenia*).

The first species of the genus *Lagenorhynchus obscurus*, Gray * (Fig. 33), has the external form as in *acutus*, but beak not distinctly marked off. Teeth, 30–32. Pterygoids in contact. Length, 5 ft. 6 in.

This species is chiefly to be distinguished by the absence of a distinct marked-off beak. This gives to the dolphin an appearance not at all like that of other species of the genus, and it has indeed been referred to *Prodelphinus.* But, as already mentioned, these two genera are not very far apart; it is a southern form.

Lagenorhynchus thicolea, also named by Gray, † is known from a single skull only. Its chief feature is the large number of teeth (45); and it is on these grounds that it has been admitted to specific rank.

In *Lagenorhynchus superciliosus*, Schlegel, ‡ the teeth are 30. Vertebræ: C. 7; D. 13; L. 20; Ca. 33 = 73. Pterygoids in contact.

This species, from the Cape of Good Hope, is only known by a skeleton.

* *Spicilegia Zool.*, 1828, p. 2.
† *Proc. Zool. Soc*, 1849, p. 2.
‡ *Abhandl. in d. Gebiet Zool.*, 1841, p. 22.

Lagenorhynchus fitzroyi, Waterhouse * (= *D. cruciger*, Quoy and Gaimard; *L. clanculus*, Gray), has a length of 5 to 6 feet. Beak short. Dorsal fin large. Teeth, 28. Pterygoids in contact.

Whether the above synonyms relate to one and the same species is far from a certainty. (Dr. Gray, indeed, adds *obscurus* and *superciliosus* to the list.) But in any case all the forms mentioned in the list are from the shores of Patagonia and from the southern ocean. They are also much patched with white, and have, according to illustrations, much the same external appearance. As mentioned before, the discrimination of the different species of dolphins is a task beyond the capacities of those who have not the entire museums of the world at their command.

The next species, *Lagenorhynchus electra* of Gray,† has only twenty-three teeth in each jaw. Skull massive. Rostrum broad, long, and flat. Mesethmoid much ossified and visible superiorly.

The four following names are probably to be regarded as synonyms :—*L. asia*, Gray; *Electra obtusa*, Id.; *Delphinus fusiformis*, Owen; *Phocæna pectoralis*, Peale; of *P. pectoralis* only is the external form known.

This species appears to differ from all other

* *Zoology of "Beagle" Mamm.*, 1839, p. 25.

† *Zool. "Erebus" and "Terror,"* 1846, p. 35.

members of the genus by the amount of ossification in the mesethmoid, and by its appearance on the dorsal surface of the skull. The species is from the Indian Ocean and the tropical Pacific.

The two next species are British, and can be easily separated.

Lagenorhynchus albirostris, Gray,* has a length of 9 feet. Teeth, 26. Vertebræ: C. 7; D. 15 (16); L. 23 (24); Ca. 43 (45) = 88 (92). Five ribs, reach sternum; 6 or 7 two-headed. Pterygoids in contact.

This species occurs on our own coasts, and is, so far as is known, purely a northern species. It appears that the winter is passed in the more temperate regions of the north, and the summer in the arctic regions. The dolphin goes about in large bands, and is a fish-eater in the main.

Lagenorhynchus acutus, Gray† (= *Delphinus eschrichtii*, Schlegel; *D. leucopleurus*, Rasch). Length, 8 feet. Dorsal fin high. Beak small. Teeth, 35–37. Vertebræ: C. 7; D. (14), 15; L. 18–22; Ca. 38–41 = 78–82. Pterygoids in contact.

This also is a northern species. It occurs in vast herds of as many as fifteen hundred individuals on the coast of Norway; it is then in pursuit of the herrings. A skeleton in the British Museum has the

* *Ann. Mag. Nat. Hist.*, 1846, xvii., p. 84.

† In BROOKE'S *Cat. Mus.*, 1828.

four last cervicals free. Six of the ribs are two-headed; but as few as five, and as many as seven, may be so.*

Lagenorhynchus obliquidens, Gill,† may be distinguished in the following terms:—Length, 7 feet some inches. Colour, greenish black above, with lateral broad longitudinal stripes of white-grey and dull black; white below. Teeth, 31. Vertebræ: C. 7; D. 13; L. 24; Ca. 30=74. Pterygoids not in contact, divergent posteriorly.

This is a North Pacific species of exceeding activity. It congregates in herds of many hundreds, "tumbling over the surface of the sea, or making arching leaps, plunging again on the same curve, or darting high and falling diagonally sideways upon the water with a spiteful splash, accompanied by a report that may be heard at some distance. When a brisk breeze is blowing they frequently play about the bow of a ship going at her utmost speed, darting across the cut-water and shooting ahead, or circling around the vessel, apparently sporting at ease." These porpoises feed upon small fish, and, says Scammon, act up to their character of the "sea swine," filling themselves to repletion. As with other dolphins, these animals will collect in calm weather in immense herds, huddled together on the surface of the water.

* Lütken, "Critical Studies upon Odontoceti," *Ann. Mag. Nat. Hist.* (2), xii., 1888, p. 179.

† *P. Acad. Nat. Sci. Philadelphia*, 1865, p. 177.

Finally, Dr. Moreno* has described *Lagenorhynchus floweri*, from the bay of St. Cruz. It is 1 m. 29 long, with nearly the whole of the middle part of the body white, the rest black. The teeth are 20.

The genus *SOTALIA* has:—Teeth, tolerably large, 26–35 in number in each jaw. Vertebræ: C. 7; D. 11, 12; L. 10–14; C. 22 = 51–55 in all. The pterygoids are separate. There are three elements in the sternum, and there are five to seven pairs of sternal ribs. The number of phalanges in the digits is as follows:—I, 0. II, 6. III, 5. IV, 2. V, 1. Beak distinct. The manus is long, falcate, or oval. The dorsal fin is falcate.

Of this genus there are some five or six species; the exact number cannot be fixed at present. They are not large dolphins. Eight or nine feet may be regarded as the greatest length attained to. The remarkable fact about the dolphins of this genus is their usually pale coloration. Thus *S. sinensis* is milky white with pinkish fins. The upper part of the body in *S. pallida* is yellowish white, the under surface white. *S. plumbea* is a uniform plumbeous grey. A good many of the species, moreover, are found in rivers and estuaries. In the Amazons and other streams of South America are two recognised species, and three more doubtful ones. *S. sinensis* lives in several rivers of China. On the other hand, there are others which are as purely marine in habit.

* *Revista Mus. la Plata*, iii., p. 385.

The most remarkable species of the genus is the supposed vegetarian *Sotalia tëuszei*, from Cameroon river, West Africa.

Sotalia sinensis is in colour milky white, with pinkish fins. Teeth, 32. Vertebræ: D. 12; L. 10; Ca. 22 = 51.

This species, from the harbour of Amoy and the Canton river, was originally mentioned by Osbeck, a pupil of Linnæus, who travelled to China in a merchant vessel in 1751. Its osteology has been fully described by Sir William Flower in the memoir cited below.* As neither Osbeck, the discoverer, nor F. Cuvier, nor Desmarest at all described the species, its specific name should be attributed to Flower. Osbeck, indeed, "not understanding," as Cuvier observed, "the principles of his master, and attaching himself exclusively, as did many others, to increasing the catalogue which Linnæus had published . . . simply defined this dolphin: like the common dolphin, but entirely of a bright white." It is not, therefore, surprising that F. Cuvier included this form among the dolphins—"dont l'existence comme espèce est douteuse."

Sotalia plumbea, of Cuvier,† has a colour of uniform plumbeous grey, white on lower jaw. Teeth, 37–39.

This species is one of the marine forms, coming

* *Trans. Zool. Soc.*, vii. (1870), p. 151.
† *Règne Anim.*, 2nd ed., 1829, p. 288.

PLATE XVI.

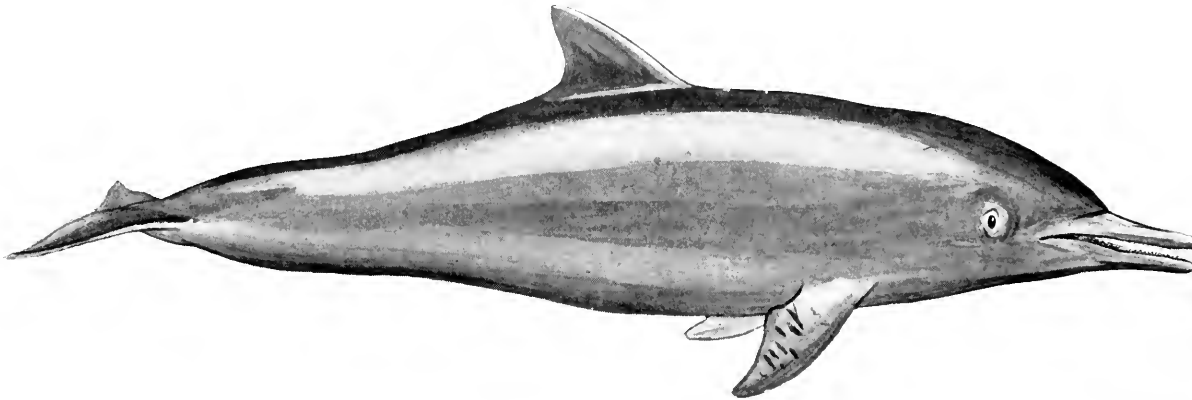


FIG. 34. Elliott's Dolphin (*Steno perniger*).

[*To face page* 269.

from the Malabar coast. Its external characters have been described by M. Dussumier, who observes that the young have much more white about them than the adults—a reversal of the conditions of colour which characterise, for example, the Beluga. This species is said to be slower in its movements than many dolphins. It reaches eight feet in length.

Sotalia gadamu, Owen,* is in colour dark plumbeous grey, below pinkish ashy grey, with a few darker blotches. Teeth, 26. Rostrum not so long as in last two species.

This species, known only from a sketch of its shape and colour, and from the skull, is named by the fishermen of Vizagapatam "Gadamu," whence its specific name.

Also described by Owen is *Sotalia lentiginosa*, of a bluish cinereous colour, freckled with dark brown. Fins smaller than in *S. gadamu*. Teeth, 33–34.

This species, from the same locality as the last, is regarded by Flower as doubtfully distinct. True, however, affirms the correctness of Sir R. Owen in giving it a separate name. And we shall follow him. Dr. Blanford would refer this and the last species (under the name of *S. perniger*†) to the genus *Steno*. (Fig. 34.)

In addition to the species of *Sotalia* enumerated,

* *Trans. Zool. Soc.*, vi., 1866, p. 17.

† *Fauna of British India*, "Mammals," p. 583.

there are a number of forms existing in the rivers of South America to which, at any rate, five names have been given. But what differences separate *S. guianensis* of van Beneden, *S. brasiliensis* of the same, *S. pallida* of Gervais, *S. tucuxi* of Gray, from each other and from *S. fluviatilis* of Gervais is a matter which is not ripe for decision, barely, indeed, for discussion. Mr. True thinks that the two marine forms *S. guianensis* and *S. brasiliensis* are distinct from the remaining, which are fluviatile. We shall accept what seems to be in itself a reasonable view.

Sotalia guianensis, of van Beneden (= *Sotalia brasiliensis*, Id.),* is in colour black or brown, white below. Teeth, 29–34. Vertebræ, 54 (55), of which 11 or 12 dorsal.

The example of *Sotalia brasiliensis* studied by van Beneden was a smaller individual than that of *S. guianensis*, itself a fact tending to throw doubt upon the distinctness of the two forms, considering the minute points of difference which distinguish them. However, Professor van Beneden's coloured figure of *S. brasiliensis* shows an animal which is largely of a pale brown colour. But this is by no means without the boundaries of colour variation, so little known, as must be constantly insisted upon among the whales. Goeldi, who has lately re-investigated the species "*brasiliensis*,"† thinks that

* *Mem. Ac. Roy. Belg.*, xli., 1875.
† *Zool. Jahrb. Syst. Abth.*, iii., 1888, p. 134.

there may be two or three rudimentary ribs behind the eleven well-developed ones. The sternum of the species is formed of three pieces, which coalesce later. Five ribs articulate with the sternum. This species is so common in the bay of Rio de Janeiro that it is impossible to cross the bay without seeing a few sporting in the immediate neighbourhood of the ship. The old-world superstitions regarding the dolphin have been in some curious fashion transferred to this new-world form. The natives think that it will bring to shore the bodies of drowned persons. The fact that it is regarded as a sacred animal is rather bad for science, as specimens are hard to obtain.

Sotalia pallida, Gervais* (probably the same as *Steno tucuxi*, Gray, and *Sotalia fluviatilis*, van Beneden and Gervais), has a black colour above, and is white or pinkish below. The teeth are thirty in each jaw. As already mentioned, materials do not exist for saying whether there is but one or whether there are two or three species comprised in the forms here provisionally grouped under one name. It may be that *S. pallida* is simply a pale-coloured variety, or there may be, as in *Inia* (q.v.), a sexual difference of coloration.

Sotalia tëuszei, Kükenthal,† is certainly distinct; it

* In CASTELNAU, *Exped. Americ. Sud.*, 1855, p. 94.
† *Zool. Jahrb. Syst. Abth.*, vi., 1892, p. 442.

is eight or nine feet in length, the nostrils projecting beyond face as a tubular process.

This dolphin comes from the Cameroon river, and is another example of a purely fresh-water species. It is an exceedingly scarce whale, only one specimen having been seen in as many as ten years. The prolongation of the nostrils is a most remarkable feature, and is amply sufficient to distinguish the species from any other.* Its habits are almost unique by reason of the fact that it is a vegetable feeder. In the stomachs of some other whales vegetable *débris* has been found; but in the present species nothing else was found. In accordance with this presumed habit the teeth are not sharply pointed as in *S. sinensis*. The animal is rather underjawed, and the skin is described as being especially thick. Of the osteology only the skull is known.

The genus *STENO* has 20–27 teeth, which are large with furrowed surfaces to their crowns. Vertebræ: C. 7; D. 12 (13); L. 15; Ca. 32 (30) = 65, 66. First two vertebræ fused, rest separate. Pterygoids in contact. The formula of the phalanges is: I, 4. II, 8. III, 6. IV, 3. V, 3. Dorsal and pectoral fins falcate. Beak distinct.

Of this genus there are two species, *S. perspicillatus* and *S. rostratus*. The former lives in the South Atlantic; the latter is more widely spread. The

* The blow hole of *Balænoptera* has been said to be puffed out during expiration.

genus is to be distinguished from *Sotalia* by the rugose crowns of the teeth, which are smooth in *Sotalia*, and by the closely approximated pterygoids.

Steno rostratus, of Desmarest,* is in colour purplish sooty black above, sides with yellowish white spots under surface white, tinged with rose. Teeth, 20–27. The ribs are 13. Vertebræ, 65.

This species, if all the synonyms (*Delphinus frontatus*, Cuvier; *D. bredanensis*, Cuvier; *D. planiceps*, Schlegel; *Steno compressus*, Gray; *D. reinwardti*, Schlegel; *D. Pernettyi*, Desmarest) rightly apply to one species, ranges from the Atlantic to the Indian Ocean. It is a largish dolphin, measuring eight or nine feet.

The remaining species, *Steno perspicillatus*, Peters,† may be thus defined:—Colour, black above, white below, sides yellowish white; a black line from ring round eye joins its fellow on opposite side round forehead. Teeth, 23. Ribs, 12. Vertebræ, 66.

This dolphin is rather smaller than the last (about 7 ft. 6 in.), and is confined to the South Atlantic.

The genus *TURSIOPS* has the teeth large, 22–26 in number. Vertebral formula: C. 7; D. 12, (13); L. 16, (17); Ca. 26 (27) = 61 or 64. Five or six ribs two-headed. Pterygoids in contact. Phalanges: I, 1.

* *Nouv. Dict. d'Hist. Nat.*, ix., 1817, p. 160.
† *MB. k. Akad. Berlin*, 1876, p. 360.

II, (6), 7. III, 6–8. IV, 3. V, 1, (2). Fins falcate. Beak distinct.

Of this genus again the exact number of species is at present a matter of opinion rather than of certainty. Sir W. Flower is doubtful whether there are more than two. Mr. True allows and defines five. The genus is universal in range. Ten feet is about the limit of size reached. It seems difficult to give anything like satisfactory definitions of more than the type species. Gray's *T. catalania*, which is allowed by both Sir W. Flower and Mr. True, is mainly to be distinguished by colour; it is said to be "a very light lead colour above and on the sides, gradually passing into the dirty leaden white of the lower parts, which were covered, as also the flippers, with longitudinally elongated blotches of dark lead colour." It has twenty-five teeth in each jaw instead of twenty-three; but are these points to be relied upon as distinguishing it? True thinks that it may be the same as Rüppel's *T. abusalam*. This whale has the upper surface sea-green, of a dark hue, instead of lead colour. It has twenty-six teeth and fewer vertebræ, the formula being: C. 7; D. 12; L. 16; Ca. 26 = 61. It is from the Red Sea, while *T. catalania* is Australian. As to the difference in the vertebral formula, Mr. True has pointed out that a specimen of *T. tursio* in the British Museum has but twelve ribs, and another but sixty-one vertebræ altogether. Its differences from *T. tursio* are at most but slight.

PLATE XVII.

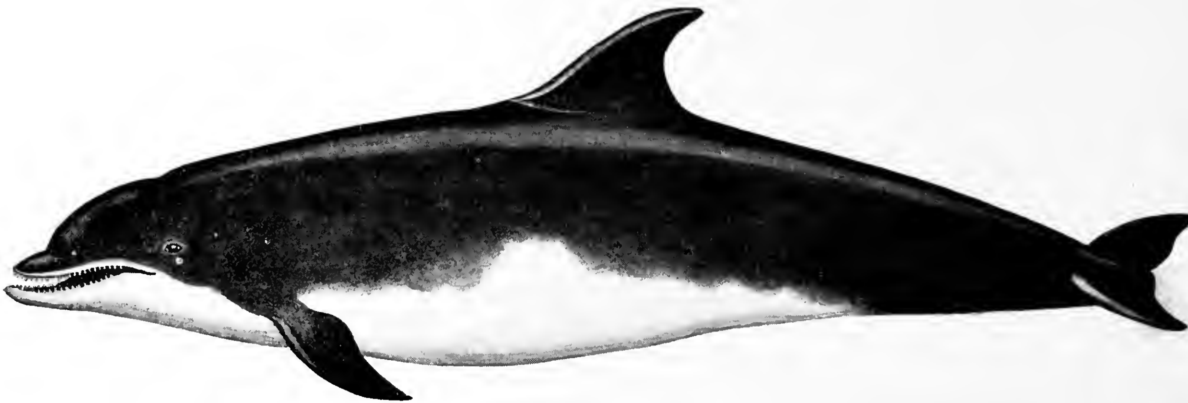


FIG. 35. *Tursiops tursio.*

(After Flower.)

[*To face page* 275.

Tursiops tursio, Fabricius,* (Plate XVII.) has the upper surface lead colour; under surface white. Teeth, 23. Vertebræ: C. 7; D. (12) 13; L. 17; Ca. 27 = 64.

This—the only satisfactory type of the genus—is apparently of universal range, specimens having been recorded from our own coasts (rarely, however), North America, New Zealand, Seychelles.

The size of this species is some ten feet, but it has been recorded as reaching twelve. Van Beneden mentions that of specimens captured at Arcachon the colour was an intense black save for a white streak on the ventral surface, which was greyer in the male. The fœtus possesses 4–7 hairs on each side.

The amount to which the cervical vertebræ are fused varies. The two first appear to be always united; of the following ones, more or fewer are also fused. Sir W. Flower has figured its external characters.† Mr. True‡ observes of this whale that its eyelids are as mobile as in the terrestrial mammalia. The name *tursio* is derived from Pliny, but there is no sure ground for identification. The ingenious Belon would derive "Marsouin" (a corruption of "Meerschwein") from *tursio*. But as Frederick Cuvier justly remarks, "We may agree that it would be difficult to place faith in specific analogies founded upon such a system!"

* *Fauna Groenland*, 1780, p. 49.

† *Trans. Zool. Soc.*, xi., Pl. I.

‡ "Observations on the Life History of the Bottlenose Porpoise," *Proc. U.S. Nat. Mus.*, 1890, p. 197.

Delphinus truncatus, Montagu; *D. metis*, Gray; *D. cymodice*, Id.,; *D. eurynome*, Id., are apparently synonyms.

Tursiops catalania, Gray,* is in size small (6 feet 9 inches). The colour is as in *T. tursio*, but the sides are covered with blotches of darker colour. Beak relatively longer than in *T. tursio*. This species, as already said, is admitted by both Sir William Flower and by Mr. True. It is a native of the north-east coast of Australia.

The skull only (as far as the skeleton is concerned) is known; but the collector, Mr. John MacGillivray, sent home to Dr. Gray careful measurements and a description of the colour of two specimens which he obtained at localities not far apart.

Tursiops abusalam, Rüppell,† is dark green above; under surface white with dark spots. Teeth, 26. Vertebræ: D. 12; L. 16; C. 26 = 61. Beak longer than in *T. tursio*.

This dolphin, from the Red Sea, does not differ widely from *Tursiops catalania*, and may very possibly be identical with it. Yet the green colour seems to be characteristic and, as dolphins go, unusual. The number of vertebræ and ribs, as a character, must be handled with caution, for Mr. True records an undoubted *T. tursio* with but twelve ribs and sixty-one vertebræ.

* *Proc. Zool. Soc.*, 1862, p. 143.

† *Museum Senckenberg*, iii., 1845, p. 140.

Tursiops gillii, the "Cowfish" of Scammon, of which he gives "approximate outlines," is black all over, only a little paler below. Though True admits it is a species, it would perhaps be well to wait for further materials before allowing it a place in the system. Certain small marks in the skull lead Mr. True to give it a separate place in the list of existing species of Cetacea.

Tursiops parvimanus, of Reinhardt,* is said to differ chiefly by more numerous phalanges of the third digit. Seeing that there is so great a variety in the number of ossifications in the hand, it is not a satisfactory way of defining a species to use this character. The species, moreover, was "founded on a single young individual from the Adriatic"—another unsatisfactory point, if we are to regard it as distinct. Lütken is inclined to suggest an identity with *T. catalania*.

The genus *CEPHALORHYNCHUS* is distinguished by the following assemblage of characters:—Teeth, 25–31, small, sharp. Pterygoids widely apart; premaxillæ ridged in front of nasal apertures. Vertebræ, 63–67. Dorsal fin triangular or ovate.

This is a genus of antarctic dolphins, limited, so far as is known, to the seas about the Cape, New Zealand, and Chili. Their external appearance is

* See LÜTKEN, *Ann. Mag. Nat. Hist.* (2), xii., 1888, p. 179. A translation of a paper in Danish.

suggestive of that of the Porpoises, and the form of the pterygoids is much like what is found in the genus *Phocæna*, as also the elevations upon the pre-maxillæ. They have not a beak well marked off from the rest of the head; but this fact of structure has not been incorporated into the generic diagnoses, since in *C. hectori* there is a hint of one, which is indistinctly marked off from the forehead. The small size and non-falcate form of the pectoral limb might perhaps be added as a generic character; but in *C. albifrons* these limbs are, though small and elongated as in the other species, slightly falcate.

Cephalorhynchus heavidsidii, Gray * (Plate XVIII.), the first described species of the genus, has the pectoral fin elliptical and the dorsal fin triangular. Teeth, 25–30. Vertebral formula: C. 7; D. 13; L. 15; Ca. 30=65. Pterygoids short and widely separated. Length, about 48 inches.

The colour of this dolphin appears to be black with a good deal of white or pale yellow on the ventral surface. But there is evidently some variation, as F. Cuvier's "Marsouin du Cap" † is stated to be entirely black save for a white spot on each side. Sir W. Flower and Mr. True unite these two forms, and the former suggests that Cuvier's "species" may be a melanic variety of the more typical form. The first

* *Spicil. Zool.*, 1828, p. 2.

† This has been called *Delphinus capensis*. Other species, called by Frederick Cuvier *D. cephalorhynchus* and *D. hastatus*, are believed to be synonymous.

PLATE XVIII.

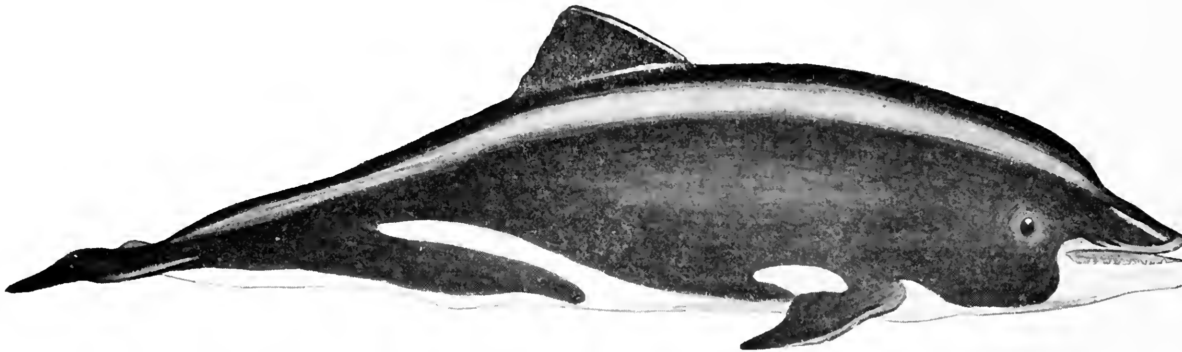


FIG. 30. Heavyside's Dolphin (*Cephalorhynchus heavisidii*).

[*To face page* 278.

six pairs of ribs are two-headed and five reach the sternum.

Cephalorhynchus albifrons, True, is a changed name for *Electra clancula*, Hector,* and has the pectoral fin falcate and the dorsal fin low and ovate. Teeth, 31. Pterygoids long and constricted at base. Length, rather over four feet.

This species, instead of being black, is grey over the greater part of the body; the fins are darker than the trunk.

The next species, *Cephalorhynchus hectori* (van Beneden),† has an obtusely-pointed pectoral fin; the dorsal fin is low and ovate; the beak is slightly marked. Teeth, 30. Vertebræ: D. 14; L. 15; C. 27 = 63.

This New Zealand species is very near to both the last. But the throat and lower jaw are white. It has not the white forehead of *C. albifrons*.

The fourth and last species of the genus *Cephalorhynchus eutropia*, Gray‡ (= *Eutropia dickei*, Id.), has thirty teeth in each half of each jaw. Skull larger than in *C. heavisidii*, with longer and more closely approximated pterygoids.

This species is only known from a skull from the coast of Chili. Sir William Flower, as well as Mr. True, pronounce this form to be quite distinct.

* *Tr. New Zeal. Inst.*, v., 1873, p. 160.
† *Bull. Roy. Acad. Belg.* (3), i., 1881, p. 877.
‡ *Proc. Zool. Soc.*, 1849, p. 1.

The genus *GLOBICEPHALUS** has 7–12 teeth on each side confined to the anterior region.

Vertebræ: C. 7; D. 11; L. 11–14; C. 27–29 = 58 or 59. Six of the ribs are two-headed. Skull raised into a very strong prominence behind blow hole. Pterygoids large and in contact. Pectoral fin long and falcate; dorsal fin moderately so. The number of phalanges is: I, 3–4. II, 9–14. III, 9–11. IV, 2–3. V, 1, 2. No beak. Very broad pre-maxillæ and rostrum generally.

The best known and most widely distributed species is *Globicephalus melas*, Traill.† (Plate XIX.) The colour of the whale is black save for a white area on breast. Teeth, 10. Pterygoids not greatly wider in front than behind.

This species has an extremely wide range; it is common in the northern seas, and specimens indistinguishable from those of British waters have been received from New Zealand and the Cape.‡

In a specimen at the British Museum without epiphyses there were six cervical vertebræ fused and only one free. In a younger individual only five were fused. This example is one of many which shows how careful it is necessary to be in using the number of vertebræ of the neck which are fused as a

* The most elaborate memoir upon the structure of *Globicephalus* is that of MURIE in *Trans. Zool. Soc.*, viii., 1873, p. 235.

† *Nicholson's Journ.*, xxii., 1809, p. 81.

‡ The Scottish vernacular for this creature, "Caa'ing whale," means Driving whale. One of the vernacular names given by Dr. Gray is "Howling whale." This is clearly a mistranslation of the Scotch!

PLATE XIX.

FIG. 37. Caa'ing Whale (*Globicephalus melas*).
(From Murie.)

[To face page 280.

character. Of the eleven ribs six have two heads. There are fourteen lumbars and twenty-two caudals. In the older specimen there are altogether forty-one lumbo-caudals.

The phalanges in digits II and III of the embryo may reach so high a number as twenty-seven and twelve respectively. The formation therefore of a species (*G. propinquus*, Malm) upon a fœtus with a greater number of phalanges than the adult *G. melas* is not permissible. The fœtus has a few hairs, four or five.

All of the seven following names are to be looked upon as synonyms:—*Globicephalus svineval*, Gray; *G. affinis*, Id.; *G. edwardsi*, Smith; *G. incrassatus*, Gray; *Delphinus intermedius*, Harlan; *D. deductor*, Scoresby; *D. globiceps*, Cuvier.

This whale has been largely fished in the Faroe Islands. Mr. H. C. Müller, a native of those islands, has recently gone into the matter and collected a large amount of information, which is here partly abstracted. It appears that the earliest date concerning the appearance of these whales was in the year 1584. The animal is spoken of as "Grindehval," a herd being termed "Grind," which signifies lattice work. Its application to the whales is apparently the placing of a line of boats across the mouth of a bay where a herd of the Cetaceans has run toward the shore. The results of the fisheries have fluctuated much in the period of years from the date already mentioned. The whales are hunted and captured in the following manner. When a herd is discovered a piece of garment is hoisted from the mast of a boat; the inhabitants then rush to their boats, and drawing together shape a half-circle round the herd; stones are thrown into the water, by means of which the herd may be driven in any direction. They are then driven in shore to a whale voe, which is a bay with a level sloping bottom of mud or sand, preferably loose, so that the water becomes muddy and the whales cannot see their way. When the herd has arrived at the mouth of this bay the boats arrange themselves in three lines, so that if one is broken through the animals may be driven back by the second, and so on. The whales are then killed with lances. The value of an average whale is £3 7*s*. 6*d*., of which the oil (one barrel-full) is estimated at 45*s*. The meat is dried or pickled, and the stomach is dried and made into buoys.*

Globicephalus scammonii, of Cope,† has a length of 15 feet some inches. Colour entirely black. Teeth, 8. Pterygoids closely approximated and closely addressed. Inter-maxillæ not projecting over margins of maxillæ.

This species, which inhabits the North Pacific, is said by Scammon to be "generally found wherever Sperm whales resort." Probably this is due to their feeding on the same kind of food as their gigantic

* "Whale-Fishing in the Faroe Islands," an essay in *Fish and Fisheries*. Edinburgh, Blackwood, 1883.

† *P. Acad. Nat. Sci. Philad.*, 1869, p. 21.

relatives—to wit, squid. The "fish" goes in schools from ten up to hundreds, which sometimes move rapidly, and occasionally lie closely huddled together at the surface. It seems to be unnecessary to state that this whale is called "black-fish," for so many whales are called by this exceedingly obvious name. It is not considered a prize by whalers, for its oil is not abundant.

Globicephalus brachypterus, also of Cope,* is in colour entirely black. Teeth, 8. Pre-maxillæ greatly expanded anteriorly, covering maxillæ.

This Atlantic species is of the form and size of the Caa'ing whale. It may show a difference in the number of lumbar vertebræ, which are stated at eleven. But the commencement of the Caudal series being marked by the first chevron, which bones are very apt to be lost, it is a little difficult to be certain upon this point. The total number of vertebræ is given at 57, one or two less than the numbers ascertained for *G. melas*.

Other reputed species are *G. sieboldi*, which in Schlegel's drawing has a very different aspect from *G. melas*, being of a more slender build with a very falcate dorsal fin; *G. macrorhynchus*, of Gray, and of unknown locality and unknown form; what is known about it is the skull.

Globicephalus indicus, of Blyth,† is allowed by

* *Proc. Acad. Nat. Sci. Philad.*, 1876, p. 129.

† *Journ. Asiat. Soc. Bengal*, xxi., p. 358.

Blanford as a distinct form. It has 6–7 teeth on each side above and 7–8 below. The pre-maxillæ are broad and entirely cover maxilla. Its colour is a uniform leaden black. The length is 14 feet 2 inches. The animal goes in shoals, and frequents the Gangetic delta.

The genus *TURSIO* must be carefully distinguished from *Tursiops*. Its characters are: Beak distinct; no dorsal fin. Teeth small and numerous, 44. Pterygoids separate.

It is a pity that the name *Tursio* antedates *Leucorhamphus*, since *Tursio* is so evidently suggestive of *Tursiops*, to which genus the present is not so nearly allied as it is to *Prodelphinus*. The name of "Right Whale Porpoise" has been applied to the dolphins of this genus on account, of course, of the absence of the dorsal fin. The northern *T. borealis* seems to be only distinguishable from the southern *T. peronii* by its slightly different coloration; this does not appear to be a sufficient reason for separating them. But the matter will not be decided here. The species *peronii* has a wide range, and is black above and white beneath, the colours joining abruptly. It is southern in range, antarctic in fact, though ranging as far north as New Guinea.

The genus *GRAMPUS** (Plate XX.) has no teeth

* The derivation of the word Grampus (which has a somewhat loose significance when used as an English word, applying also to Orca) is variously given as *grand poisson* and *gras poisson*.

PLATE XX.

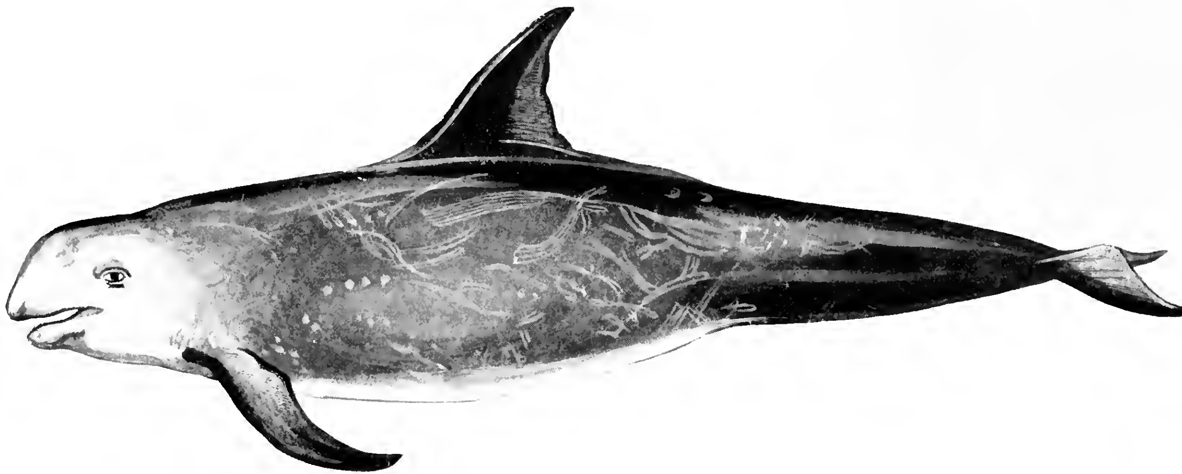


FIG. 38. *Grampus griseus.*

(After Flower.)

[*To face page* 284

in upper jaw, but 3–7 on each side of mandible near to the symphysis. Vertebræ: C. 7; D. 12; L. 19; Ca. 30=68. Six or seven pairs of ribs two-headed; five pairs, sometimes seven, reach the sternum. Skull with pterygoids in contact; pre-maxillæ in front of nares raised. No beak. Pectoral fin long, pointed, falcate; dorsal fin high and falcate. Number of phalanges: I, 2. II, 8–10. III, 6–8. IV, 3. V, 1.

In the vertebral column only the seventh vertebra of the cervical series appears to remain free.

The only species is *Grampus griseus*, Cuvier.* *D. rissoanus*, Desmarest; *Grampus cuvieri*, Gray; *G. souverbianus*, Fischer; *G. sakamata*, Gray; *G. stearnsi*, Dall; *G. chinensis*, Gray, are believed really to refer to the same whale.

This dolphin, often called Risso's dolphin,† is mainly Mediterranean and North Atlantic in range. But like so many other Cetaceans its limits are not very fixed, and a skull (conceivably belonging to a different species) has been recorded from the Cape. It may return to those more southern latitudes during the winter. Risso's dolphin is from 10–13 feet in length, and is distinguished by its very remarkable coloration. The prevalent tint is grey, varying on the fins and tail to black, and to white on the belly. This white has a yellowish tinge anteriorly, but the curious feature of the coloration is a series of

* *Ann. Mus.*, xix., 1812, p. 14.

† W. H. Flower, "On Risso's Dolphin," *Trans. Zool. Soc.*, 1872, vol. viii., p. 1.

irregular light streaks and spots suggestive of scrapings upon wet paint. In a younger individual the sides were marked with six regular transverse stripes. This animal (only six feet in length) had eight whitish bristles on each side of the upper lip.

This is not by any means a common Cetacean. Only a dozen records of its capture upon the English and French coasts are extant. It feeds upon cuttle-fish and is gregarious.

The genus *ORCA** (Plate XXI.) has 10–13 teeth, large, with recurved crowns. Pterygoids not quite meeting. Vertebræ: C. 7; D. 11–12; L. 10; Ca. 23 = 51 or 52. First two or three cervicals fused. The first seven ribs are two-headed; five reach the sternum. Dorsal fin large and pointed.

The Killer whales ("Tyrannus balænarum," "Formidabilis balænarum hostis"), sometimes called "Grampus,"† are the largest among the Delphinidae, reaching a length of 20–30 feet. They are powerful, rapacious animals, and are the only whales that feed upon their own kind and upon large prey. It is perhaps not necessary to believe with an old writer that a Killer has been seen with a seal under each flipper, a third tucked away under the dorsal fin, and a fourth in the mouth; but it is stated by Eschricht that from the stomach of one of these fierce whales

* See especially VAN BENEDEN, in *Mém. Acad. Belg.*, 1882.

† A French word for this whale, used by Rondeletius, is Epaulard; *i.e.*, peisaulard.

PLATE XXI.

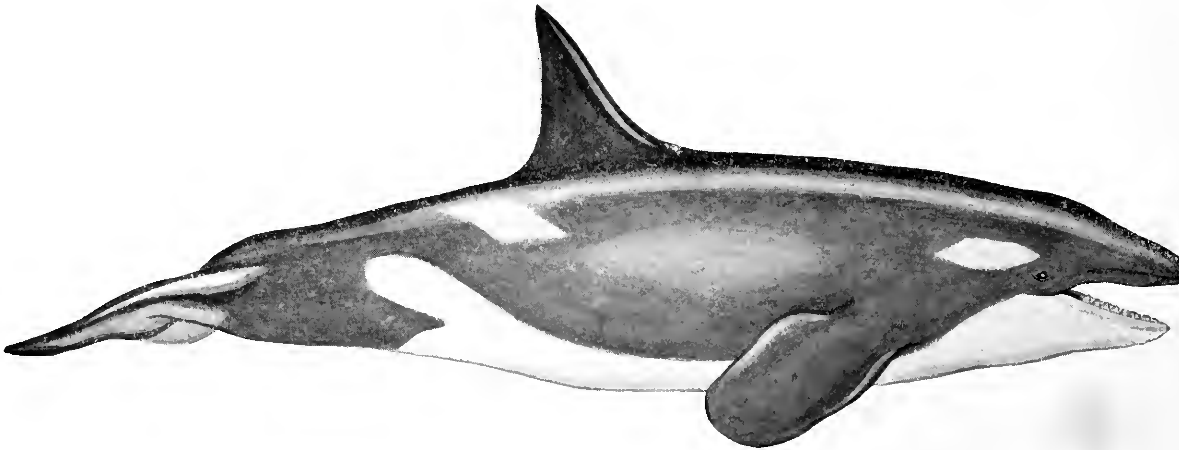


FIG. 39. Killer Whale (*Orca*).

(From cast in Nat. Hist. Mus.)

[*To face page* 287.

no less than thirteen porpoises and fourteen seals were extracted. Scammon relates how they may sometimes "be seen peering above the surface with a seal in their bristling jaws, shaking and crushing their victims, apparently with great gusto, and swallowing them." A party of Killers will also assault the largest whales. Scammon relates an attack of this nature upon a Californian Grey whale, which he witnessed. "They made alternate assaults upon the old whale and her offspring, finally killing the latter, which sunk to the bottom, where the water was five fathoms deep. During the struggle the mother became nearly exhausted, having received several deep wounds about the throat and lips. As soon as their prize had settled to the bottom the three Orcas descended, bringing up large pieces of flesh in their mouths, which they devoured after coming to the surface."

The ferocity, or at any rate the boldness, of this predaceous Cetacean is also attested to by his Highness the Prince of Monaco.* "Two years ago," the Prince writes, "I chased a school of three of these just off the Monaco rock, and very soon one was struck by my whaler's harpoon. While it was ending with violent struggles the two others came alongside the whale-boat, and seemed willing to fight for their companion. They swam round and round, sometimes so close that the men touched their enormous backs with their hands." It has been even said that the

* In *Nature* of June 30th, 1898 (p. 203).

long and pointed dorsal fin is used for aggressive purposes, to rip up the belly of a whale!

The Hon. Paul Dudley* thus describes the attacks of the Killers upon whalebone whales: "They go in company by dozens and set upon a young whale, and will bait him like so many bulldogs. Some will lay hold of his tail to keep him from threshing, while others lay hold of his head and bite and thresh him, till the poor creature, being thus heated, lolls out his tongue, and then some of the Killers catch hold of his lips, and, if possible, of his tongue; and after they have killed him they chiefly feed upon the tongue and head, but when he begins to putrefy they leave him. This Killer is doubtless the *Orca* that Dr. Frangius describes in his *Treatise of Animals.* His words are these: 'When an Orca pursues a whale the latter makes a terrible bellowing, like a bull when bitten by a dog.' These Killers are of such strength that when several boats together have been towing a dead whale, one of them has come and fastened his teeth in her and carried her away down to the bottom in an instant."

In more northern regions the Orca pursues the White whale and the walrus. Not indeed the adult walrus, whose strong tusks may be supposed to be a sufficient protection. It is the young that the Killer hunts. "The cub will mount upon its mother's back for refuge, clinging to it with instinctive solicitude. When in this apparently safe position the

* *Phil. Trans.*, xxxiii., 1725, p. 82 (abridged edition).

rapacious Orca quickly dives, and, coming up under the parent animal, with a spiteful thud throws the young one from the dam's back into the water, when in a twinkling it is seized, and with one crush devoured by its enemy." These observations refer to the Killer whales in general. A large number of different species have been described or at least named. "But," observes Sir W. Flower, "their specific differential characters, if any, have never been clearly defined." We shall not, therefore, attempt any discrimination of species. These have been partly founded upon the varying length of the dorsal fin and upon the colour, which is black, more or less pervaded with white blotches (yellow in v. Beneden's figure). The typical *Orca gladiator** has much white about the body, and an excellent model of this Cetacean, agreeing with Mr. True's figure of the whale, has been set up in the Natural History Museum at South Kensington. It is a whale that has been frequently met with upon our shores, and a few years since a herd of three ascended the Thames for some distance. It occurs also in all parts of the world. It is quite possible that there are several species of the genus. But probably the bulk of the dozen or so of species allowed by Dr. Gray have no existence save in his and in other catalogues.

* It is only possible to be certain of the existence of one species. In this case *O. duhameli*, Lacepède: *O. schlegelii*, Liljeborg: *O. minor*, Malm, etc., are merely synonyms.

It is probable, according to F. Cuvier,* that this whale is the "aries marinus" of the ancients (possibly the "horrible Sea-satyre" of Edmund Spenser), for the white marks on the head might be fancifully interpreted as closely adpressed horns.

The genus *PSEUDORCA* is thus definable :—Teeth, 8–10, much like those of *Orca*. Rostral portion of pre-maxillæ broader than in *Orca*. Vertebral formula : C. 7 ; D. 10 ; L. 9 ; Ca. 24 = 50. Six or all cervicals united. Six ribs two-headed. Dorsal fin rather small, falcate.

There is but a single recognised species, which is *Pseudorca crassidens*, Owen.† This whale reaches a length of about fourteen feet. It was originally described from a skull found in the Lincolnshire fens, and was naturally supposed to be an extinct species. But afterwards it was discovered to live in the North Sea, and a species at first regarded as distinct, *Ps. meridionalis*, was received from Tasmanian seas. The whale is scarce, and there is not very much to be said about it. It is not precisely evident why systematists have thought fit to remove it from the genus *Orca*, to which it is clearly very closely allied.

The genus *ORCELLA* is thus characterised :—Teeth, 14–19, small, sharp. Pterygoids widely

* *De l'Histoire Naturelle des Cétacées*, p. 179.

† *British Foss. Mamm.*, p. 516 (= *Pseudorca meridionalis*, Flower, *Proc. Zool. Soc.*, 1864, p. 240).

separate; rostral portion of pre-maxillæ broad. Vertebral formula: D. 14; L. 14; C. 26=61. Seven ribs two-headed; five reach sternum. No beak. Dorsal fin small, falcate.

Of this genus there is really but one species, *Orcella brevirostris*, Owen.* Head convex anteriorly. Pectoral fins triangular; dorsal fin small, falcate.

The present species is a partly fresh-water form, and occurs in the Irrawaddy 3–900 miles from the sea. It is also marine. I unite the two species which True regards as separate† on the authority of Mr. Thomas,‡ who has recently examined material.

The genus *SAGMATIAS* has the pre-maxillæ elevated into a crest in front of nostrils. Pterygoids short, scarcely or not at all touching. Teeth small, 32.

Of this genus but a single species, *S. amblodon*, is known, and that only (as will be observed from the definition) from a single skull, described by the late Professor Cope. But the singular crest formed by the elevation of the pre-maxillæ is a character which seems to be in the present state of our knowledge of generic value; it is, however, met with in *Phocæna*.

* *Trans. Zool. Soc.*, vi., p. 24.

† *Orcella fluminalis*, Gray (from Anderson's MSS.), Suppl. Cat. Whales, p. 80.

‡ *Ann. Mus. Civ. Genova* (2), x., p. 927.

The genus *FERESA* need hardly detain us long. It is only known from two skulls with 10–12 teeth in each half of each jaw, both assigned now to the same species, *F. intermedia* (one was described as *F. attenuata*). Sir W. Flower describes it as "a connecting link between *Globiceps*, *Grampus*, and *Lagenorhynchus*." It must not be confounded with the very doubtful "*Delphinus feres*," of Bonnaterre, which has been variously interpreted as an *Orca* or as a Ziphioid.

CHAPTER XI.

ANOMALOUS DOLPHINS

FAMILY, *PLATANISTIDAE*

WE can define this family by the following characteristics :—Cervical vertebræ all free, and individually of considerable length. Jaws long and narrow with a considerable extent of symphysis, and numerous teeth. Lacrymal bones not distinct from jugal. Pectoral limbs large ; phalanges of digits few in number.

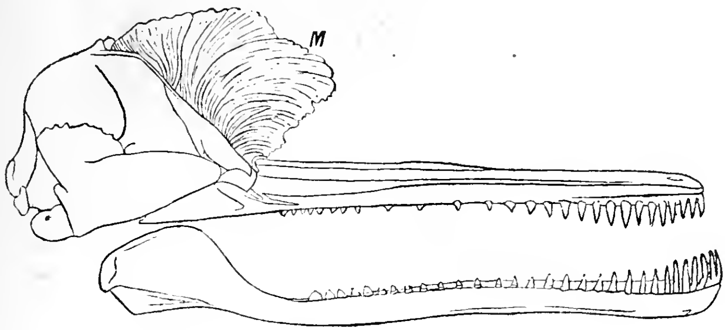
This undoubtedly ancient family of dolphin-like Cetacea would be more easily definable if we could eject *Pontoporia*, which is very distinctly nearer to the true dolphins than are either of the two remaining genera, *Platanista* and *Inia*. This indeed is done by Gray, who does actually relegate *Pontoporia* to the dolphins, making a separate family for the two other genera—a family, that is to say, for each of them. Sir William Flower was content with urging the adoption of sub-family rank for each of the forms *Platanista* and *Inia*, avoiding the placing of *Pontoporia*, which was not so thoroughly known at the time when he wrote upon these forms as it is now.

The genus *PLATANISTA* may be thus distinguished from its allies :—There is no dorsal fin ; the pectorals are large and truncated at the extremity ; teeth not so numerous as in *Inia*, some twenty-nine in each half of each jaw. Scapula with the acromion coinciding with the anterior margin of the bone, and a rudimentary coracoid process only. In the skull there are enormous maxillary crests.

The most remarkable feature of the cervical region of the spinal column is the independence and the comparatively great thickness of the individual vertebræ. There is a fairly strongly-marked odontoid process on the axis, a very rare feature in whales. The thoracic vertebræ are locked together in a way which is also peculiar to *Platanista* among whales ; but the mode of attachment of the ribs is on the whole like that of *Inia*. The first seven of these are attached to the transverse process of their own vertebræ and to the centra of the vertebra in front.

There are eight lumbar vertebræ. The sternal ribs, as in *Inia*, are cartilaginous. The sternum is not so modified as is that of *Inia*. It consists of three pieces placed end to end, of which the middle one, at any rate, shows traces of its double origin by a suture running down it longitudinally. To the sternum four ribs are attached. The main peculiarity of the scapula (quite unique among whales) has been pointed out in the definition of the genus. As in *Inia*, the humerus is unusually long. The most remarkable feature in the skull, not even excepting the extraordinary maxillary crests, is the condition of the palatines. These do not enter into the formation of the bony palate, but are concealed by the pterygoids.

FIG. 40. Skull of *Platanista*, lateral view.
(After van Beneden and Gervais.)



m, Maxillary crest.

Platanista gangetica, the *species* named by Lebeck,* the "long-snouted Dolphin of the Ganges," is limited to that river and to its branches, and to the Indus and its branches. It appears never to leave the streams for the sea. Its food is chiefly fish and prawns, and it is believed largely to grub about in the river mud to obtain its food. The diminutive eyes render pursuit of an active prey at least difficult, but the whale makes up for these defective organs of vision,

* *Gesellsch. Nat-Freunde*, Berlin, 1801, p. 280. The fullest account of the anatomy of this whale is by Dr. Anderson in *Anatomical and Zoological Researches . . . Yunnan*, 1878, p. 417, with many plates of both skeleton and "soft parts."

as is elsewhere the case in the animal world, by a sensitive beak. Grain has been found in the stomach of this dolphin; but Dr. Anderson believes that its presence is accidental and not deliberately caused by the dolphin. The most generally used vernacular term for this Cetacean is Susu; this and some of the other expressions used by natives in different parts of its range are onomatopoetic words intended to imitate the sound made during spouting. As everything that breathes seems to form the food of some tribe or individuals, it is unnecessary to state that the Susu is devoured by many natives.

The animal may reach a length of 9·5 feet, but is not usually so large. As to external characters, the most striking point which would be at first noticed is the existence of a distinct neck. Its long snout is curiously suggestive of that of the Gavial of the same region of the world.

The next genus, *INIA*, has only a rudimentary dorsal fin, but large ovate pectorals. The teeth have often a distinct additional tubercle. The maxillary crests are not largely developed. The palatines are separated in the middle line by the vomer. Scapula normal.

This genus, like *Platanista*, includes but a single species. The genus itself is in some respects the most central type of the Platanistidae. It is much more un-dolphin-like than *Pontoporia*, but not so highly abnormal in the bulk of its characters as is *Platanista*.

The skeleton of this whale has been described by Sir W. Flower* from a specimen in the British Museum.

The skull is very slightly asymmetrical; it is crested behind the nares, the vertex being formed by the frontals.

There is no distinct lacrymal bone. The maxillæ are narrow, and excavated by the pre-maxillæ in a way paralleled in *Pontoporia*, but not found among the dolphins. The palatines are separated from each other by the vomer, and the pterygoids are nearly in contact. "The mandible presents a remarkable miniature resemblance to that of a Cachalot." Its most remarkable feature is the great length of the symphysis.

The vertebræ are very few, only forty-one in all, which are thus distributed: C. 7; D. 13; L. 3; Ca. 18 = 41. The neck, as in *Platanista*, is particularly long, and for the matter of that distinguishable externally. This is due to the relatively great length and complete separation from each other of all the cervicals—an uncommon state of affairs in toothed Cetacea, but found in *Platanista*, Beluga, and *Monodon*. There is a faint indication of an odontoid process to the axis, more developed in *Platanista*.

The dorsal vertebræ have high and erect spines. There are both anterior and posterior zygapophyses on the first nine; anterior zygapophyses only on the tenth and eleventh. The transverse processes begin

* "Description of the Skeleton of *Inia geoffrensis*, etc.," *Trans. Zool. Soc.*, vi., p. 87.

to be divided into tranverse processes proper, and metapophyses on the fifth dorsal. The former gradually move up towards the anterior zygapophyses, which they entirely supersede on the twelfth vertebra. The latter processes move down and become (on the ninth) fused with the process of the centrum, to which the capitular head of the rib is attached. The arrangement of these tubercles and processes of the vertebræ is related to a singular disposition of the ribs, which is unique among Cetaceans, and is more like that of the Cachalot and Ziphioid whales. The anterior vertebræ have a process springing from the neural arch for the tubercular attachment of the rib; between each two vertebræ (half on each) is a facet for the capitular attachment of the rib. In the fifth vertebra the facet is confined to the anterior edge of the body of that vertebra; and therefore on this vertebra and those following each rib is solely attached to its own vertebra. As far as the seventh each rib has a double attachment, but on the eighth or ninth the two facets of insertion have, as already mentioned, coalesced; from this point, therefore, the ribs are single-headed.

In having only three lumbar vertebræ *Inia* is remarkable among whales. It is a point of likeness to the Sirenia. These vertebræ are compressed and ridged below. There seem to be eleven chevron bones.

The ribs are thirteen pairs—the sternal ribs being cartilaginous as in the Physeteridae. It is possible that only two pairs of these reach the sternum, which will be, if confirmed, another small point of likeness to the Sirenia. The sternum itself is not unlike that of a Manatee; it is a single bone, oval in outline, with a deep anterior notch. In the whalebone whales the sternum also consists of a single piece.

The scapula, unlike that of *Platanista*, is not aberrant, but conforms to the ordinary dolphin pattern. Both acromion and coracoid are long. The humerus is unusually long (a clearly unspecialised character), and longer than the radius or ulna, the reverse being the case in other Cetacea. The hand has five carpals besides the pisiform. The formula of the phalanges is this: I, 1. II, 5. III, 4. IV, 2. V, 2.

The teeth of *Inia* are from 104 to 132, the formula being $\frac{26 \text{ to } 32}{26 \text{ to } 32}$.

The teeth (as in *Steno*) are markedly rugose on the crowns. They also show a very important character (in the approach to the complex teeth of terrestrial carnivores) in the presence of a supplementary lobe to the hinder teeth.

The only species is *Inia geoffrensis*,* with the synonyms: *Delphinus amazonicus*, Spix and Martius; *Inia boliviensis*, d'Orbigny; *D. geoffroyi*, Desmarest.

This dolphin frequents the Amazons, and reaches an extreme length of eight feet. It has a striking coloration, as well as a considerable amount of variability, which, it may be incidentally remarked, throws doubt upon other identifications of Cetaceans

* DE BLAINVILLE, *Nouv. Dict. Hist. Nat.*, ix., p. 151.

by colour alone. According to the most recent observer of this species, Mr. E. E. Austen,* it "is either wholly pink or flesh-coloured or else entirely black, or black above and pink beneath." Individuals of the different colours are to be seen in company, and it may be that the difference of colour is sexual. The late Mr. Bates, however, denied that the two sets of individuals were intermingled, so the matter must be regarded for the present as unsettled. As to the colour, it is remarkable that there are other examples of pale-coloured river dolphins (*e.g.*, *Sotalia sinensis*), a circumstance which must make us pause before accepting the view that the white hue of the arctic Beluga is protective in its nature. The rostrum of this dolphin is beset with scattered stiff hairs, and the dorsal fin is rudimentary, being reduced to a mere ridge. The native name of the animal is "Bouto," and there are legends to the effect that it will attack a man in the water, while the species of *Sotalia* found in the same river will endeavour to protect him, the two animals thus playing respectively the rôles of the Jaguar and the Puma, according to Mr. Hudson. In any case the natives fear the dolphin, and cannot be induced to harpoon it. Nor will they use the oil for fear that it should bring them bad luck. It is curious that another river dolphin in quite another part of the world, the "river pig" of Canton (? *Sotalia sinensis*), is, according to the Rev. H. Friend, "looked upon as a

* *Proc. Zool. Soc.*, 1896, p. 771.

creature of ill-omen, and on that account its name is tabooed."

There is also, according to the late Mr. H. W. Bates, a legend that this dolphin of the Amazons assumes the shape of a beautiful woman and perambulates the river banks. Meeting with an impressionable young man in that torrid region, and enticing him by the aspect of her long hair hanging loose at her heels, she inveigles him near the bank and disappears with him beneath the waves. It is stated that such legends, and they abound in the region, are not native at all, but introduced by the Portuguese. Professor Agassiz also having, after some difficulty, secured a specimen of this dolphin, found that, when it finally arrived into his possession, it was sadly mutilated by reason of the superstitious reverence that attached to its eyes and to other parts of its anatomy.

Genus *PONTOPORIA*. Dorsal fin falcate. Teeth very numerous, over 200. Articulation of ribs as in dolphins. Sternum in two pieces. Scapula as in *Inia*. Palatines separated in the middle line by the vomer.

I retain this genus (of which the proper name is really *Stenodelphis*, but *Pontoporia* is so much more familiar) in the family Platanistidae on account of its long and beak-like jaws, the numerous small teeth, and the general similarity of its nearly symmetrical skull to that of *Inia*. It was thus placed provisionally by

Sir William Flower* after an examination of the skull only; since Sir W. Flower wrote, the late Professor Burmeister† has described the other bones and certain of the viscera. The facts thus discovered are not so strongly in favour of the Platanistid affinities of *Pontoporia.* But, though it may be regarded as leaning towards the dolphins, there can be no great harm in leaving it for the present in the family Platanistidae.

The seven cervical vertebræ are all free, as in other Platanistids; there are ten dorsal vertebræ only. Burmeister gives also seven lumbars and eighteen caudals, this bringing up the total number of vertebræ to forty-two. I find the same total number in a specimen in the British Museum, but allow only five lumbars, the rest being caudals. My enumeration must be accepted if we are to allow the presence of the first chevron bone to mark the commencement of the caudal series. This whale, therefore, is dolphin-like in the greater number of the lumbar vertebræ—that is, of course, as compared with *Inia.* The sternum consists of two pieces which are ossified; Burmeister mentions a cartilaginous piece between. The hinder half of the sternum was divided longitudinally into two halves; the British Museum specimen appeared to be adult.

There are ten pairs of ribs, of which I found the first three pairs to be double-headed. The ribs in this genus are not like those of *Inia*, but like those

* In his memoir upon *Inia* quoted above.

† *Proc. Zool. Soc.*, 1867, p. 484.

of dolphins, that is to say, the single-headed ribs suddenly begin, they lose their capitular attachment, and have only the tubercular; there is no fusion between the two heads, as in *Inia*. But other examples among the Cetacea (cf. *Kogia* and *Physeter*) teach us that this is not a difference of first-rate importance. Burmeister states that there are four ribs, *i.e.*, four pairs with a double attachment to the vertebral column.

The scapula of this dolphin is normal in the origin of the acromion, as in Cetacea generally, but not as in *Platanista*. Four pairs of ribs appear to join the sternum, of which the last pair, however, are attached by a ligament only. The sternal ribs in front of this seem to be ossified. Burmeister distinctly states that they are.

The skull of *Pontoporia* is very symmetrical as compared with other dolphins. Its surface is very flat—not ridged behind the nares like that of *Inia*. The palatines, moreover, do not cover the vomer, a point of likeness to *Inia*. The symphysis of the mandible is long, and the teeth are estimated by Sir W. Flower to be as many as 221 in all.

Pontoporia blainvillii, Gervais.* As there is, so far as we know, but a single species of this dolphin-like Platanistid, it is unnecessary—and indeed impossible—to give it a satisfactory definition. The colour was stated by M. de Fréminville, who brought home the original skull upon which the genus and

* *Bull. Soc. Philom.*, 1844, p. 39.

the species were founded, to be white with a black dorsal band. D'Orbigny described another dolphin which he thought, but without any evidence, to be the same species; as this evidence is wanting it will be unnecessary to repeat his description. Mr. Lydekker, on the other hand, has described it as a palish brown, harmonising with the brown-coloured water of the estuary of the Amazons and the Rio de la Plata.

EXTINCT PLATANISTIDS

More generic types have been described as belonging to this group of the Cetacea than to any other. And it is furthermore remarkable as being the only existing group that goes back to the far past of the Eocene period; indeed, apart from the Zeuglodonts these whales are the only ones that have so ancient a history. But, as is so often the case, their remains are for the most part fragmentary, and not much of great importance has been or apparently can be deduced from their study. The restricted range of the existing Platanistidae is in interesting harmony with the great antiquity of the race; it is so often the case that a rapidly dwindling group of animals consists of existing forms which occupy very limited areas; it is as if the long continuance of the types in question had rendered them partially effete and unable to cope with changed conditions and new forms allied to themselves; in order to survive they have had to creep into corners where the tide of

Cetacean life does not enter. It is often held that the original terrestrial ancestors of the whales gradually adopted the marine life by first taking to rivers and then gradually passing through estuaries to the sea. It is alleged that these very Platanistids, being largely fresh water in range themselves, furnish such a proof of the way in which the ancestors of the whales changed to an aquatic from a land life. For they present, as has been pointed out, certain archaic points of structure, and are fresh water in habitat. There is, however, no *a priori* reason why the original whale should not have boldly plunged into salt water at once without gradually accustoming himself to the change. For we have the sea otter as an instance of a land animal frequenting the waters of the sea. And, furthermore, the remains of extinct Platanistids are from definitely marine strata. The question, indeed, is one upon which guesses alone are possible.

Seeing that the Platanistids (represented at any rate by the genus *Iniopsis*) go back as far in time as the Zeuglodonts, we might expect to find some approximation in structure between these two tribes, nearer than that which obtains between the Zeuglodonts and others. There are, however, so few apparent points at which the two groups touch that it seems necessary to look upon the two as independently evolved from some more ancient form, and to regard the Zeuglodont type as having culminated in the later Squalodonts (see p. 307) and then to have become extinct. There are, however, two genera assigned by Cope* to the Platanistids which approach *Zeuglodon* in one point, and that is in the length of the cervical vertebræ; these are *Zarrhachis* and *Priscodelphinus*. This character, however, as it seems to us, is rather one that betokens antiquity than one which points in any particular direction. The general tendency of whales of every group to lose their teeth is exhibited in these old Platanistidae; the genus *Rhabdosteus* has teeth at the base of the maxillary only; in *Agabelus* the teeth seem to have entirely vanished, leaving only an alveolar groove, which may, perhaps, have contained rudimentary teeth like those now found in the upper jaw of Physeter and the Ziphioids. Some other facts dealing with fossil members of this group will be found at p. 209.

* "The Cetacea," *American Naturalist*, 1890, p. 599.

CHAPTER XII.

ZEUGLODONTS AND THEIR ALLIES

Family, *SQUALODONTIDAE*

THIS family, consisting entirely of extinct forms, may be thus defined:

Teeth in both jaws specialised into incisors, canines, pre-molars, and molars. Skull, dolphin-like.

These whales, whose remains are known from the Miocene and Pliocene of Europe, America, and Australia, form a connecting link between the Zeuglodonts (with which group they have been united) and the modern Odontocetes. Like the Zeuglodonts the teeth are specialised; and, moreover, the molars have a coarsely serrate cutting edge like the Zeuglodont tooth, but the serrations are confined to one side. The teeth too are more numerous, though some of them are two-rooted as in *Zeuglodon*.

The archaic characters of the Squalodontidae are also shown by the fact that a number of the teeth of the upper jaw are borne by the pre-maxilla. The skull, however, apart from this feature, is not archaic, and the rudimentary nasals of modern Cetaceans have been acquired. In *Prosqualodon*, however, this process has not been fully completed, and there are small nasals which just project over the nasal vacuities. The symphysis of the mandible of *Squalodon* is very long, thus recalling the Platanistids and *Physeter*.

These whales, which did not exceed some thirty feet in length, have been divided into numerous genera; but as little is known of the skeleton this proceeding is at present rather premature. Cope, however, allows another genus in addition to those mentioned, and that is *Trirhizodon*, characterised by the fact that some of the molars are three-rooted.

ARCHÆOCETI

This, the last of the three divisions of whales, embraces only a single family, and, so far as can be said with certainty, only a single genus, *Zeuglodon*.

It is usually regarded as an assemblage equivalent to either of the other groups, and this view will be followed here. But the differences in structure might fairly be considered as entitling it to a more isolated position among the Cetacea. Nevertheless, there is no question of the Cetaceous nature of *Zeuglodon*. It is quite possible, however, that the Zeuglodonts are the ancestral group from which both Odontoceti and Mystacoceti have been derived. But this view, a very general one, cannot be elaborated in detail; we shall simply find an example of what is so disappointingly general when an attempt is made to trace pedigrees in animals.

The Archæoceti are toothed whales; but, whereas in the Odontocetes the teeth are all alike (with merely difference in size), the teeth of the present group are like those of more typical mammals, in being distinctly separable into three series. There are three incisors on each side of each jaw, and those of the upper jaw are borne by the pre-maxillæ, the bone which bears the incisors in mammals generally; behind the junction of the pre-maxilla with the maxilla is a definite canine, and behind this again five teeth, which are no doubt both molars and pre-molars, though there is no positive evidence of a double dentition in the Zeuglodonts. It will be noted too that the total number of teeth (thirty-six) is that of many mammals.

The skull is elongated like that of whales in general; and, as in other whales, the snout is long. The frontal bones come down over the orbit as in all whales; but the nasals are long and, ordinarily, mammalian. The result of this latter arrangement is that the blow hole was in the middle of the snout instead of at its base, as in all whales except *Physeter*, where, it will be remembered, there is a canal embedded in the soft tissues of the head leading to the extremity of the snout. It is the whalebone whales among living Cetacea which have best preserved the form of the nasal bones of *Zeuglodon*. Other bones of the skull besides the nasals are not upon the Cetacean plan. The pre-maxillæ take a large share, as has been already implied, in the formation of the gape. The parietals, which in existing whales have no lot or part in forming the top of the skull, meet in these ancient whale-like creatures to form a sagittal crest upon the vertex. The cervical vertebræ, as in the ancient Platanistidae and in a few only of other existing Cetacea, are separate; they are, moreover, not compressed antero-posteriorly as are those of recent whales, but are not different in length from the succeeding vertebræ. The scapula is not typically Cetaceous, since it has but a small coracoid process and a large acromion. The ribs are double-headed, like the anterior series of the toothed whales. The sternum too is constructed upon the plan that characterises the Odontoceti, being composed of several pieces.

If the Archæoceti are the most primitive of whales, it must be among them that the clue to the relationship of the whales will be found. This is a topic, however, about which more has been written than ascertained. The only view that demands a notice here (for we cannot, of course, accept any Ichthyosaurian descent for these animals) is the opinion held by one or two persons that the Zeuglodonts are most nearly related to seals.

The facts upon which these comparisons have been based are principally the characters of the teeth, the long neck—"like that of a seal in proportions"—the scapula without the typical whale-like form. All these points are just so far seal-like as they are generalised characters. All mammals except the Cetacea, and to a less extent the Sirenia, have moderately long cervical vertebræ. Included in this series are, of course, the seals. It is likely that whales have been derived from animals with this more typical mammalian arrangement. There is certainly one family only, and probably but a single genus of this group of whales. The remains of this have been found in many parts of the world, indicating that its distribution was like that of most Cetacea of the present day, wide. This genus was one of the great whales, and reached a length of certainly seventy feet. The best known species is *Zeuglodon cetoides*. But in spite of the abundance of its remains no complete skeleton has ever been got together.

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(The numbers printed in heavy type indicate the page where a full description of the Family, Genus, or Species will be found.)

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