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GIANT FISHES, WHALES AND DOLPHINS

GIANT FISHES, WHALES AND DOLPHINS

BY

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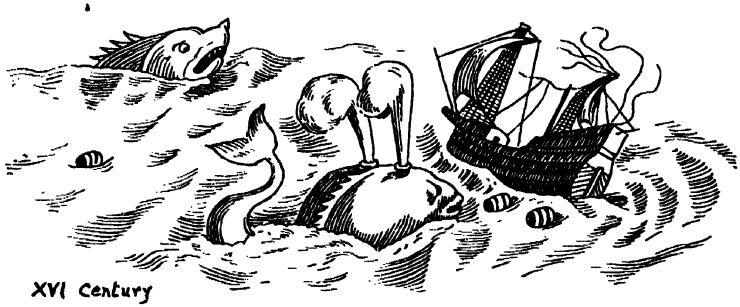


PREFACE

THE past ten or fifteen years have revealed a marked growth in the popular interest in the life of the sea, a growth which is perhaps associated with the ever-increasing popularity of the pleasure cruise. So numerous and varied are the inquiries received at the British Museum (Natural History) for facts concerning whales, dolphins, and the larger kinds of fishes, that the authors feel that little apology is needed for the publication of this book. Most of these inquiries come from travellers, seafaring men and sportsmen, and it is mainly for them that the book has been written. Arranged in convenient form for handy reference, the authors hope, nevertheless, that it will prove to be more than a mere reference work, and will provide general reading for anyone interested in the study of marine life.

From the outset the question as to which animals should be included and which omitted provided a difficulty, but, as far as the whales and dolphins are concerned, it was decided to include all the better-known forms. In the case of the fishes, all those that ordinarily grow to a length of 6 feet or more find a place, as well as certain smaller forms, such as the flying-fishes, pilot-fishes, and remoras, which are so often observed during a sea voyage. The term "fishes" is, of course, used in a strictly scientific sense, and includes only those animals with a backbone (Vertebrates), adapted for a

purely aquatic life, that propel and balance themselves by means of fins, and obtain oxygen for breathing from the air dissolved in the water by means of gills. Thus, such creatures as sponges, jellyfishes, crustaceans, shellfish, and even the gigantic squids of the ocean depths, often popularly referred to as " fishes ", are excluded, since they all lack a backbone.

The main part of the book is divided into two sections, one devoted to whales and dolphins, the other to fishes, and the authors are each responsible for one of these sections. Only in the case of the introductory chapter has actual collaboration been attempted. At the same time, every effort has been made to ensure that the method of treatment of the various forms and the arrangement of the subject-matter is roughly the same throughout.

Zoologically speaking, the two groups of aquatic animals dealt with in the separate sections of the book are vastly different in size and importance. In classifying the great group of Vertebrates, the zoologist divides this into a number of primary divisions or classes. These classes are : Lampreys and Hag-fishes, etc. (Marsipobranchii) ; Sharks, Rays and Chimæras (Selachii) ; Bony Fishes (Pisces) ; Frogs, Toads, Newts, Salamanders, etc. (Batrachia) ; Reptiles (Reptilia) ; Birds (Aves) ; and Mammals (Mammalia). The Cetaceans (Whales, Dolphins, Porpoises, etc.) represent *one* of the *Orders* into which the class Mammalia is further subdivided, whereas the " fishes " include no less than *three classes* of Vertebrates.

The aim of the book is twofold. In the first place, by the provision of simple keys, descriptions and accurate illustrations, it is hoped that the reader may be able to identify any of the whales, dolphins or large fishes that he may be in a position to examine. It is not claimed that these will enable a whale or fish to be recognized when swimming in the sea, although in many cases careful perusal of the descriptions and figures should render this possible. In the second place, the authors have tried to provide a readable account of the appearance, size, habitat, mode of life, food, breeding habits, economic importance and so on of the various creatures that find a place in the book. They have not hesitated to draw upon the subject-matter of a large number of books and scientific papers not readily available to the general public.

The use of technicalities has been avoided as far as possible, and these are included only where their omission would be at the expense of clarity. The introductory chapter has been designed to explain the meaning of the few scientific terms whose use has proved unavoidable, as well as to illustrate some of the more characteristic features of the Cetaceans and Fishes, so that the reader may have no difficulty in following the descriptions of the various forms given in later pages.

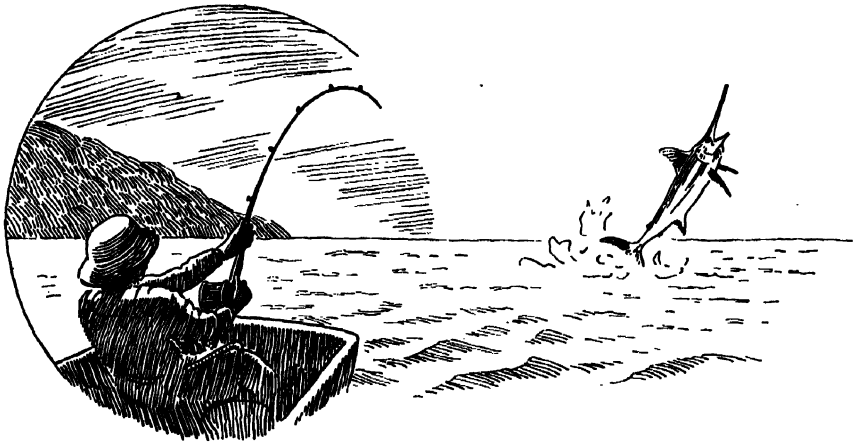
A few words are necessary concerning the scientific names that have been used for the fishes. With the 6-foot rule as the standard for inclusion, it follows that we shall sometimes be dealing with a whole family of fishes, sometimes with the members of a single genus, and sometimes with one or more species selected from a genus. Immediately in front of each description is given the popular name or names of the fishes dealt with therein, and the scientific name of the family or genus (sometimes both) to which they belong. For convenience it has been considered preferable to retain in this book the larger and more conservative generic groupings favoured by the older naturalists, so that the generic names employed for certain forms may not correspond with those to be found in some modern works on fishes. Since modern authorities themselves are by no means in agreement as to the limits of fish genera, or as to the names by which they are to be called, the advantage of this plan appears clear. To take an example, in the case of the Blue Sharks or of the Whip-tailed Sting Rays, a number of species have here been grouped together under the generic names *Carcharinus* and *Trygon* respectively, but many modern authorities would subdivide each of these groups into several distinct genera.

Finally, the authors wish to take this opportunity of thanking Lieut.-Col. W. P. C. Tenison, D.S.O., for his collaboration and for the care and skill that he has displayed in the preparation of the illustrations. All these have been drawn specially for this book, from specimens in the British Museum (Natural History), as far as these were available.

J. R. N.
F. C. F.

LONDON, 1937.

GIANT FISHES, WHALES AND DOLPHINS



INTRODUCTION.

A GLANCE at a typical Fish and a typical Cetacean (whale, dolphin or porpoise) reveals at once a general similarity in bodily form. This resemblance, however, as might be expected in two animals with such markedly divergent ancestral histories, is a purely superficial one, and a closer study of their anatomy reveals a number of important differences. The fish has always lived in the water, but the whale is a mammal that has exchanged a terrestial for an aquatic life, a change that has been accompanied by the assumption of a stream-lined and superficially fish-like form, designed to slip easily through the water. The whale has also undergone a number of other important modifications in connection with its adopted environment.

For convenience, as well as for descriptive purposes, we may divide the body of a fish or cetacean into three regions: a head, a trunk and a tail (Figs. 1, 2). As a general rule there is no trace of the neck so characteristic of most land Vertebrates, and the outline of the head passes into that of the trunk smoothly and without any sign of constriction. Similarly, the trunk itself merges imperceptibly into the tail, the line of division between the two regions being denoted by the vent. In fishes, the last of the external gill-clefts in the Selachians (sharks and rays), and the hinder edge of the bony gill-cover,

or, if this is absent, the gill-opening in the true or Bony Fishes, marks the boundary between the head and the trunk.

In addition to the skin, most fishes are provided with another covering in the form of scales. In the Selachians these scales take the form of small, tooth-like bony structures known as dermal denticles (p. 2), but in the Bony Fishes the scales are usually thin, flexible bony plates, regularly arranged, and overlapping one another like the tiles on a roof.

The skin of the whales has lost all trace of sebaceous and sweat-glands. Hair, so typical a feature of ordinary mammals, is reduced to a few scattered bristles on the surface of the head and snout, and is more frequently seen in young than in adult specimens. There are never any scales on the body, and the surface of the skin is exceedingly smooth, with a bright glossy sheen when fresh and dry.

Immediately below the skin in a fish are the muscles, but in the cetacean there is a fibrous layer loaded with oil, known as blubber, in between. This acts mainly as an insulator, to prevent loss of heat, for it must be remembered that, unlike the generality of fishes, the whale is a warm-blooded animal and has to maintain a constant temperature within its body.

The lateral line is a characteristic feature of most fishes, but nothing of this nature is found in any cetacean. This forms a kind of tunnel beneath the skin, which communicates at regular intervals with the surface by a series of small openings, which in scaly Bony Fishes are situated in a lengthwise row of special scales running along each side of the body. The lateral tunnels are continued on the head, where they form a branching system running in the bones of the skull. On the inner walls of the tunnels, which are filled with a jelly-like mucus, are special organs of sense, which alternate with the openings to the exterior. The function of the lateral line system is as yet imperfectly understood, but it is probably connected with the perception of movements in the water, perhaps enabling the fish to avoid obstacles, and providing it with a hint as to the presence of prey or natural enemies. It may be noted that the internal ear of a fish, which serves as an organ of balance as well as of hearing, is nothing more than a greatly enlarged and specially modified lateral line organ.

The fins, which provide so characteristic a feature of any

fish, are supported by structures known as fin-rays, and are further strengthened at their bases by special parts of the internal skeleton. The fins are of two kinds: median or unpaired, and paired. The median fins consist of a *dorsal* in the middle line of the back, an *anal* on the middle line of the belly behind the vent, and a *caudal* or tail-fin at the hinder end of the fish. The fleshy part of the tail behind the dorsal and anal fins is known as the caudal peduncle. The paired fins are of two kinds only, the *pectorals* and *pelvics*, corresponding

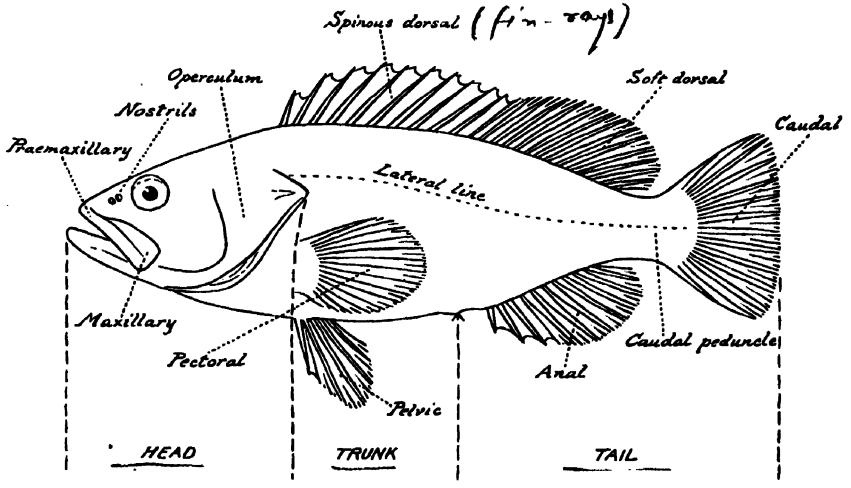


FIG. 1.—Topography of a Fish.

respectively to the fore- and hind-limbs of land Vertebrates. The pectorals are nearly always placed just behind the head, but the position of the pelvics varies in different fishes, sometimes being well back on the belly, sometimes more or less below the pectorals, and sometimes in front of the pectorals. The form and position of the various fins present considerable diversity in the different groups of fishes, and are of some importance in classification (Fig. 1).

We have seen that the fins are supported by structures known as fin-rays, which are usually joined to one another by fine membrane. In the Selachians the rays are all covered over with a thick skin and are quite invisible. In many Bony Fishes all the fin-rays have the form of flexible jointed rods (soft-rays), which may be simple or branched and brush-like

at their tips, but in many others the front rays of the dorsal and anal fins and the outer rays of the pectorals and pelvics are transformed into sharply pointed, stiff spines, sometimes with saw-like edges. Such spines provide useful offensive or defensive weapons.

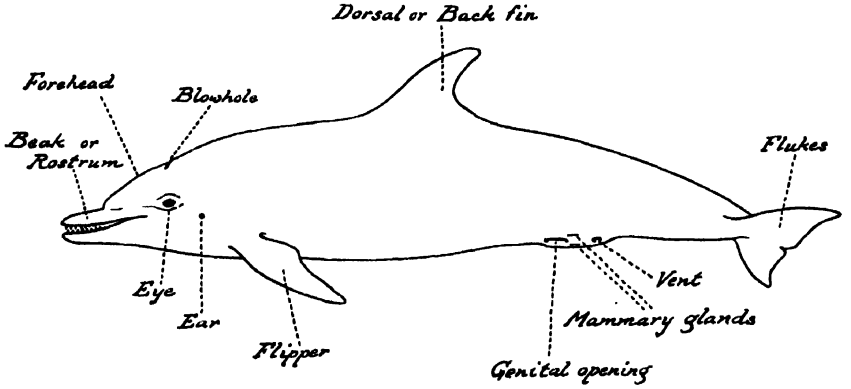


Fig. 2.—Topography of a Cetacean.

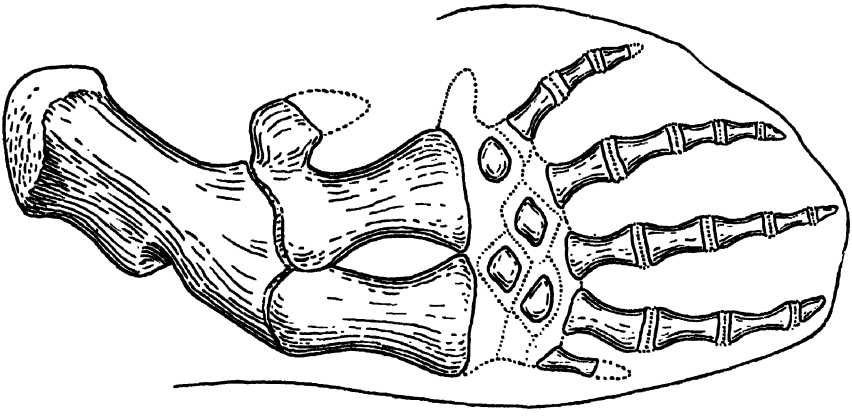


Fig. 3.—Flipper of a Sperm Whale.

In the cetaceans the hinder end of the body is flattened out into flukes (Fig. 2). These fleshy extensions are set in a *horizontal* plane, whereas the caudal fin of a fish is always set in a *vertical* plane; this position of the tail provides a ready means of distinguishing any fish from any cetacean. On the middle of the back of cetaceans there is very frequently a fleshy eminence, the dorsal or back fin, which may be triangular

or sickle-shaped, but is never supported by any internal skeleton (Fig. 2). There is no structure corresponding to the anal fin of a fish.

The fore-limbs of a cetacean are modified to form flippers, which are superficially like the pectoral fins of a fish, but within their solid flatness, instead of the irregularly arranged cartilages or bones of the pectoral fins, may be found the bones that constitute the limb skeleton of a typical land mammal; upper arm, fore arm, wrist and finger bones are all present (Fig. 3). No external trace of hinder limbs remains, but within the body in the neighbourhood of the vent two small bones, entirely free from the backbone, represent the two halves of the pelvis, and, occasionally associated with them, are small nodules of bone—all that remains of the leg bones.

In the vast majority of fishes the propulsion of the body is brought about mainly by means of lateral flexions of the muscular tail, aided by movements of the caudal fin. That is to say, the tail is lashed vigorously from side to side in order to drive the fish forward. The cetaceans swim in much the same way, but the movements of the tail are in a different plane. The horizontal position of the flukes is undoubtedly associated with the necessity for the whale to rise to the surface of the water periodically to renew the supplies of air to the lungs. The dorsal and anal fins of a fish, and probably also the back fin of the whale, normally serve as keels, and their purpose is to give stability to the body, but some fishes with fairly long and flexible fins make use of wave-like movements of these fins to propel the body at slow or moderate speed. The pelvic fins of a fish assist the dorsal and anal in keeping the body balanced, and appear to function after the manner of bilge keels. The pectoral fins, like the flippers of a cetacean, are probably used mainly for steering and balancing, but also act as brakes to check forward movement.

The head of a fish or a cetacean, although presenting great diversity in size and appearance, possesses all the usual organs that might be expected in a Verbetrate animal—snout or muzzle, nostrils, eyes, mouth and so on. In a fish the nostrils are scarcely ever used for breathing purposes, and serve merely as organs of smell. In a cetacean the nostrils form a single or double opening called the blowhole, and are situated, almost

without exception, on the highest point of the head and usually at some distance from the tip of the snout (Fig. 2). The eye of a fish is built on the same general plan as that of other Vertebrates, but is somewhat modified for vision under water. Neither fishes nor cetaceans show any traces of external ears. In a fish there is no visible external aperture, and the internal organ associated with the sense of hearing is of comparatively simple design. In a cetacean the aperture is situated between eye and edge of flipper, and is so small and inconspicuous that even in a 100-foot monster its diameter is not greater than that of a lead pencil.

The mouth, both in fishes and cetaceans, varies greatly, not only in size and shape, but also in position. In fishes the jaws are usually provided with teeth of one form or another. Among the cetaceans, teeth are present only in the members of the sub-order Odontoceti, the Toothed Whales (p. 256), and, although they are very variable in number and size, they do not show any differentiation into incisors, canines and molars in any living species. They are all uniform, usually conical in shape, and the range in number extends from 1 to more than 50 in a tooth row. Teeth may be present in both jaws, or they may be restricted to either the upper or the lower jaw. In certain forms such teeth as persist are concealed beneath the gums throughout life, so that the animals appear to be toothless. The members of the sub-order Mystacoceti, the Whalebone Whales, feed in quite a different manner, and instead of teeth, the characteristic whalebone or baleen is developed. This is horny in structure, and is suspended in two rows of flattened plates from the under surface of the rostrum (p. 203). The two skulls illustrated here (Figs. 4, 5) show the main differences between the mouths of the Whalebone and Toothed Whales.

With the organs of respiration we encounter one of the most important differences between the fishes and cetaceans. The fish obtains the oxygen necessary for life from the air dissolved in the water by means of special organs known as gills. When a fish breathes, water is taken in through the mouth, and, after passing over the gill-plates or gill-filaments, is expelled through the external gill-openings in the sides of the " neck ". These plates are richly supplied with fine blood-vessels, in which the

blood is separated from the surrounding water only by a delicate membrane. As the water bathes the plates, the blood absorbs the necessary oxygen, and at the same time liberates the waste products from the body in the form of carbon dioxide.

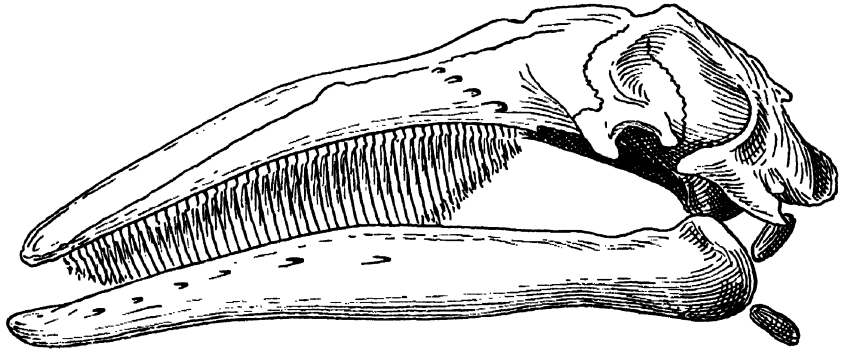


FIG. 4.—Skull of a Whalebone Whale (Californian Grey Whale).

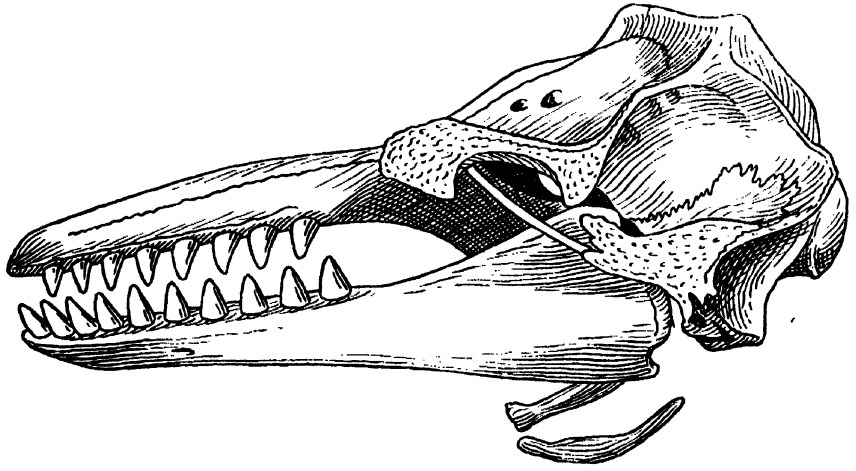


FIG. 5.—Skull of a Toothed Whale (False Killer Whale).

The principle of respiration is essentially the same in all fishes, but the form and arrangement of the gills is somewhat different in the Selachians and the Bony Fishes; these differences are illustrated in the accompanying diagrams (Fig. 6). Briefly, in Selachians, the walls of the gullet are perforated on each side by a row of from 5 to 7 narrow openings, the internal gill-clefts, each of which leads into a kind of flattened pouch,

which in turn communicates with the exterior by a comparatively narrow cleft, the external gill-cleft or external gill-opening. There are, thus, from 5 to 7 external openings in the sides of the " neck ". The jointed gristly structures

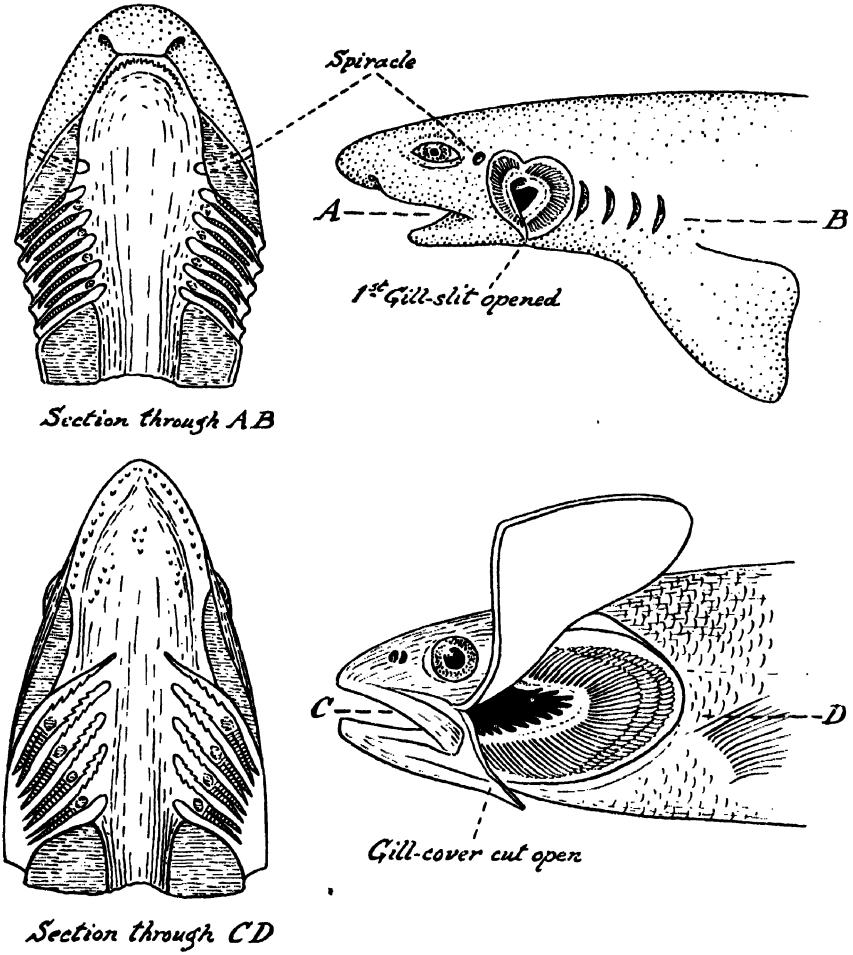


FIG. 6.—Respiratory organs in a Shark and a Bony Fish.

known as the gill-arches lie between the gill-pouches, and encircle the walls of the gullet like hoops to provide supporting girders. The gill-plates are placed on the opposing walls of each of the gill-pouches. In the Bony Fishes there is the same series of internal openings in the walls of the gullet, but, instead of opening directly to the exterior by a similar number

of external gill-clefts, they all open into a common branchial chamber on each side, with a single external gill-opening at the back of the head. The outer wall of this chamber is usually provided by a movable bony flap, the gill-cover or operculum, and, if this is lifted up, the delicate red gill-plates, attached in double rows to the outer edge of each of the hoop-like bony gill-arches, may be observed crowded together in the underlying cavity.

In those fishes whose normal food consists of more or less minute creatures swimming in the water, there is clearly a danger of some of these escaping by way of the gill-clefts and perhaps clogging or injuring the delicate gill-plates. To lessen this danger special structures known as gill-rakers may be present, which function in exactly the same way as the baleen plates of the whalebone whales, and serve to strain the water, which is to pass over the gills, and to prevent any solid particles from passing with it. These gill-rakers take the form of a double row of more or less stiff appendages on the inner edge of each hoop-like gill-arch, which project across the inner openings in the walls of the gullet. In fishes that feed upon minute animals and plants the gill-rakers form long, slender bristles, and are very numerous and set close together; in those whose food consists mainly of other fishes the rakers are few in number, stouter, and set wider apart, or they may even be reduced to a few bony knobs.

Mention may be made here of the organs known as spiracles, which are found in many of the Selachians, but in only one or two Bony Fishes. There is one spiracle on each side of the head, and this takes the form of a (usually) small opening situated close behind the eye. The spiracle actually represents the vestige of what was once another external gill-cleft.

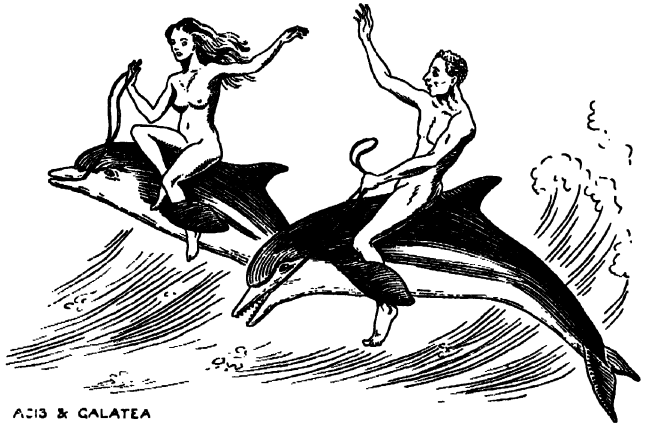
The cetacean obtains its supplies of oxygen from the atmospheric air by means of lungs like any other mammal, the air being taken in by way of the blowhole. The channel from nostrils to lungs is modified so that the windpipe extends to fit round the hinder end of the nasal canal. In this way a continuous connection is made between blowhole and lungs, so that no water can get into the latter by way of the mouth. The blowhole is closed by an elaborate set of pocket valves when the animal is submerged.

The internal skeleton of a fish calls for little or no comment here, and for details of the various bones the reader is referred to a good text-book of zoology. In the cetaceans the bones are spongy in texture and in form rather simplified, so that, in the backbone, for instance, the elaborate articulation between one bone and the next, common in ordinary land mammals, tends to be lost. The skull is very specialized, as may be seen in the accompanying figures (Figs. 4, 5), and the articulation of the lower jaw with the skull is much less complicated than in most land mammals. The 7 vertebræ of the neck are very much compressed. They remain distinct in the more primitive members of the group, but in the rest the first 2 or 3 may be fused, or all 7 merged into one bony unit. The sacrum of land mammals, formed by the fusion of vertebræ between the trunk and tail elements of the backbone, is completely wanting in cetaceans; all the vertebræ in this region are separate, changing gradually in form from trunk to tail.

Of the internal organs it will be necessary to mention only the air-bladder, an organ peculiar to Bony Fishes, and of considerable importance in classification. When present, this has the form of a long, cylindrical bag, with glistening silvery walls, situated within the body-cavity and just below the backbone. This bladder is filled with a mixture of gases, and in the majority of fishes serves as a hydrostatic organ or float, enabling its possessor to accommodate itself to the varying pressure encountered at different depths. In a few forms, however, it serves as an accessory breathing organ, functioning exactly like a true lung. The air-bladder may be connected with the gullet by a narrow pipe, or it may be entirely enclosed.

Finally, in the possession of mammary glands and teats, by means of which they can suckle their young after birth, the cetaceans differ from all the fishes, in which no such organs are developed. Even if the young of fishes are brought forth alive, they are never suckled by the mother. The paired mammary slits of the cetacean lie on either side of the genital opening, and give access to little cavities in which lie the retracted teats. There are two apertures on the under surface of a whale, situated about two-thirds to three-quarters of the body length from the snout; the one nearer the head is the

genital aperture, the other the vent or anus. It is possible to distinguish the sex by the distance between the two apertures, these being closely approximated in the female and farther apart in the male. There is a modification in these aquatic mammals of the normal manner of suckling the young, necessitated by the environment in which they live. The mammary glands have large sinuses or reservoirs, in which the milk collects, and which, by the contraction of certain body muscles, are forcibly emptied by way of the teat into the mouth of the young, so that the whole process of feeding is greatly accelerated.



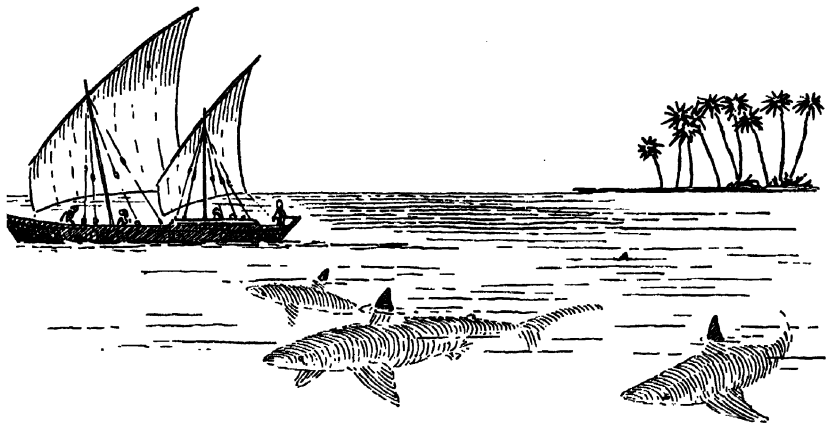
ACIS & GALATEA

Part I

GIANT FISHES

BY

J. R. Norman, F.L.S., F.Z.S.



CHAPTER I: SHARKS.

Characters of Selachians. General features of the Sharks. Comb-toothed or Cow Sharks. Six-gilled Shark or Griset. Seven-gilled Shark or Perlon. Sand Sharks and Elfin Sharks. Sand Sharks or Slender-toothed Sharks. Elfin or Goblin Shark. Mackerel Sharks. Porbeagles and Mako Sharks. Great White Shark or Man-eater. Basking Shark. Thresher or Fox Shark.

WE have already seen that the Sharks, together with their relatives the Rays and the small and little-known fishes called Chimæras, constitute a distinct class, Selachii, and may be collectively described as Selachians, a name derived from the Greek word meaning a shark. The other two classes covered by the popular term "fishes" are the Marsipobranchii (Lampreys and Hag-fishes) and the Pisces (Bony Fishes). The Marsipobranchii will not concern us here, as the members of this group are all of small or moderate size, but we may briefly indicate the principal differences between a Selachian and a Bony Fish—between, say, a Shark and a Tarpon.

The skeleton of a Shark is entirely cartilaginous or gristly, and, although it is sometimes strengthened by the addition of limy matter, there are never any true bones. The slits in the walls of the gullet in the Shark open directly to the exterior by a corresponding series of external gill-openings, 5 to 7 in

number, situated on each side of the hinder part of the head; whereas, in the Tarpon these open into a common branchial chamber on each side, protected on the outside by a bony gill-cover or operculum, and with a single opening to the exterior at the back of the head. The Shark has a single nostril on each side of its snout; the Tarpon (but not quite all Bony Fishes) has two. There is no air-bladder in the Shark, but this organ is developed in the majority of Bony Fishes. The male Shark is provided with curious organs called "claspers", organs which are unknown in Bony Fishes. Finally, instead of being covered with overlapping scales as in the Tarpon, the body of a Shark is armed with numerous closely-set bony nodules, known as dermal denticles. The claspers, dermal denticles, and the teeth of Selachians are worthy of further consideration.

Unlike the generality of Bony Fishes, the eggs of a Shark or Ray are fertilized within the body of the female as in most higher animals, and there is consequently a definite union of the sexes. The claspers of the male, which are actually modified portions of the pelvic fins and have a highly complicated internal structure, are used for the purpose of introducing the seminal fluid into the body of the female.

The surface of a Shark or Ray is nearly always rough or prickly to the touch, and this is due to the presence of the innumerable tiny denticles embedded in the skin and covering the whole of the head, body and parts of the fins. These denticles are usually arranged in regular oblique rows, and, examined with a hand lens or under the microscope, each may be seen to consist of a bone-like base, which is embedded under the skin, and therefore invisible during life, and a superficial enamel-covered spine, which projects freely outwards and backwards. An even more intimate examination of one of the denticles reveals that in its structure it is essentially similar to one of the teeth in the jaws, being made up mainly of a substance known as dentine, with an internal pulp cavity and an outer coating of enamel. Thus, the very interesting fact emerges that the teeth of Selachians and Bony Fishes, indeed of all higher animals, including ourselves, must have arisen in the first place from the dermal denticles of the Shark's skin, the denticles in the region of the jaws having

become enlarged or joined up with their neighbours to form the teeth.

Another feature of interest concerning the teeth of Selachians is the fact that instead of being more or less firmly attached to the jaws they are simply embedded in the gums. Further, a Shark does not retain the same set of teeth throughout the greater part of its life, nor is it content with two sets like ourselves, but provision is made for a constant supply of new teeth to replace those in use—a most enviable arrangement! If the jaws of a large Shark be examined, the young teeth can be seen lying in a shallow cavity on the inner surface of the jaw closed by membrane (Fig. 59). They lie closely packed, one on top of another, with their points directed downwards in the lower jaw, upwards in the upper jaw. Those near the edges of the jaws can be seen to be in a more advanced stage of development and in a more erect position than those further back, and are, in fact, all ready to take the place of the row at present in use as soon as these shall be worn out and cast off. The forward movement of the whole phalanx of teeth goes on throughout life, a row or two doing duty for a time, only to be replaced by their successors, standing by, as it were, in the rear!

The number of different kinds of Selachians living to-day is far less than that of the Bony Fishes, but the class includes, nevertheless, a large and diverse assortment of types. The origin of the class may well be said to be wrapped in the mists of antiquity, for our knowledge of the earliest Sharks is based upon the discovery of isolated denticles, teeth, fin-spines and so on, buried as fossils in the rocks of the Silurian and Devonian periods of the earth's history. Since there is reason to believe that these rocks were laid down at least 200,000,000 years ago, the class is a very ancient one, and the very diversity of the fossils suggest that even at this remote age there already existed a wealth of different kinds of Sharks.

Unlike the Bony Fishes, comparatively few Selachians can be described as of very great value to mankind. Some of the smaller Sharks and Rays, it is true, provide wholesome and nutritious food, and in parts of the Orient there is quite a respectable trade in shark-fins for use in making soup. The crude skins of certain Sharks and Rays, with the dermal

denticles *in situ*, are used by carpenters and cabinet-makers, as well as by metal-workers and others, while the dyed skins, suitably prepared, provide a handsome shagreen for ornamental purposes. With the denticles removed, and after undergoing a special tanning process, the skins of certain Sharks and Rays provide a strong and durable leather, and there is nowadays a brisk demand for shoes, bags and other articles made from this commodity.

All the existing Sharks are grouped into a single order, the Pleurotremata (literally " side openings "), and may be readily distinguished from the Rays, which form the second order of existing Selachians, the Hypotremata (literally " under openings "), by the position of the external gill-clefts, which are placed on the sides of the head ; by the free front edges of the pectoral fins, which are never joined to the sides of the body or head ; and by the distinct margins of the eyes. The order Pleurotremata includes a number of genera and species, ranging from veritable monsters 50 feet or more in length to comparative dwarfs scarcely more than 2 feet long. Sharks are to be found in nearly all the seas of the world, and at most depths ; a few even ascend rivers beyond the influence of the tides, and at least one lives permanently in fresh water. The great majority are active animals, chasing and hunting down their prey, aided by a very well-developed sense of smell. All have a carnivorous diet, but the food taken varies from shellfish and tiny shrimp-like creatures to fishes, marine mammals and even man himself, and includes also a good deal of carrion and garbage. Most of the larger Sharks are viviparous, that is to say the eggs hatch within the body of the mother and the young are brought forth alive, but many of the smaller kinds produce large yolky eggs, which are deposited in horny protective cases.

COMB-TOOTHED OR COW-SHARKS.

(Family HEXANCHIDÆ.)

Sharks with a comparatively long body and a long unequally lobed tail. The snout is pointed and overhangs the mouth, which is large and not connected by grooves with the nostrils.

The teeth are different in the two jaws, but are mostly flattened and more or less comb-like in character (Fig. 59). The spiracles are small, and the external gill-clefts, 6 or 7 in number on each side, are all placed in front of the pectoral fins. There is only 1 dorsal and 1 anal fin, and both are without spines. There is no pit at the root of the caudal fin.

The Comb-toothed Sharks are found in all warm seas, but as a rule are not numerous. All are viviparous. Fossil remains, mostly teeth, date back to the Cretaceous period.

SIX-GILLED SHARK OR GRISET.

(Genus *Hexanchus*.) Fig. 7.

There are 6 external gill-clefts on each side. The coloration is uniformly dark brownish-grey or black above, shading to paler below; there is usually a pale streak along the middle of each side. Young individuals are brown.

Grows to a length of 26 feet or more.

The single known species (*H. griseus*) is found in the Mediterranean, Atlantic and Pacific. The so-called Shovel-nosed Shark (*H. corinus*) from the coast of California is probably only a variety.

Little is known of the habits of this shark, but it is believed to be fierce and voracious, and to feed almost entirely upon fishes. It occasionally strays close to the British coasts, especially in the summer months, and there is a record of one, 26 feet 5 inches long, caught at Polperro, Cornwall, in February, 1846. It is of no use as food, and those who have sampled the flesh report a strong purgative effect.

SEVEN-GILLED SHARK OR PERLON.

(Genus *Heptranchias*.) Fig. 8.

There are 7 external gill-clefts on each side. The coloration is brown or grey above, shading to paler below; the back, especially in the young, is sometimes provided with small, scattered, dark spots.

Grows to a length of more than 10 feet.

The Perlon (*H. perlo*) is found in the Mediterranean, in the

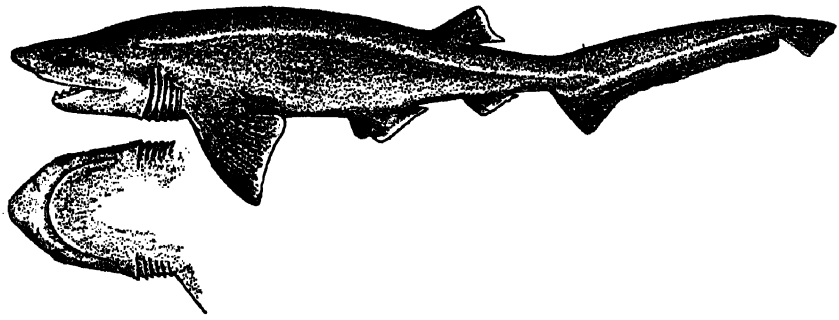


FIG. 7.—Six-gilled Shark or Griset (*Hexanchus griseus*).

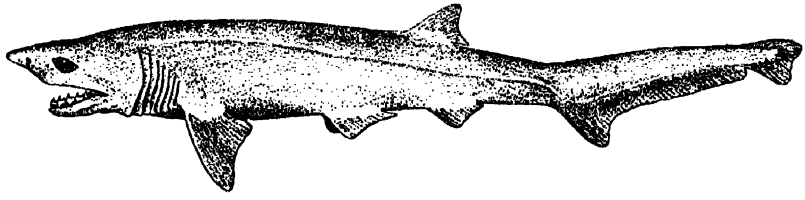


FIG. 8.—Seven-gilled Shark or Perlon (*Heptranchias perlo*).

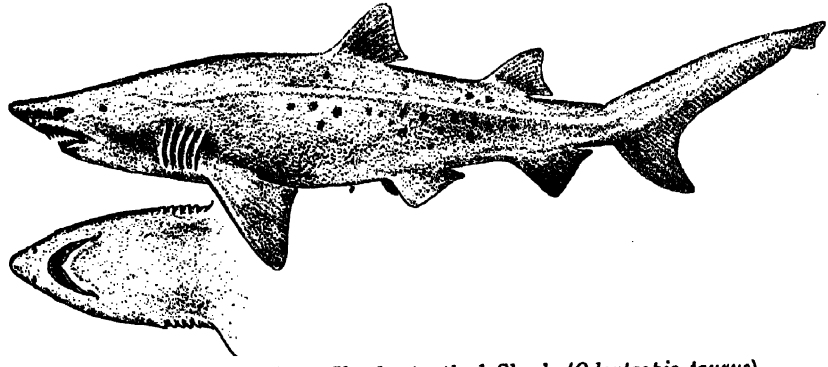


FIG. 9.—Sand Shark or Slender-toothed Shark (*Odontaspis taurus*).

Atlantic, and in the neighbourhood of Japan. Other species of Seven-gilled Sharks (*H. platycephalus*, *H. pectorosus*) occur in the Mediterranean, Indian Ocean, Eastern North Pacific, Patagonia, Australia and New Zealand.

Like the Griset, this shark is a fish-feeder. One species is not uncommon round the North Island of New Zealand, where the Maoris called it *Tuatini*, and are reported to have used its teeth to make a saw-like instrument (*Ripi* or *Mira tuatina*) for cutting human flesh. It is of some interest to note that, whereas in South Australia this shark is regarded as dangerous to man, in New Zealand the same species is recorded as harmless. In Japan the Perlon is known as the " Aburazame " or Oil Shark, on account of the oil yielded by its liver.

SAND SHARKS AND ELFIN SHARKS.

(Family ODONTASPIDÆ.)

Sharks with a long body, flattened head, and sharp snout. There is no third eyelid, and no grooves connecting the mouth with the nostrils. The mouth is large and crescent-shaped, and lies below the snout. The teeth are large, long, slender, and roughly awl-shaped, with smooth edges ; most teeth have 1 or 2 small points at the base on either side of the main cusp (Fig. 59). The spiracles are small. The external gill-clefts are 5 in number on each side, and are all placed in front of the pectoral fins. There are 2 dorsal fins, which are nearly equal in size and without spines, and 1 anal fin. The tail is not provided with a keel, is long and flattened, and is asymmetrical in shape.

These sharks are found in nearly all warm seas, and are believed to be viviparous. Fossil remains date back to the Cretaceous period.

SAND SHARKS OR SLENDER-TOOTHED SHARKS.

(Genus *Odontaspis*.) Fig. 9.

The snout is short, and the mouth is capable of being protruded only to a moderate extent. The dorsal, anal and pelvic fins are all nearly equal in size. There is a pit at the

root of the caudal fin, and the lower lobe of the fin itself is distinct. The coloration is grey above, becoming paler beneath. The young are spotted and blotched with brown or black.

Grows to a length of 10 to 12 feet.

The Common Sand Shark (*O. taurus*) is found in the Mediterranean, in the Atlantic and in South African seas. Other species (*O. ferox, O. cuspidatus, O. owstoni, O. platensis*) are found in the Mediterranean, Indian Ocean, Japan, South America, and in Australian and New Zealand seas. Some of these other species appear to grow to a somewhat larger size.

The Sand Sharks are mostly of small or moderate size, but are of voracious habit, and subsist mainly upon a fish diet, although lobsters, crabs and squids are also eaten. While the vast majority of sharks appear to chase and seize their prey in a more or less haphazard manner, the Sand Shark may be said to be at times distinctly methodical in its manner of feeding. Mr. Coles describes how he saw a school of a hundred or more at Cape Lookout on the coast of New Jersey which surrounded a shoal of bluefishes, and forced them into a solid mass in shallow water, and then the entire school dashed in and attacked the prey. In Australian waters the sharks are said to attack schools of the fishes known locally as " Sea Salmon " or " Kahawai " as they migrate northwards in the summer-time near the beaches, causing great havoc among the fish. In this part of the world the two species of Sand Sharks are known respectively as " Grey Nurse " and " Blue Nurse ", and both have the reputation of being dangerous to bathers. The word " nurse ", sometimes written as " nusse ", is simply an ancient term for any large fish, and does not imply that the shark would be reliable with children! Mr. Stead writes of the Grey Nurse that " these ' wolves of the sea ' rove along the eastern shores of Australia at least in thousands, freely entering harbours ". They are at times a great nuisance to fishermen, especially along the Atlantic coast of the United States, as they bite readily at a hook and are very destructive to nets. They are of little value to man, although the skin makes a good leather.

ELFIN OR GOBLIN SHARK.

(Genus *Scapanorhynchus*.) Fig. 10.

The snout is long and the mouth is capable of being greatly protruded. The dorsal fins are smaller than the pelvics or the anal. The pit at the root of the caudal fin is indistinct and the lower lobe of the fin itself is not very prominent. The coloration is generally greyish-brown, with the lower parts somewhat paler. The fins are all darker towards their edges.

Grows to a length of about 14 feet.

The single known species (*S. owstoni*) is well known in Japan, and has also been recorded from the Indian Ocean. It probably has a much wider distribution in warm seas, for a second species which has been described from deep water off the coast of Portugal is probably identical.

Originally discovered in 1898, this curious shark, locally known as " Tenguzame ", is taken from time to time in the warm Black Current or gulf stream of Japan. Its occurrence in the Indian Ocean was recorded in an unusual way. A " break " occurred in one of the submarine telegraph cables lying at a depth of about 750 fathoms on the ocean floor, and when the cable was brought to the surface for examination the damage was found to have been caused by a shark, one of whose broken teeth was lodged between the coils of wire protecting the cable. Closer examination of this tooth revealed its owner to have been an Elfin Shark. Little is known of the feeding habits of this creature, but, judging by the form of its curiously protrusible jaws, and the flat blade-like snout, it seems likely that it is mainly a ground feeder, and the supposition is that in the case quoted above the shark pierced the cable when feeding on barnacles or other succulent forms of animal life growing on its outer cover. It is of interest to note that the Elfin Shark is a survivor of a very ancient type, for fossil sharks have been found in Cretaceous rocks which are essentially similar to the form existing to-day.

MACKEREL SHARKS.

(Family LAMNIDÆ.)

Very similar to the Sand Sharks, but with a stout, torpedo-shaped body, and usually with a strong keel on each side of the tail. The spiracles are minute or absent altogether. Where the external gill-clefts are small, the fifth or last is placed just above the root of the pectoral fin; where they are large, the last extends downwards just in front of the base of the fin. The second dorsal fin is much smaller than the first, and is placed nearly opposite to the anal. The caudal fin is roughly moon-shaped, with the lower lobe but little shorter than the upper, or the upper lobe is very long and the lower quite short. The pectoral fins are sickle-shaped.

These are large surface-swimming sharks, found in most of the seas of the world. All are believed to be viviparous. Most of the genera appear to date back to the Cretaceous period.

The general shape of these sharks, with their powerful tails, suggests active, predaceous creatures, capable of producing a high rate of swimming when required. The torpedo-like, streamlined body is eminently suited for rapid progression in a comparatively dense medium such as water, and the pointed snout overhanging the mouth provides an efficient cutwater which greatly facilitates progress. The coloration is practically the same in all the members of the family, being a dark bluish-grey on the back, shading away gradually to white on the lower parts. This is the typical coloration of most pelagic fishes, that is to say of fishes that habitually live at or near the surface of the sea, and illustrates the principle of what is known as obliterative shading. The shading is exactly the reverse of that which is produced by light thrown upon the fish from above, and its general effect is to destroy the appearance of thickness and to make the creature appear as a flat object. This type of coloration also tends to conceal the fish in its natural surroundings, for, seen against a background of dark water coloured very much like its own back, it is almost indistinguishable.

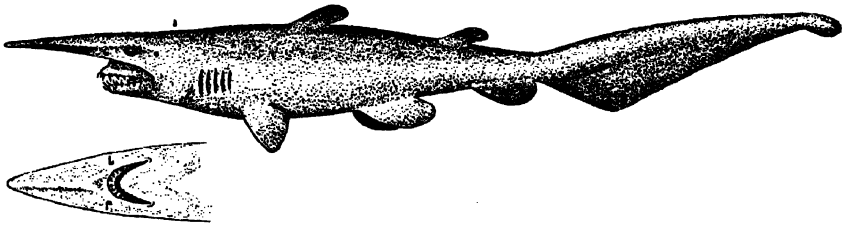


FIG. 10.—Elfin or Goblin Shark (*Scapanorhynchus owstoni*).

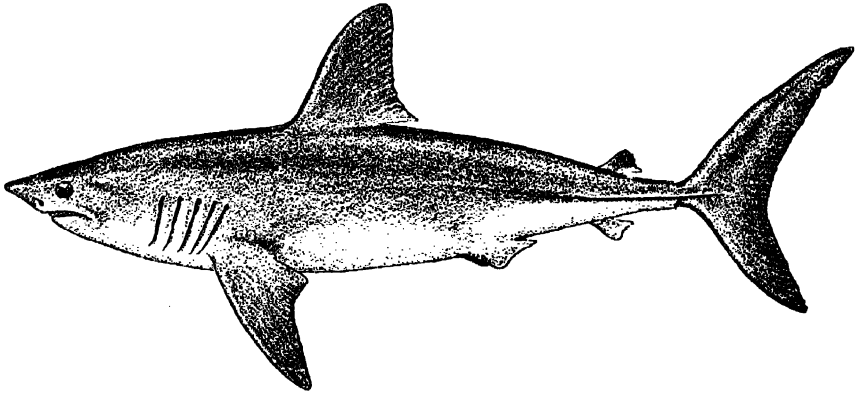


FIG. 11.—Common Porbeagle (*Lamna cornubica*).

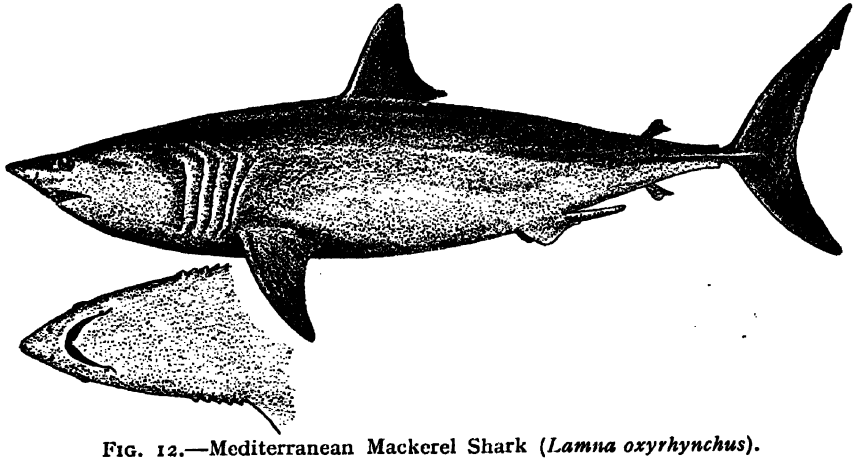


FIG. 12.—Mediterranean Mackerel Shark (*Lamna oxyrhynchus*).

PORBEAGLES AND MAKO SHARKS.

(Genus *Lamna*.) Figs. 11, 12.

The snout is pointed and overhangs the large, crescentic mouth, which is armed with large, slender, awl-shaped teeth, with smooth edges (Fig. 59); sometimes the teeth have a pair of small points at the base. There are 3 or 4 rows of teeth in use at a time, and these point either directly down the throat or towards the roof of the mouth. The external gill-clefts are wide. The coloration is dark bluish-grey above, shading to white beneath.

Grow to a length of 12 feet or more.

The Common Porbeagle (*L. cornubica*) is found in the Mediterranean, North Atlantic and North Pacific; the American Porbeagle (*L. punctata*), sometimes referred to locally as " Blue Shark ", is found on the eastern coasts of the United States; the Sharp-nosed Mackerel Shark (*L. tigris*) ranges from Cape Cod to the West Indies; the Blue Pointer or Mako Shark (*L. glauca*) inhabits the seas of Australia and New Zealand; and the Mediterranean Mackerel Shark (*L. oxyrhynchus*) is found in the Mediterranean and the adjacent parts of the Atlantic.

The Common Porbeagle is not uncommon round the coasts of the British Isles. It is also known as the Beaumaris Shark, as Pennant, in his ' British Zoology ', published in 1776, described a specimen from that district of North Wales. The fishermen sometimes refer to it as the " Bottle-nosed Shark ".

All the Porbeagles and their allies are fierce, voracious sharks, and feed mainly upon fishes; herring, cod, whiting, hake, mackerel and dogfish being the favourite food; squids and cuttlefishes are also included in the diet of some species. On the British coasts the Porbeagle is frequently captured in mackerel and salmon nets, or on lines that have been laid to catch bottom-living food-fishes, and when they entangle themselves in drift or gill-nets, and roll themselves up into an inextricable mass of twine, they can be a perfect nuisance to the fisherman. It is recorded that a shark taken in the cod gill-nets in the Firth of Forth at the beginning of the present century had in its stomach no less than eleven hooks with

their attached hair " snoods ", the fish having passed along the fisherman's line and removed the catch by biting through the snoods. In Alaska its ravages among the salmon have earned for it the name of " Salmon Shark ".

Porbeagles and Makos are usually observed in small companies, although they can scarcely be called gregarious; sometimes a single shark will pursue its prey alone. The teeth are not adapted so much for cutting as for seizing the prey, which seems to be swallowed whole—a tribute to the digestive powers of this shark ! The Mako is said to be a lover of the open sea, where it dashes madly after its food, and does not hesitate to attack boats, in the woodwork of which it not infrequently leaves some of its teeth. Most of the species are savage and dangerous to man, although the Porbeagles found close inshore in our own seas are mostly too small to cause much damage. Mr. Couch once wrote : " I have been informed of an instance, where in the prospect of being taken, it sprang at a fisherman and tore a piece out of his clothing."

Little is known as to the exact breeding season of these sharks, but it has been ascertained that from 2 to 5 young are produced at a single birth.

The Porbeagles are of no great economic importance. They are not normally used for food, although the flesh was at one time esteemed in some parts of France. One observer even describes the Common Porbeagle as emitting " an extremely disagreeable fetid smell ", and the ultimate fate of individuals captured by fishermen, if they are not killed and thrown back into the sea, is to be used as manure. In some parts of the world the oil from the liver used to be prized by curriers, but this minor industry has long since died out. It is of interest to note, however, that the liver of a 9-foot shark yielded as much as 11 gallons of oil. The Maoris of New Zealand use the teeth of the Mako Shark as articles of adornment.

At least two members of this genus provide good sport for the sea angler. The Common Porbeagle is taken on rod and line on the west coast of Ireland, and to play a large shark from a small boat is no mean test of the angler's strength and skill. In the fish gallery at the British Museum there is a plaster cast of a fine specimen of 210 lb., which was taken in this manner by the Marquis of Sligo in 1932 off Achill Island,

co. Mayo. The Mako is still more famous as a game-fish, and in New Zealand waters provides strenuous and exciting sport. The world's record Mako Shark captured by fair angling stands to the credit of Mr. White-Wickham. It was taken in the Bay of Islands in January, 1931, was 11 feet 6 inches in length, and weighed 798 lb.

The scientific name *Lamna* is derived from a Greek word for a horrible monster of man-eating tendencies, a creature used by the ancient Greeks to terrify naughty children. The term " Porbeagle " is simply a combination of porpoise and beagle, and refers to the porpoise-like appearance and active, predaceous habits.

GREAT WHITE SHARK OR MAN-EATER.

(Genus *Carcharodon.*) Fig. 13.

Similar in appearance to the Porbeagles and Mako Sharks, but may be readily distinguished by the large, flat, triangular teeth, with fine, saw-like edges (Fig. 59). The coloration is bluish-grey or slaty grey above, shading to white beneath; the fins are nearly all darker towards their edges.

Grows to a length of 40 feet or more.

The single living species (*C. rondeleti*) is found in all the warm seas of the world, and occasionally strays into more temperate waters.

The Great White Shark, sometimes called the White Pointer, is just as swift and fierce as the Porbeagles, but is very much larger and more powerful. The huge, strong jaws, with their jagged knife-like teeth, are truly formidable weapons. There is a pair of jaws in the British Museum collection which belonged to a shark 36 feet in length, and the largest single tooth in either jaw is nearly 3 inches long. The " Challenger " Expedition dredged some teeth from the floor of the Pacific Ocean which measured no less than 5 inches in length, and these must have belonged to a shark nearly 100 feet long. Fossil teeth from the rocks of the Eocene period and later are even larger, and indicate that veritable monsters must have roamed the seas in these times.

The food of the Great White Shark consists mainly of fishes of

all kinds, but the late Professor Jordan has recorded a specimen taken near Soquel, California, in 1880, which had a young sea lion in its stomach. Mr. Coles mentions a large shark more than 20 feet in length seen by him near Cape Lookout, North Carolina, in 1905, which he believed to be a Man-eater. "It apparently had no fear of us," he writes, "as it struck the side of the skiff with some force. It then swam away for a distance of several hundred yards, then turned and swam rapidly towards us. I was about to fire into it as a large loggerhead turtle arose to the surface and was attacked by the shark. The shark seized the turtle in its jaws and both disappeared beneath the surface. The next day I harpooned this turtle and found the upper shell for a width of nearly 30 inches showing the marks of the shark's teeth. The edge of the shell and the right hind flipper had been torn away."

Further testimony as to the voracious habits and catholic diet of this shark is provided by the late Sir Frederick McCoy, who wrote as follows concerning a specimen from Port Phillip, Australia: "A specimen between 15 or 16 feet long had been observed for several days swimming around the ladies' baths, looking through the picket fence in such a disagreeable manner that the stationmaster had a strong hook and iron chain made so as to keep the rope out of reach of his teeth, and this, being baited with a large piece of pork made to look as much like a piece of lady as possible, was swallowed greedily, and then, with the aid of a crowd of helpers, the monster was got on shore. On opening the stomach, amongst a load of partially digested objects, a large Newfoundland dog was found, with his collar on, identifying him as one lost the day before, no doubt swallowed while enjoying a swim in the comparatively shallow water."

Perhaps the queerest meal of all is one mentioned in what must rank as one of the most remarkable of all shark stories. This is vouched for by Mr. Frank Cundall, Secretary of the Institute of Jamaica, and though the shark was never identified it may well have been a Man-eater: "In the eighteenth century an American privateer was chased by a British man-of-war in the Caribbean Sea, and, finding escape impossible, the Yankee skipper threw his ship's papers overboard. The privateer was captured and taken into Port Royal, Jamaica, and the

Captain was there placed on trial for his life "—(Mr. Cundell says " for violation of the Navigation Laws "). " As there was no documentary evidence against him he was about to be discharged when another British vessel arrived in port. The Captain of this cruiser reported that when off the coast of Haiti a shark had been captured, and when opened the privateer's papers had been found in the stomach. The papers thus marvellously recovered were taken into court, and solely on the evidence which they afforded the Captain and crew of the privateer were condemned. The original papers were preserved and placed on exhibition in the Institute of Jamaica in Kingston, where the ' shark's papers ', as they were called, have always been an object of great interest. (*Signed*) A. Hyatt Verrill, New York, Nov. 20, 1915."

According to the great Swedish naturalist, Linnæus, it was the Man-eater Shark that swallowed the prophet Jonah, but this is only one of several claimants to credit for this feat. " Jonam Prophetum," he writes, " ut veteris Herculem trinoctem, in hujus ventriculo tridui spateo baeisse, verosimile est."

The question as to whether or no a shark will attack and devour a man is one which has always been hotly debated, and which still remains a matter of considerable controversy. The normal diet of nearly all sharks consists of living animals, but not a few will turn scavenger when occasion offers, and will follow ships for days at a time in the hope of securing food thrown overboard. The presence of unusual numbers of dangerous sharks in Sydney Harbour at one time was believed to be due to the discharge of blood and offal from the local abattoirs into the harbour waters, and there can be little doubt that sharks with their keen sense of smell may be attracted by the scent of blood. The stomach of one Great White Shark was found to contain " a tin can, a number of mutton bones, the hind quarters of a pig, the head and fore-quarters of a bull-dog, a quantity of horseflesh, and other and smaller things—as the auction bill says—too numerous to mention "—eloquent testimony to this shark's powers as a scavenger. It must be admitted that the bodies of drowned men and women would not come amiss to a hungry shark, and human corpses partially eaten after death are perhaps

responsible for some of the stories of men killed and eaten by " man-eaters " ! Nevertheless, there are a number of well-authenticated cases of attacks on human beings, frequently resulting in the death of the victim, but it seems likely that the man happened to be particularly handy, as it were, and the shark more than usually hungry.

Mr. Gilbert Whitley, of the Australian Museum, has compiled an interesting list of attacks in Australian waters. " 1920, March 8 . . . Young man. Cleveland Bay . . ." ; " 1920 (or earlier). Head of native in shark's mouth. Thursday Island . . ." ; " 1924, Feb. 13 . . . Woman. Bronte, N.S.W. . . ." ; " 1925, June. Human arm found in shark. Princes Royal Harbour, W.A. . . ." ; " 1930, Dec. Female lunatic's body found bitten after death. Parramatta River, N.S.W." ; these are a few extracts taken at random from his grim list of some 80 cases. Of more than 40 records from New South Wales alone, about one-half of the attacks seem to have been fatal. Mr. Whitley classifies the modes of attack into five categories : (1) taking of surfers on ocean beaches ; (2) taking of bathers in harbours or well up rivers ; (3) bumping of boats, often viciously attacked ; (4) biting of hands, legs, or bodies of bathers ; and (5) net fishermen bitten when hauling in their catch. He further notes that the worst months for attacks are from October to April—the most popular bathing months in that part of the world !

Dr. F. A. Lucas, of the American Museum of Natural History, who has made a long and critical study of " shark stories ", is decidedly more comforting. He admits the existence of a number of well-authenticated records of fatal attacks in tropical seas, but states most implicitly that the danger of being seriously molested in temperate waters is very small indeed. It is noteworthy that at the end of the last century an American, Mr. Herman Oelrichs, offered the sum of $500 " for an authenticated case of a man having been attacked by a shark *in temperate waters* ", but the reward was never claimed ! Mr. Lucas also disposes of one or two popular fallacies concerning shark attacks. " One of the commonest statements," he writes, " is that ' the shark bit off the man's leg as if it were a carrot ', an assertion that shows that the maker or writer of it had little idea of the strength of the

apparatus needed to perform such an amputation. Certainly no shark recorded as having been taken in these waters could possibly perform such an act, though this might occur if a shark thirty feet or more in length happened to catch a man fairly on the knee-joint where no severing of the bone was necessary. The next time the reader carves a leg of lamb, let him speculate on the power required to sever this at one stroke —and the bones of a sheep are much lighter than those of a man." Mr. Lucas goes on to record his disappointment at witnessing the efforts of a 12-foot shark to cut a chunk out of a sea lion. " The sea lion had been dead a week and was supposedly tender, but the shark tugged and thrashed and made a great to-do over each mouthful." His final advice is pertinent : " It is the part of wisdom to keep away from both ends of a captured shark, for a blow of the tail is almost as bad as a bite ".

Although it had been assumed that, like its relatives the Makos and Porbeagles, the Great White Shark was viviparous, it was not until quite recently that the young were observed. In the summer of 1934 a shark was caught at Agamy, near Alexandria, in the Mediterranean, weighing 2½ tons, and of a length of 14 feet. It was only after a struggle lasting several hours that it could be landed by three boatloads of Egyptian fishermen. When it was cut open, 9 young were discovered inside, each 2 feet long and weighing 108 lb. Judging from the published photographs of the mother, and from the size of her babies, there can be little doubt that this was a Great White Shark, which is well known in these waters, and this must be very nearly the first time that the young have been observed.

The Great White Shark is of practically no economic importance. It has been taken on occasions by sea anglers, and the largest specimen taken on rod and line was captured at Brielle, New Jersey, in June, 1935 ; this weighed 998 lb., and was 12 feet long.

The names Great White Shark and White Pointer refer to the pure white colour of its belly. The scientific name, *Carcharodon*, is derived from two Greek words meaning " rough " and " tooth ".

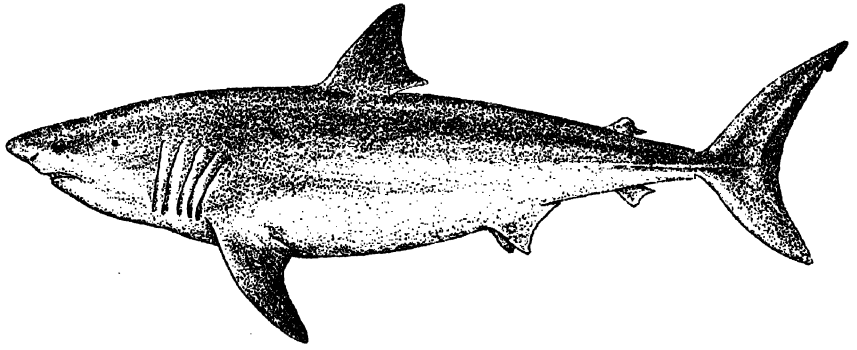


FIG. 13.—Great White Shark or Man-eater (*Carcharodon rondeleti*).

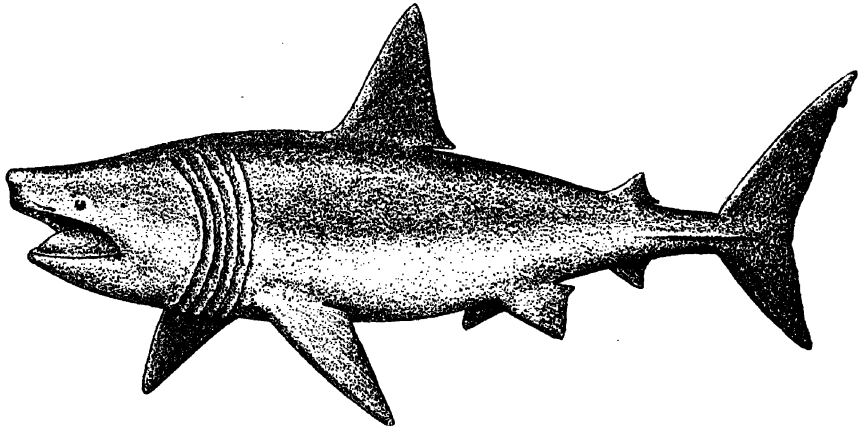


FIG. 14.—Basking Shark (*Cetorhinus maximus*). To 40 feet.

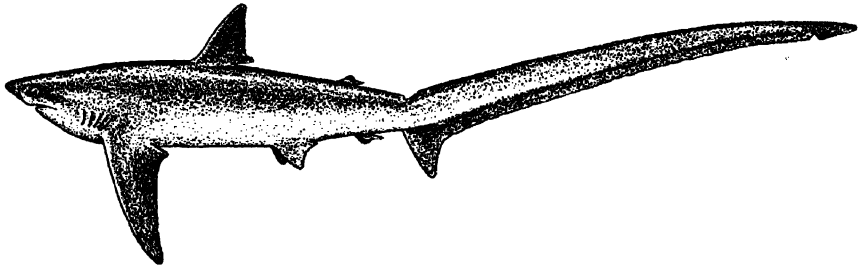


FIG. 15.—Thresher or Fox Shark (*Alopias vulpes*).

BASKING SHARK.

(Genus *Cetorhinus*.) Fig. 14.

The snout is bluntly pointed and overhangs the mouth ; it is especially prolonged in young individuals. The mouth is large, with numerous, very small, conical teeth, set in several rows in both jaws. The spiracles are small and situated behind the eyes. The external gill-clefts are very large, extending nearly right round the neck, and the gill-arches in the walls of the gullet are provided with long, slender, comb-like rakers. The colour is bluish-grey, greyish-brown, or sometimes nearly black on the back, generally becoming paler on the lower parts.

Grows to a length of 40 feet or more.

The single species (*C. maximus*) is found in the temperate seas of both hemispheres, and is especially common in the North Atlantic.

This relatively enormous shark is easily the largest to be found in temperate waters, and is exceeded in size only by the Whale Shark of tropical seas. It is a sluggish and quite inoffensive creature, which derives its name from the habit of lying motionless at the surface of the sea, as if basking in the sun. The inhabitants of Wales and the west coast of Ireland know it as the " Sun-fish " for the same reason, but this name is more properly used for a totally different fish (*Mola*) with similar habits (see p. 183). When " basking " it is generally to be seen with the dorsal fin and sometimes part of the back above the surface, but at times it will lie on its side or even belly uppermost. Sometimes solitary in its habits, sometimes swimming about in twos or threes, at certain times, probably during the breeding season, the Basking Shark may be observed in shoals of 60 to 100 individuals. Its seasonal movements are as yet imperfectly understood, but there appears to be a regular annual migration along the west coast of Ireland to the western isles of Scotland, and thence northwards, the sharks approaching Ireland during the spring and reaching Norway during August.

It is a by no means uncommon spectacle to see two large Basking Sharks swimming one behind the other in tandem fashion, and it is likely that the sight of two large dorsal fins showing above the water about 40 or 50 feet apart has sometimes provided the basis of one more story of the great " sea serpent ", especially if the foremost shark is swimming with his mouth open and his snout projecting above the surface. At the British Museum accounts are received from time to time of gigantic " sea serpents " left stranded by the tide, generally on some remote and inaccessible shore, and these monsters are nearly always described as possessing a long and eel-like body. Some of the descriptions are further elaborated by accounts of a " head just like a camel with an upturned nose ", and a " body covered all over with coarse white hair ". On closer investigation these monsters generally prove to be stranded whales or Basking Sharks in an advanced stage of decomposition, and the covering of hair is seen to be the frayed muscle-fibres produced by the disintegration of the flesh under the action of the waves. As the carcase of the shark rots on the shore, or is buffeted against the rocks, the whole of the gristly skeleton of the jaws and gill-arches, by far the bulkiest part of the head skeleton, as well as that of the pectoral and pelvic fins, is soon washed away, leaving only the backbone and the somewhat curiously shaped box-like cranium to represent the eel-like body and camel-like head respectively. In one or two cases of recorded " serpents " the shark in question was a male, and the remnants of the pectoral fins and of the pelvics with their associated claspers were still attached to the carcase, giving the appearance of fore and hind limbs. Such a monster was found stranded at Stronsay in the Orkney Islands at the beginning of the nineteenth century, and was actually described as an unknown species of animal in a learned journal under the imposing name of *Halsydrus pontoppidiani*. In this case, however, a few of the bones were preserved, and on subsequent investigation these were shown to be vertebræ of a large Basking Shark.

Especially interesting features of the Basking Shark are the minute teeth, the very large gill-clefts, and the curious rakers on the hoop-like gill-arches—features which are found in only one other shark, the Whale Shark already mentioned. These

rakers, each of which is from 4 to 6 inches long, are closely set in a row on each gill-arch, and, as they project across the internal clefts leading into the gullet, they form a very effective sieve or strainer. Their microscopic structure is very similar to that of the teeth. In appearance they recall the baleen plates of the whalebone whales (see p. 203), and have an exactly similar function. Indeed, they provide an excellent example of what is known to scientific men as parallelism: that is to say, the evolution in totally unrelated groups of animals of similar structures designed to serve the same ends. It was the fancied resemblance of the gill-rakers to the whalebone plates that led the older whalemen to call this shark the "Bone Shark", a name still in use in some parts of the world. A study of the normal food of the Basking Shark gives a clue to the meaning of these structures. The diet consists almost entirely of small shrimp-like crustaceans, together with other minute creatures that swarm near the surface of the sea and make up what is known as the plankton. The manner of feeding is simplicity itself, and the Basking Shark has no call to go in active pursuit of its prey like its fish-eating relatives. Swimming among a mass of plankton, with its large mouth wide open, the shark takes in quantities of water with the contained life. This water is forced out through the gill-clefts, leaving the food adhering to the inner walls of the gullet and to the sieve-like gill-rakers, where it can be swallowed at leisure. The water which passes over the gills serves to oxygenate the blood, so that the Basking Shark may be said to feed and breathe by one and the same action!

Nothing is known of the breeding habits of the Basking Shark, but it is assumed to be viviparous like the other members of the family. Very young specimens have never been seen, and it is probable that these stay in deep water until they grow to a fair size. Small individuals, 10 to 15 feet in length, are sometimes captured, however, and differ markedly from the adults in the shape of the head. The fore part of the head is considerably drawn out, and forms a thick, pointed, fleshy snout, the tip of which is produced into a curved, soft hook.

The flesh is of little value as food, and the Basking Shark cannot lay claim nowadays to be of much economic value.

It has, however, an enormous liver, which yields a large quantity of oil, which can be used for tanning, for tempering steel, and for other purposes. Individual sharks yield from 80 to 200 gallons of oil, with an average of 125 gallons, and there is a record of 400 gallons from a single liver. At one time there was a regular fishery for Basking Sharks off the coasts of Norway, Scotland and Ireland, while it is said to have been hunted to a somewhat lesser extent on the coast of Massachusetts in America. The method of hunting was much the same as that employed for Whales, individual sharks being harpooned from a small boat. As the sharks tended to become less abundant, probably as the result of their wholesale slaughter, and as the commercial value of the oil gradually declined, these fisheries slowly died out.

The methods employed in hunting the Basking Shark on the west coast of Ireland were illustrated in an interesting and picturesque manner in the film " Man of Aran ", which met with such well-deserved success in recent years.

Mr. Couch, writing in 1877, gives a detailed and vivid account of the hunt: " The boat . . . approaches the fish with a man in the bow ready to harpoon it; the line attached to the harpoon is 200 fathoms long, and is coiled up in the bow; a man stands by with a hatchet, ready to cut it, should it get entangled or foul of anything in running out. When the fish is struck, he will at the first dart carry out from 70 to 150 or 200 fathoms of line; he makes this rush to the bottom, where he rolls himself, and rubs his wound against the ground to free himself from the harpoon. The fishermen generally allow him an hour to tire himself before they begin to haul upon the harpoon line; they coil up the slack of it again, ready for him to make another rush, and play him in this way, sometimes for eight or nine hours, before they can get him to come to the surface; and when he does so they are ready to strike him with two or three more harpoons; and when these are fixed in him, they are able to pull him alongside the vessel with the harpoon lines; they then stretch him fore and aft along the vessel's side, and get a jowl rope round his head, and the bight of a hawser round his tail; they then give him two deep cuts, one on each side of the tail with a hatchet. In his agony and his efforts to get free, he works his tail so hard, that

he snaps the bone across where the cuts were made; they then cut flesh holes in the body of the fish on both sides, that will take a large rope through them; they then reeve ropes through these holes, and by hauling taut on the side of the fish next the vessel, and slacking away rope to the other side of the fish, it will cant him over on his back. They then split down the stomach, take out the liver, which is the only part they use for oil, and let the rest of the fish go adrift."

". . . These fish are most powerful in the water, and if harpooned in the shoulder they are very hard to kill, often carrying off the whole harpoon line; but experienced harpooners strike them in the body near the dorsal fin, rather low down, where it will go through into the intestines, or near the vertebræ towards the tail. They must be struck with great caution, as they will stave in the boat with a blow of their tail, if it is at all within their reach."

The shark is apparently quite indifferent to the approach of a boat, and a clever harpooner is sometimes able to place his weapon quite close to the snout, thus preventing the fish from diving before other harpoons can be brought into play. A lean fish is said to hold out for a much longer period than a fat one.

THRESHER OR FOX SHARK.

(Genus *Alopias*.) Fig. 15.

Similar in form to the Porbeagles, but easily distinguished by the very long tail, which is as long as the head and body together, and gently curved rather like the blade of a scythe. The tail is not provided with a keel. The snout is short and blunt. The teeth are small, flat, triangular, and with smooth edges. The external gill-clefts are only of moderate size. The pectoral fins are long and sickle-shaped. The coloration is dark greyish-brown to nearly black on the back and upper parts of the sides, changing somewhat abruptly to the white of the lower parts; the lower sides of the pectoral fins and a space below the gill-openings are leaden in hue.

Grows to a length of 15 to 20 feet, and a weight of nearly 1000 lb.

There is probably only one species of Thresher (*A. vulpes*),

which is found in most subtropical and temperate seas, being especially abundant in the Mediterranean and Atlantic. A Japanese writer has recently described two forms to be found in the seas around Formosa, distinguished principally by differences in the shape of the caudal fin, the size of the eye, and the proportions of the tail and body, but it seems possible that these are only varieties of the same species, the one with the larger eye inhabiting deeper water or even living near the sea bottom, and the one with the smaller eye living at the surface. The Thresher is one of the commonest of the larger sharks found on the British coasts.

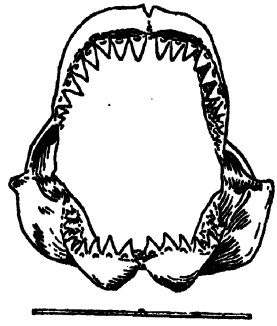
This is a rather formidable looking shark, although quite harmless to man. It is a great nuisance to fishermen, as it not only destroys their catches, but also becomes entangled in their nets with disastrous results. It is a speedy surface swimmer, feeding almost exclusively upon fishes, especially herring, shad, pilchard and mackerel. In obtaining a meal the Thresher sometimes makes use of a curious and unique method, swimming round and round a shoal of fish in ever-decreasing circles, lashing the water with its tail, and thus driving the prospective victims into a compact mass, when they form a comparatively easy prey. Sometimes a pair of sharks will combine in carrying out this organized method of feeding. Mr. Coles has described one which was feeding in shallow water on the coast of Carolina, which was " throwing the fish to its mouth with its tail, and . . . one fish, which it failed to seize, was thrown for a considerable distance, clear of the water ". A Thresher taken in the trawl in the Firth of Forth had half a bushel of garfish in its stomach—a good example of its voracious appetite ! Stories of Threshers attacking whales in league with swordfishes are probably without foundation, and may be due to faulty observation, the shark being confused with the Killer Whale. Its mouth and teeth are both far too feeble for the achievements in this direction that have been ascribed to it.

The breeding habits of the Thresher are unknown, but the young are believed to be born during the summer.

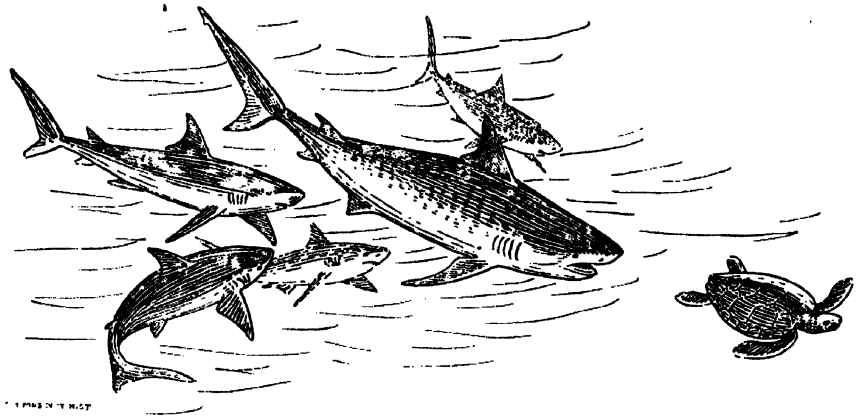
It is of practically no economic value, although the Chinese and Japanese make some use of it. Dr. Day reports that the Greek fishermen are said to have sought the Thresher for food,

and that a certain Dr. Caius, in 1569, " compared its flesh to that of the salmon, but admitted it was not quite so agreeable to the palate ".

The names Fox Shark and Whip-tailed Shark probably refer to the length of its tail, while such popular names as Thresher, Thrasher, Swingletail, Swiveltail, etc., have reference to the peculiar method of feeding. The generic name, *Alopias*, is the Greek word for a fox, and the trivial name, *vulpes*, is the Latin word for the same animal.



JAWS OF MAN-EATER



CHAPTER II: SHARKS (*continued*).

Orectolobid Sharks. Nurse Sharks. Whale Shark. Wobbegongs or Carpet Sharks. Zebra Shark. Requin Sharks. Blue Sharks. Tiger Shark. Topes. Hammer-head Sharks. Spined Sharks. Greenland or Sleeper Shark. Bramble or Spinous Shark. Angel- or Monk-fishes.

ORECTOLOBID SHARKS.

(Family ORECTOLOBIDÆ.)

RELATED to the Sand Sharks (Odontaspidæ), but distinguished from them by having grooves connecting the mouth with the nostrils, and by the position of the last 2 to 4 external gill-clefts, which lie on either side above the base of the pectoral fin. The two dorsal fins are placed well back on the body, the first being above, a little in front of, or behind the level of the pelvic fins.

This family includes a number of different looking Sharks, some large, others quite small. All are found in tropical and subtropical seas. Fossil remains of Sharks believed to belong to this family date back to the Jurassic period.

NURSE SHARKS.

(Genus *Ginglymostoma.*) Fig. 16.

The body is long and nearly circular in cross-section, and the tail is long and bent upwards at its base. The head is short and blunt, and the snout does not project much beyond the straight mouth. The eyes are small and without folds below. There are several rows of small teeth in each jaw, all or most of the rows being in use at one time (Fig. 59); each tooth has 3 or more points. The spiracles are small and situated behind the eyes. The external gill-clefts are of moderate size, the last 2 close together, and the last 2 or 3 above the base of the pectoral fin. The second dorsal fin is above or partly in front of the anal, which is quite free from the caudal fin, the lower lobe of which has a small notch. The coloration is more or less uniformly brownish, but young individuals often have small, scattered round black spots.

Grow to a length of 6 to 12 feet.

The Common Nurse Shark or Gata (*G. cirratum*) is found in the tropical Atlantic and on the west coast of Mexico. Other species occur in various parts of the Indian and Pacific Oceans.

The Nurse Sharks are shore-dwelling creatures, and the common species is abundant in the comparatively shallow water round Florida Keys and in the coral reefs of the West Indies. They are sluggish and quite inoffensive, and may often be observed basking in the sunshine in small groups, or nosing about in search of food among masses of seaweed or pieces of loose coral. At times they lie in water so shallow that their dorsal fins project above the surface, and they have been known to allow a boat to bump into their heads before moving away.

These sharks have a varied taste in food, including such diverse creatures as small fishes, squids, cuttlefishes, shrimps, lobsters, crabs, sea-urchins and shellfish in their diet. An American author has described them as looking like " well-fed pigs in a barnyard ", and adds that " there is no more sport in harpooning or hooking one than in doing so to a fat pig ". " So harmless, so sluggish and so lacking in fear are these

sharks," writes Dr. Gudger, " that they may rather easily be driven into shallow water and caught without harpooning. . . . My men used to drive them into shallow water, catch and drag them up on the beach, and after I had finished measuring and examining them, put them back into the water."

In their breeding the Nurse Sharks are ovo-viviparous ; that is to say, the eggs are shed from the ovaries, passed into a shell-gland where they are enveloped in a brownish-black horny case, and then lie in the lower part of the oviduct (the passage leading from the ovary to the exterior) until the young are finally hatched by the breaking of the shell. It is probable that the ancestors of these sharks produced eggs, which were deposited in cases in the open sea like those of the Dogfishes, and that to-day they are on the way to becoming viviparous, but still retain the egg-capsule within the body of the mother.

The skin of the Nurse Sharks, with its very small, close-set, tile-like denticles, is said to provide a particularly good shagreen. They seem to have little other economic value.

The name " nurse " would seem to be a contemptuous epithet, and to refer to the ease with which they may be captured. " Nurse " or " Nusse " is also an ancient term for a large fish. As early as 1699 we find in Dampier's ' First Voyage to Campeachy ' a reference to " sharks, sword-fishes, *and nurses* ". Dampier states that " the Nurse is just like a Shark, only its skin is rougher, and is used for making the finest Rasps ". The scientific name, *Ginglymostoma*, is derived from two Greek words meaning " hinge " and " mouth ".

WHALE SHARK.

(Genus *Rhineodon.*) Pl. II A.

A very large Shark, with a long, nearly cylindrical body, and a broad, blunt head. The upper part of the body is provided with curious keels or ridges, running lengthwise, one along the middle line of the back and 2 or 3 on each side. The eyes are small and without folds below. The large straight mouth is nearly at the end of the head, and each of the jaws is armed with a band of numerous, very small, curved teeth, forming a kind of rasp. The spiracles are small and are placed

behind the eyes. The external gill-clefts are wide, and the last two on each side are placed above the base of the pectoral fin ; the gill-arches are provided with long, close-set gill-rakers as in the Basking Shark (*Cetorhinus*). The second dorsal fin is above the anal, which is quite free from the caudal fin. The caudal fin itself has a well-developed lower lobe, without a notch, and, as the axis of the fin is bent strongly upwards, it appears almost symmetrical. The pectoral fins are large and somewhat sickle-shaped. The general coloration is brownish or greyish, becoming paler on the lower parts, and the head and body are covered with round white or yellow spots ; on the head the spots are smaller and much closer together, giving it a marbled appearance, while on the body they are separated by narrow vertical streaks of the same colour.

Grows to a length of at least 50 feet and a weight of several tons.

The single existing species (*R. typus*) is found in the warmer parts of the Atlantic, Indian and Pacific Oceans.

This enormous surface-swimming Shark may be readily distinguished from all other forms of the open sea by its striking colour pattern. It was first discovered in 1828, when a specimen was harpooned in Table Bay, South Africa, and examined by Dr. Andrew Smith, an army surgeon, and a keen student of South African fishes. He published the first scientific description of the Whale Shark, but it was not until twenty years later that his figure of the Shark appeared. Dr. Smith records that the skin of this specimen was purchased for £6, and was forwarded to the Natural History Museum in Paris. Since that time a number of individuals of varying sizes have been washed ashore or harpooned in different parts of the world, but mounted skins are still rarities in museums. A 38-foot specimen captured in Florida waters in 1912 caused so much interest that it was skinned and stuffed and then carted round the principal towns of the eastern United States.

In spite of its huge bulk, it is quite inoffensive, and the only danger to be apprehended from the largest Whale Shark is an accidental bump of its head or body against the side of a small boat or a blow from its powerful tail. Like the Basking Shark it can be easily approached and harpooned, but on being wounded it will either dive straight down or set off at

a high speed, dragging the boat behind it. Its staying powers are remarkable, and several hours may elapse before it finally succumbs. On more than one occasion a Whale Shark basking at the surface has been rammed and nearly cut in two by a large vessel. It is believed that when once lanced or harpooned the Shark will in some way contract the muscles of the back, and in this manner try to prevent the entrance of another weapon.

In many respects the Whale Shark recalls the Basking Shark of our own seas, dealt with in the previous chapter. There is the same bulk, tiny teeth set in a huge mouth, long, close-set gill-rakers, wide external gill-clefts, and keeled tail with apparently symmetrical fin. Indeed, some authorities are inclined to place the two forms close together, but others are of the opinion that these resemblances have been brought about by the adoption of similar modes of life, and particularly of similar methods of feeding, and do not indicate actual relationship. Our knowledge of the anatomy of the Whale Shark is not yet complete, but it would seem to be more closely allied to the Orectolobid Sharks. It is of some interest to note that the curious ridge-like keels along the body also occur in the Zebra Shark and in other members of this family, but not in any other Sharks.

Like the Basking Shark the Whale Shark feeds on small crustaceans and other planktonic creatures, which it strains from the water by means of the sieve-like gill-rakers. So huge is its mouth, however, that other objects may enter on occasion, and it is recorded that an individual caught in the Philippine Islands had swallowed a number of shoes, leggings, leather belts, etc., and another from Japan had a fragment of an oak pole, about a foot long, in its stomach !

Nothing at all is known of its breeding habits, but it is almost certainly viviparous. It appears to have no economic value, although the liver might be expected to yield an oil of commercial importance.

The Whale Shark is known by a variety of names in different parts of the world, of which " Chagrin " (Seychelles), " Tiburon ballenas " (California), " Tintoreva " (Gulf of Panama), " Chacon " (Philippines), and " Mhor " (Karachi) may be mentioned. The name Whale Shark may refer to its size,

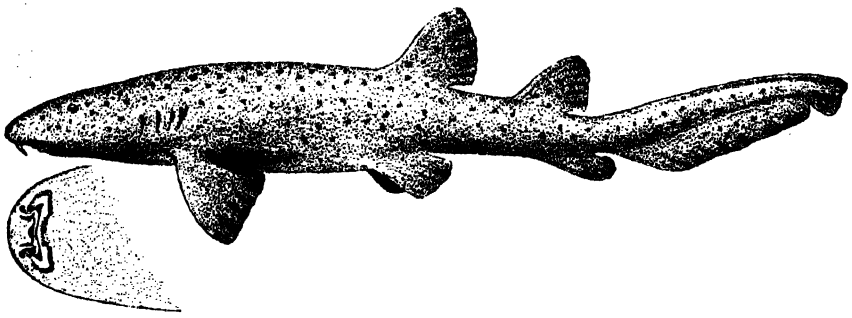


FIG. 16.—Common Nurse Shark or Gata (*Ginglymostoma cirratum*).

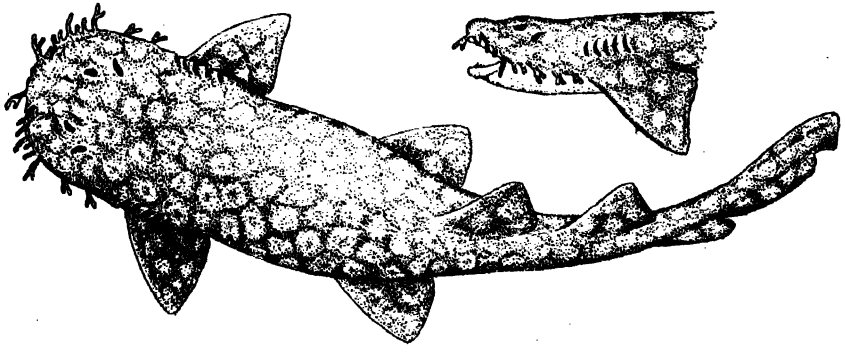


FIG. 17.—Wobbegong or Carpet Shark (*Orectolobus barbatus*).

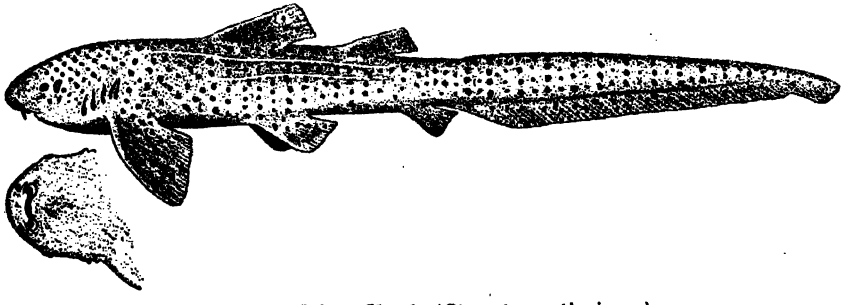


FIG. 18.—Zebra Shark (*Stegostoma tigrinum*).

but more probably to the baleen-like gill-rakers. The scientific name, *Rhinepdon*, is derived from the Greek words for " file " and " tooth ", and refers to the rasp-like tooth bands.

WOBBEGONGS OR CARPET SHARKS.

(Genus *Orectolobus*.) Fig. 17.

The body is thick-set and its front part is more or less flattened; the head is broad and flat, with a very blunt snout. The sides of the head, and often the chin as well, are provided with tassels of skin. The eyes are small and are provided with folds below. The mouth is wide, nearly straight, and is situated almost at the end of the head; it is armed with slender, pointed teeth, of which those in the centre are larger and with a single point and those at the sides smaller and with some additional points. The spiracles have the form of wide, oblique slits, situated behind and below the eyes. The external gill-clefts are of moderate size, and the last 3 or 4 on each side are above the base of the pectoral fin. The second dorsal fin is about as large as the first, and is placed in front of the anal, which reaches to or is actually joined at its base to the lower lobe of the caudal fin. The caudal fin is moderately long, with a straight axis, and there is a notch in the hinder part of the lower lobe. The pectoral fins are broad and often rounded. The coloration is very variable, the ground-colour being yellowish, greyish or brownish, and variously marbled, spotted, barred or striped with paler and darker.

The larger species grow to a length of 6 to 8 feet or even more.

There are about five species, occurring on the coasts of China, Japan, eastern and southern Australia.

The flattened, thick-set shape, the curious tassel-like appendages on the blunt head, and the mottled coloration, give these Sharks an appearance very different from any so far considered. When the mode of life, however, and especially the manner of obtaining food is considered, the meaning of these features becomes clearer. Instead of going in active pursuit of prey like a Blue Shark, a process associated with a

slender, streamlined, uniformly coloured body, or gulping down large masses of planktonic life like the Whale Shark, the Carpet Sharks rely on cunning to obtain their meals, and make use of less strenuous but none the less effective methods of feeding. A Carpet Shark spends most of its time on or near the sea bottom, lying motionless among rocks and weeds or half buried in sand or mud, until such time as a prospective victim—a fish or crustacean—comes within reach of the jaws. It is not built for speed, but any loss of swimming power is amply compensated for by the remarkable resemblance of the Shark to its surroundings. When at rest it looks for all the world like a rock or stone overgrown with seaweed, and the flaps of skin on the head and round the mouth, waving gently in the water or lying spread out on the sand, enhance the deception, and at the same time help to break up the outline and render the Shark less conspicuous.

As a general rule Carpet Sharks are quite harmless, but they will snap viciously when caught and have been known to attack persons wading in shallow water.

Little is known of their breeding habits, but they are ovo-viviparous like their relatives the Nurse Sharks. A large number of young is produced at a single birth.

The small rough denticles in the skin, and its handsome variegated pattern, makes it a favourite shagreen for decorative purposes, and there is in consequence a considerable demand for these Sharks. They have little or no value as food.

ZEBRA SHARK.

(Genus *Stegostoma.*) Fig. 18.

The body is long, with its hinder part flattened from side to side; the head is short and blunt. There are some ridges or keels running lengthwise along the back and sides. The eyes are small and without folds below. The mouth is straight, and is provided with many rows of small teeth, each of which has 3 points. The spiracles are of moderate size and are situated behind the eyes. The external gill-clefts are fairly large, and the last 3 on each side are above the base of the pectoral fin. The second dorsal fin is rather smaller than the first, and is placed partly above and partly in front

of the anal, which just reaches the caudal. The caudal fin is very long, with a straight axis, and with a notch in the hinder part of the lower lobe. The pectoral fins are broad. The general coloration is yellowish-brown, ornamented with many vertical series of rounded dark spots; the young have a very different pattern, with broad dark brown cross-bars with black edges, separated from one another by narrower interspaces of pale yellow. As the fish grows up the bars gradually become paler and dark spots appear on them, while the dark edges of the cross-bars break up into spots.

Grows to a length of 6 feet or more.

The single existing species (*S. tigrinum*) is widely distributed in the tropical parts of the Indian Ocean, East Indian Archipelago, and Chinese Seas, and occasionally strays southwards to the coasts of Australia.

This handsome shore-dwelling Shark is quite harmless, and feeds mainly upon shellfish and crustaceans. Little is known of its habits. It produces eggs, that are deposited close to the shore. Apart from the use of its skin as shagreen, it has little economic value.

REQUIN SHARKS.

(Family CARCHARINIDÆ.)

Sharks with a long body and somewhat flattened tail. The snout is more or less pointed, flattened above, and projects above the crescent-like mouth. The eyes are each provided with a third eyelid, or nictitating membrane, that can be drawn up across the eye from below. There are no grooves connecting the mouth with the nostrils. The spiracles are small or absent altogether. The last 1 or 2 external gill-clefts on each side are above the base of the pectoral fin. There are two dorsal fins, without spines, the first of which is usually placed in front of the pelvic fins; there is a single anal fin.

This is the largest family of existing Sharks, and its members are found nearly all over the world. The family is a comparatively modern one, as fossil remains, mostly teeth, do not occur in rocks older than those of the Eocene period. All the Requin Sharks are viviparous or ovo-viviparous.

BLUE SHARKS.

(Genus *Carcharinus*.) Pl. II B ; Fig. 19.

The teeth either stand erect or are set obliquely in the jaws ; each tooth has a single, strong, sharp point, which is either smooth or finely saw-edged (Fig. 59). There are no spiracles. The second dorsal fin and the anal fin are both very small. There is a pit at the root of the caudal fin, which has a distinct lower lobe. The coloration is always uniform, and is usually grey or bluish-grey on the back, shading away to white on the lower parts ; in certain species some or all of the fins are tipped with black.

The largest species (Great Blue Shark) grows to a length of 25 feet or more ; many others attain to a length of 10 to 15 feet.

This is a large genus of Sharks, containing many species, and some authorities group these into four or more distinct genera or subgenera, distinguished from one another mainly by the size and character of the teeth. Blue Sharks are to be found in almost all tropical and subtropical waters. The Great Blue Shark (*C. glaucus*) is cosmopolitan in its distribution, and small individuals are not uncommon on the British coasts ; the Black-finned or Black Shark (*C. melanopterus*) occurs in the Indian and Pacific Oceans ; the Dusky Shark (*C. obscurus*) is found in the North and Middle Atlantic ; and the Cub Shark or Requiem (*C. lamia*) abounds in the Mediterranean and in the tropical parts of the Atlantic. These are four of the better-known species. The Zambesi Shark (*C. zambesensis*), which has been captured 120 miles from the river mouth, and the Ganges Shark (*C. gangeticus*), common in the Ganges, Tigris and other large rivers, are examples of species that habitually enter rivers. One species (*C. nicaraguensis*) is unique among Sharks in being confined entirely to fresh water, and is found only in Lake Nicaragua and its outlet the Rio San Juan.

These Sharks, as their lithe, streamlined bodies and uniform coloration suggest, are mostly dwellers in the open sea, and pass a roving, predatory life in the upper layers of the water. Whether disporting themselves at the surface in the sunlight,

or swimming about in shallower water, often quite close to the shore, they readily catch the eye. Nearly all the sharks described in books of travel belong to this genus, and those observed by the voyager following in the wake of a vessel are almost always Blue Sharks. They have more than once been compared to hungry dogs in search of food when seen from the deck of a ship, and they well merit the names of " wolves of the sea " or " chien de mer " that have been bestowed upon them.

The Great Blue Shark visits the coasts of the British Isles during the summer months, and small individuals may be seen on calm, warm days swimming lazily near the surface, often with the tail and the tips of the dorsal fins projecting from the water. When in pursuit of prey, or when otherwise excited, they have been observed repeatedly to cover and uncover their eyes with the third eyelids, and it seems that this is a kind of " blinking " caused by the irritation of the intense light. At night their activity is greatly increased, and at such time they hunt their prey mainly by scent. The tiny pores with which the surface of the snout is pitted probably serve some sensory function.

The Blue Sharks are both fierce and voracious, and their appetites are well nigh insatiable. Other fishes form the principal food, and they may even include their own kind in their dietary, but no kind of animal food, whether alive or dead, comes amiss to them. The larger species of the open sea chase and seize the pelagic fishes, while their smaller, more thick-set shore-dwelling relatives feed on bottom fishes, crabs, lobsters and shellfish, which they are able to locate by means of their acute sense of smell. Wounded sea birds are often carried down, and offal of all kinds is not disdained. The Cub Shark is notorious as a scavenger, especially in the neighbourhood of harbours and wharves, and hordes are soon attracted by the smell of blood or decomposing flesh. The shark fishermen of Florida, knowing how keen is the sense of smell of these creatures, make use of such baits as rank meat or slaughter-house offal to draw them within striking distance.

Whaling men are familiar with the huge congregations of sharks that gather like vultures when a whale has been killed and greedily await the process of " cutting in ". One authority

has described how during this process " when the water for an acre round the ship was stained a ghastly yellow from outpouring blood, the scrambling sharks would make the sea a living mass as each fish tried to bury its teeth in the exposed surfaces of dark red muscle. Now and then a shark would flounder right out on top of the whale, and cling there until a descending ' blubber-spade ' had put an end to all its ambition. If the ' cutting in ' of a whale was at any time deferred several hours . . . the sharks would seemingly become impatient ; they would then attack the carcass, and, thrusting their heads partly above the surface, would bite large mouthfuls out of the blubber."

It is an interesting fact that captured Sharks often turn the stomach inside out and evert this through the mouth to the extent of a foot or more. An American authority has suggested that this may denote " a habit of ejecting indigestible material such as most sharks frequently swallow ".

A widespread and popular fallacy concerning the feeding of Sharks may be mentioned here. The statement is often made that, owing to the position of the mouth on the underside of the head, it is necessary for the Shark to turn over on to its back in order to seize its prey. A moment's consideration should suffice to show what little chance it would have of securing an active fish in this way, and actually the Shark raises the fore part of its head when within striking distance of the prospective victim, often pushing its snout out of the water, and thus brings the jaws into a suitable position for an effective bite. When dealing with a lump of meat or garbage flung overboard in the wake of a ship, a Shark will lazily turn over in order conveniently to swallow the meal as it sinks slowly through the water, and, since it is under such conditions that most people observe the feeding of Sharks, it is possible to understand how this misconception has arisen.

These sharks have an evil reputation as " man-eaters ", but happily this is largely undeserved, and authentic cases of unprovoked attacks upon living human beings are comparatively rare. They will not hesitate to feed upon corpses, and this habit would be sufficient to account for most of the records of human remains taken from the stomachs of captured

sharks. Nevertheless, the Blue Shark cannot be entirely acquitted of a liking for living human flesh, and large individuals must always be regarded as dangerous. The Ganges Shark is said to be particularly savage, and not infrequently to seize the arm or leg of an incautious native bather. The commonest accidents with Blue Sharks occur when one has been hooked and hauled on board a boat, or when one has become entangled in a net and efforts are made to capture it or to cut it adrift. A snap of its powerful jaws with their jagged teeth, or even a blow of the tail, will cause a lot of damage.

There is a strong superstition among seafaring men that when a sailor dies at sea these sharks will gather in the wake of the ship to await the committal of the body to the deep. It is, of course, obvious that the presence of the sharks is quite fortuitous, but the belief persists, and the sailor's hatred of them is very real. Should a shark be captured he will frequently torment it without mercy before finally killing it and throwing it back into the sea. Happily for the shark, it seems to possess very little susceptibility to pain, although its tenacity of life is prodigious. Mr. Couch mentions an individual which, having been thrown into the sea after the removal of its liver, pursued and endeavoured to seize a mackerel. An American observer tells us that "a blue shark, horribly mutilated by repeated thrusts of a whaleman's blubber-spade, was seen to return immediately to the whale upon which it had been feeding and to continue ravenously until it practically died in the act, and sank slowly into the dark depths of the sea". There is an even more amazing record of a Shark that had been cut open, gutted, and returned to the sea, which was subsequently caught on a hook baited with its own intestines!

Comparatively little is known of the breeding habits of the Blue Sharks. The young of the Great Blue Shark in the Mediterranean and Atlantic are born about May or June, and as many as 30 or more have been counted in a single female. The ancient writers credited the Blue Shark with being a devoted parent—a fact that was celebrated in verse by Oppian at the beginning of the third century, A.D. It was even seriously stated that when danger threatened the young took

shelter within the gullet or even in the stomach of one or other of the parents, but such a belief is clearly based upon faulty observation.

The flesh of these Sharks is white and firm, but is very tough and is said to have an unpleasant smell. It is canned for food in some countries, however, and is also employed as fertilizer. The natives of the Philippines and other parts of the Orient eat it fresh, and at one time it was an article of diet among the poorer classes in Italy. The liver is rich in oil, and the skin provides a valuable economic product. With the dermal denticles untouched, the skin makes a good shagreen, from which are manufactured sword scabbards and coverings for sword grips, expensive Morocco bindings, coverings for jewel cases, and other articles; the crude skin is also converted into rasps for the use of cabinet-makers and metal polishers. With the denticles removed, and suitably tanned, the skin is converted into a durable leather, which is in some demand for shoes, bags, etc. In Ceylon, the Philippines and elsewhere there is a flourishing trade in the fins of these and other sharks and rays, which are exported in a dried state for making shark-fin soup. The delicate fin-rays are the essential parts for this purpose, as they dissolve into gelatine of pleasant flavour. The fins are cut from the body, dusted with a mixture of hot wood ashes and powdered salt, or with lime, and afterwards dried in the sun or smoked over a fire, according to the prevailing weather. The finished product, which is brittle, crisp, and pale blue-grey in colour, is then graded, baled and shipped, the principal markets being China, Hong Kong, Singapore and Siam. The backbones of Blue Sharks are sometimes made up into walking-sticks by sailors, who are said also to cut out the crumbly limy ear-stones for medicinal use. Many of the species give excellent sport to the sea angler.

The terms "requin" or "requiem" appear to have been first applied to these Sharks by French sailors, who regarded them as highly dangerous. The scientific name, *Carcharinus*, is derived from two Greek words meaning "jagged" and "file".

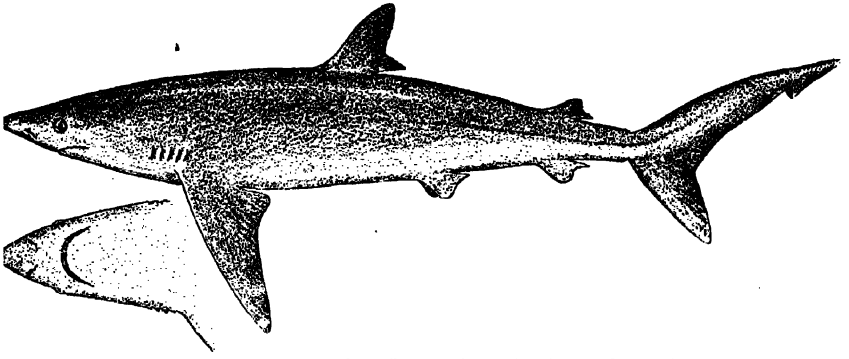


FIG. 19.—Great Blue Shark (*Carcharinus glaucus*).

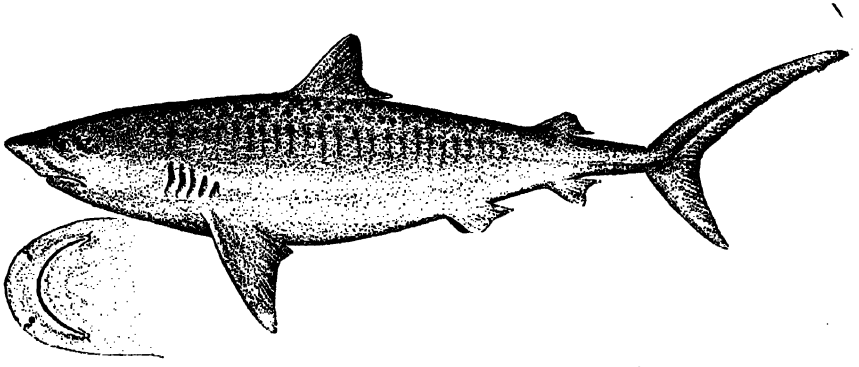


FIG. 20.—Tiger Shark (*Galeocerdo arcticus*).

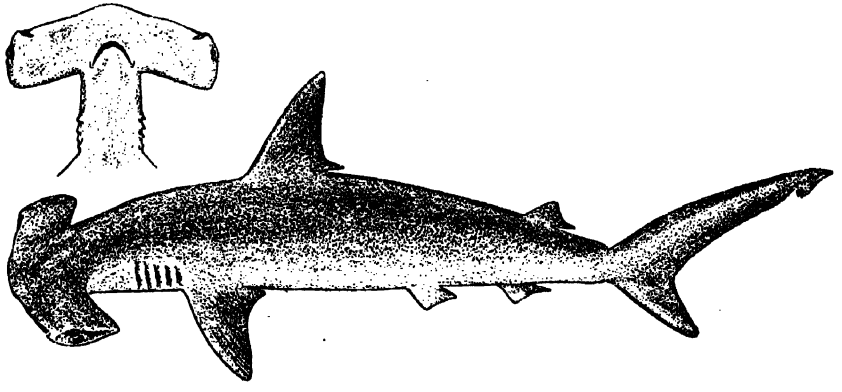


FIG. 21.—Hammer-head Shark (*Sphyrna zygæna*).

TIGER SHARK.

(Genus *Galeocerdo.*) Fig. 20.

In general appearance not unlike the Blue Sharks, but readily distinguished by the curious teeth, which are alike in the two jaws. Each tooth is large, flat, roughly sickle-shaped, with a fluted edge recalling that of a patent bread-knife, and with a triangular point which projects obliquely outwards (Fig. 59). The coloration of young individuals is pale brown, and the body and fins are more or less spotted and barried with dark brown. With advancing age these markings gradually disappear, and full-grown specimens are nearly uniformly greyish-brown.

Grows to a length of 15 to 20 feet, occasionally reaching 30 feet.

The single existing species (*G. arcticus*) is found in the warmer parts of all the oceans. It frequently enters harbours and estuaries.

This is a slender, active, handsome-looking Shark of voracious habits, and, whether regarded from the point of view of its looks or its habits, well deserves the popular name bestowed upon it. The Tiger Shark is a true rover of the high seas, and includes in its diet practically every form of animal life. Porpoises, dolphins, turtles, sea birds, other sharks, fishes of all kinds, crabs, squids and shellfish have all been found within the stomachs of these creatures. Unlike some of the Blue Sharks, they appear to disdain garbage, but will certainly turn scavenger at times. One individual examined had in its stomach some beef bones and a mass of hair, while another, hauled on deck alive, promptly vomited several small mammal bones, among which were the leg bones of three sheep! "There can be little doubt," writes Dr. Coles, "that the tiger shark regularly preys on other sharks to a considerable extent. During the few weeks that I was watching the fishery at Cape Lookout I examined the stomachs of three young tiger sharks, and in all three I found cleanly bitten pieces of freshly eaten shark meat with skin attached, just as if the chunk of meat had been cut off from the side of a shark. In the largest example, 7 ft. 9 in. in length, caught

in my nets June 25, there were eleven of these chunks of shark meat of from one to five pounds each in weight, and they represented hammerhead, sharp-nosed and ground sharks."

In parts of India the natives affirm that the Tiger Shark prefers its food a little high, and they therefore make a practice of burying meat that is to be used for bait in the ground for a day or so. Dr. Jerdon, a keen observer of Indian fishes, has noted that this shark cunningly swells itself out so as to look like a floating mass of animal substance, and, having thus decoyed its prey, it immediately attacks it. It has several times been known to attack men, and is more dreaded in the West Indies than any other shark.

Even the Sting Ray, with its whip-like tail armed with a jagged, poisonous spine, is by no means immune from attack by the Tiger Shark, which has been observed to circle round one of these rays, sparring for an opening, as it were, and then to dart in and seize the prey in spite of the vigorous lashing of its tail. The " sting " does not seem to have any ill-effect upon the Shark, and Captain Young, a shark-hunter of world-wide experience, affirms that the saw-edged spines work their way out through the walls of the stomach, get among the muscles, and then, like needles, work their way towards the head or the tail according to the direction in which they happen to be pointing.

In the ' Philosophical Transactions of the Royal Society of London ' for the year 1784 there is a very interesting paper by Mr. William Andre, in which he describes the jaws of a Tiger Shark with a portion of the spine of a Sting Ray " driven quite through the lower jaw among the posterior teeth, and fixed almost immovably ". His picture of the teeth with the spine *in situ* reveals one interesting feature, a feature which provides ample confirmation of the forward movement of the teeth that goes on throughout life. The embedding of the spine in the jaw had injured one of the tooth buds, causing two imperfect right and left halves to develop instead of a normal tooth, and this malformation was not confined to the row containing the spine but occurred as well in every row in front of it.

The Tiger Shark is known as a prolific breeder, but little is

actually known of its breeding habits. Captain Young has recorded taking as many as 57 young from a single female.

From a commercial point of view this Shark is of considerable value, as its skin is in great demand for leather. It is very tough, and has a tensile strength of from 6 to 10 times that of ox-hide. The demand for shark leather has shown a steady and continuous rise in recent years, and it may be of interest to outline briefly the methods employed in its manufacture. It has already been pointed out that the untanned skin or shagreen has for several centuries been employed for various purposes, but a more general use of the hide has been impossible owing to the difficulty of removing the dermal denticles without damaging the skin itself. This difficulty, however, has now been overcome, and it is possible to soften the toughest hide so that it can be used for every purpose to which the best bullock leather is put. Further, the modern processes retain, not only the markings on the skin, but also its remarkable wearing properties. The most important articles for which shark leather is used are boots and shoes, handbags, attaché cases, bags of all kinds, and pocket-books.

The sharks are usually caught by means of special nets set in the water, in which they entangle their heads, but sometimes capture is by baited hooks or harpoons. Skinning is a skilled process, as a false cut may considerably lessen the value of the hide. Further, the skin is so tough that cutting is a matter of some difficulty and the keenest knife is soon blunted. Having been removed from the carcase in one piece, the skin is then subjected to a process known as " beaming ", in the course of which the surplus flesh is cleaned off the inner side by the use of a cleaver-like knife. The skin is then soaked in sea water and a good coating of brine placed on the inner surface. After about a week another coating of brine is applied, and two weeks later a third application completes the curing, and the hide is now ready for the tanner. The tanning process involves the dissolving of the tissues round the roots of the dermal denticles, with further treatment designed to soften and finish the product.

After removal of the skin, the remainder of the body is not necessarily wasted. The liver of the Tiger Shark gives a better yield of oil than that of most other kinds, and, suitably

prepared, this has a high medicinal value comparable to that of the best cod-liver oil. The fins can be dried and used for soup. The meat can be cut up and dried or salted for food, and the remainder of the carcase can be converted into fertilizer or into a high-grade poultry food.

The Tiger Shark provides good, if somewhat strenuous sport for the sea angler, and examples up to 600 lb. in weight are regularly caught with hand lines from the pier at Durban, Natal. The record Tiger Shark taken on rod and line weighed 298 lb.

The scientific name, *Galeocerdo*, is derived from two Greek words, one meaning " a kind of shark " and the other " fox " or " weasel ".

TOPES.

(Genus *Eugaleus*.) Pl. V D.

Similar in appearance to the Blue Sharks. The teeth are alike in the two jaws, in which they are set obliquely; each tooth is notched and has a fine saw-edge. There is no pit at the root of the caudal fin, which is rather short. The coloration is brownish or dusky grey above, becoming paler beneath; the greater part of each pectoral fin, the front parts of both dorsal fins and the tip of the caudal are black.

The common species grows to a length of 6 or 7 feet, the Japanese species much larger.

The Tope (*E. galeus*) is almost cosmopolitan in its distribution, and is abundant on parts of the coasts of the British Isles. The so-called " Oil Shark " or " Soup-fin Shark " of California is probably the same species. There is another species (*E. japonicus*), found only in the seas of Japan.

The Topes are fierce and voracious Sharks, and recognized enemies of commercial fishermen. From the fact that it frequently takes the baits from their lines and is only very rarely entangled in their drift-nets, it may be inferred that the Tope normally swims and feeds near the bottom. Its food consists of small fishes, crustaceans, starfish and shellfish, and it is by no means averse to dead food.

The young are produced alive during the months of June, July, August and September, and from 20 to 50 have been

recorded at a single birth. They seem to be born in shallow water, where they remain for some time after the parents have returned to the deeper water offshore.

The flesh of the Tope is poor, but is eaten in parts of France and elsewhere. The name "Sweet William", sometimes applied to the common species, seems to be an ironical one, as both skin and flesh have a rank, offensive smell. The skin, however, provides a good shagreen, and the liver yields a coarse but valuable oil. In California the fins are much prized by the Chinese for soup-making, and a set fetches from 1 to 2 dollars.

Apart from its commercial value, the Tope is a favourite with the angler, and the sport of Tope fishing has gained much in popularity during the past twenty-five years. The bait is usually a whole mackerel, as fresh as possible, and special tackle is required. The record fish taken on rod and line scaled 61 lb.

Other vernacular names for the common species include "Toper", "Whithound", "Penny-dog", and, in Wales, "Ciglas", a word meaning literally Blue Dog. The French call it "Chien de mer", and the Italians, "Lamiola".

HAMMER-HEAD SHARKS.

(Family SPHYRNIDÆ; Genus *Sphyrna.*) Pl. V A; Fig. 21.

Very similar to the Requin Sharks (Carcharinidæ), but they may be readily distinguished by the curious shape of the head, the sides of which are drawn out to a greater or lesser extent into fleshy lobes, which are supported inside by special outgrowths of the gristly skull. The eyes are situated at the extremities of the lobes. There are no spiracles. The first dorsal fin is placed well in front of the pelvic fins. There is a pit at the root of the caudal fin. The coloration is more or less greyish above, becoming paler on the lower parts.

These Sharks are found in most warm seas. Fossil teeth have been found in rocks of the Miocene period and later.

The largest species (Hammer-head) grows to a length of 15 feet or more and a weight of 1500 lb. The Bonnet Shark is a smaller species, rarely exceeding a length of 5 feet.

There are about five species of Hammer-heads, which exhibit a complete gradation in the shape of the head from that of a kidney in the Shovel-head or Bonnet Shark (*S. tiburo*) to that of a hammer in the true Hammer-head Shark (*S. zygæna*) ; that of the species *S. tudes* is roughly intermediate. The Hammer-head is a rare visitor to the British Isles.

These Sharks are often found in deep water, but may also be seen at the surface, with the dorsal and caudal fins projecting from the sea. The curious shape of the head is unique among fishes, and it is difficult to see what use the lateral outgrowths can be to their possessor. It has been suggested that they allow it to manœuvre and turn with great speed, but, in the absence of direct evidence, this must be looked upon as " a shot in the dark " ! Some idea of the extent of the lobes in the true Hammer-head may be gained from the fact that in a large Shark the width of the " hammer ", measured from eye to eye, may be as much as 3 feet.

The Hammer-heads live mainly upon other fishes, although squids, crabs, and even barnacles are included in their diet. One individual, more than 13½ feet long, which was caught at Ilfracombe, Devon, in 1865, was found to contain 2 thornback rays and a bass. Dr. Gudger mentions a specimen of 12½ feet, harpooned at Beaufort, North Carolina, as it was chasing some sting rays over sand flats, which had been feeding almost exclusively upon these fearsome creatures. In addition to the semi-digested remains of the rays in its stomach, there were no less than 50 " stings " embedded in various parts of its anatomy ; some were in the neck region and in the back, but the great majority had been driven into the mouth and gullet. Some of the " stings " had been but recently implanted, but others were older and had become embedded in cysts.

The larger species of Hammer-heads have the reputation of being dangerous to man, but authentic records of attacks are difficult to trace. Indeed, the reputation seems to rest mainly upon the find of the remains of a man, together with parts of his clothing, in a specimen captured in America in 1805.

The Hammer-heads are viviparous, and 37 embryos have been taken from a female 11 feet in length, while another captured in Carmarthen Bay had 31 young.

The skin of these Sharks is rather thin, but is said to provide a durable and handsome leather. The flesh has a fine grain, and is a favourite food of the Japanese.

The scientific name, *Sphyrna*, is derived from the Greek word for a hammer; *zygæna* is the ancient name for the Shark, and is probably derived from a Greek word meaning "yoke".

SPINED SHARKS.

(Family SQUALIDÆ.)

Sharks with a more or less long body, which is not flattened from above downwards. The eyes have no third eyelid. The mouth is situated on the under-side of the head, and there are no grooves connecting this with the nostrils. The teeth are small or of moderate size, and vary greatly in form in the different genera. Spiracles are present. The external gill-clefts on each side are all in front of the base of the pectoral fin. There are 2 dorsal fins, each of which often has a spine in front of it. There is no anal fin. The pectoral fins are normally shaped.

This family includes a number of different looking sharks, of which the majority are of comparatively small size. Only the Greenland and Bramble Sharks grow to any size, and are consequently dealt with here. The Spined Sharks are found in most parts of the world, but are more abundant in the temperate than in the tropical regions. A few of the genera appear to date back to the Cretaceous period.

GREENLAND OR SLEEPER SHARK.

(Genus *Somniosus*.) Fig. 22.

The body is rather stout and clumsy, the head small, and the snout bluntly rounded. The mouth is only slightly arched, with a groove on either side. The teeth are quite different in the two jaws: those of the upper jaw are small, narrow, conical and arranged in several rows; those of the lower jaw are broad, oblique, and have the points so much turned outwards towards the sides of the jaw that the inner margins

form the cutting edges. The spiracles are of moderate size and the external gill-clefts small. The 2 dorsal fins are without spines, about equal in size, and both small; the first is placed about midway between the pectoral and pelvic fins. The caudal fin is short and deep. The pectoral fins are small. The skin is uniformly covered with tiny denticles. The coloration is slaty grey or black above, shading away to paler beneath.

Said to grow to a length of 20 feet, but the average size is about 8 to 12 feet.

The Greenland Shark (*S. microcephalus*) is found in most arctic and northern seas, and ranges southwards to Cape Cod and France in the Atlantic, and to Oregon and Japan in the Pacific. The species from the Mediterranean (*S. rostratus*) is very closely related and may eventually prove to be identical. A few years ago a member of this genus was found near Macquarie Island, south of New Zealand, but it is not certain whether this is the same as the Greenland Shark or whether it is a distinct species. The Greenland Shark is not uncommon in our own waters, especially in the neighbourhood of Scotland.

This is a clumsy creature, and quite the most sluggish of the larger sharks. It seems to spend most of its time at or near the sea bottom, only coming to the surface in search of carrion food. As soon as winter is over the young sharks move into the shallower coastal waters, followed a little later on by the adults, but in September they retire once more into the depths. Greenland Sharks feed mainly upon seals and fishes, although crabs are also eaten. It is remarkable that so sluggish a creature is able to pursue and to catch living seals. Carrion and offal of all kinds have an irresistible attraction for them, and the more putrid the meal the better it seems to be relished. The sense of hearing as well as that of smell is very acute, and the sharks are readily attracted to the scene of a seal hunt or the cutting up of a whale. The Greenland Shark abounds among the refuse of the salmon canneries in Alaska, and its habit of feeding upon fish offal on the New England coast has earned for it the name of "Gurry Shark". One individual examined had nearly a whole reindeer in its stomach, and one of the older writers on the fishes of Iceland relates that when horses used to venture on to thin ice and were drowned Greenland Sharks would

make their way up the narrowest fiords, in which they were never seen in the ordinary way, in order to feed upon horseflesh.

There are many ancient stories of these Sharks attacking living whales, but this is highly improbable, and the individuals in question were most probably feeding on a carcase. When a whale has been killed they will make their appearance in numbers, and speedily commence to tear large lumps from the body and finally gorge themselves into a condition bordering upon coma. While thus engaged, they seem to be insensible to blows on the head or repeated stabs with lances or knives, merely sheering off for a moment and then returning to the feast with fresh vigour. As far as man is concerned, they are quite harmless, and the old stories of Greenlanders attacked when in their kayaks are without foundation.

There is still some doubt as to the reproductive habits of this shark. Numerous round, soft eggs, up to the size of a hen's egg, but without any shell, have been found within the bodies of females, but whether these are shed on the sea floor or whether they develop within the mother is by no means certain. The fact that the species from the Mediterranean (*S. rostratus*) has long been known to be viviparous suggests that the Greenland Shark may also produce living young.

The Greenland Shark is of considerable economic importance, chiefly on account of the liver oil. Fisheries have long existed on the coasts of Greenland, Iceland and Norway, and considerable quantities of oil were at one time exported from these countries. A large shark will give anything from 1 to 2½ or even 3 barrels of oil. In Greenland the industry seems to date from about 1805, and by the middle of the last century the natives were catching between 2000 and 3000 sharks each year. By 1914 the annual catch had risen to about 32,000, but there has been a steady decline in recent years. In Iceland the export of oil in 1880 was 8192 barrels, but by 1920 it had fallen to a mere 1881 barrels, and to-day the industry is of little importance. In Iceland and Greenland the flesh is used as food for the dogs, and at times it is also eaten by the natives themselves. It is of interest to note that in a dried state, or when semi-putrid, the flesh is quite wholesome, but when fresh it produces a kind of intoxicant poisoning both

in dogs and to a lesser extent in man. For this reason, the natives only eat it when it has become partly rotten.

Use is also made of the raw skin for footwear. Some of the Eskimos of Greenland make special knives from the sharp teeth, which are used for cutting the hair of their children, there being a superstition that harm will result from the use of iron for this purpose.

In Greenland shark fishing may take place from small wooden boats, or from the frail kyaks, but in the winter months it may be carried on almost from the "doorsteps" of the fishermen. Holes are cut in the ice, and sharks are attracted to the spot by placing in the holes the intestines of seals or other delicacies. Sometimes they are brought to the surface by means of a light, gaffed with an iron hook and hauled out on to the ice; at other times they are caught on baited hooks at the end of an iron chain suspended in the water. Yet another method consists in baiting ordinary iron fish-hooks and letting these down to the bottom with long lines of common twine, and by means of these frail lines the great clumsy sharks are pulled up to the surface.

The scientific name, *Somniosus*, is derived from a Latin word meaning "sleepy"; *microcephalus* simply means "small-headed".

BRAMBLE OR SPINOUS SHARK.

(Genus *Echinorhinus*.) Fig. 23.

The body is more slender than that of the Greenland Shark. The mouth is crescent-shaped, and the teeth are alike in the 2 jaws, each tooth having the middle point very strongly developed and turned outwards towards the side of the jaw. The spiracles are minute, and the external gill-clefts of moderate size. The 2 dorsal fins are without spines, of small size, and the first is placed above the pelvics. The skin is armed with scattered, round, flat, button-like denticles, some of which are surmounted by a tuft of small prickles like those on a bramble. The coloration is dark brown above, sometimes with some darker spots, and paler or whitish beneath.

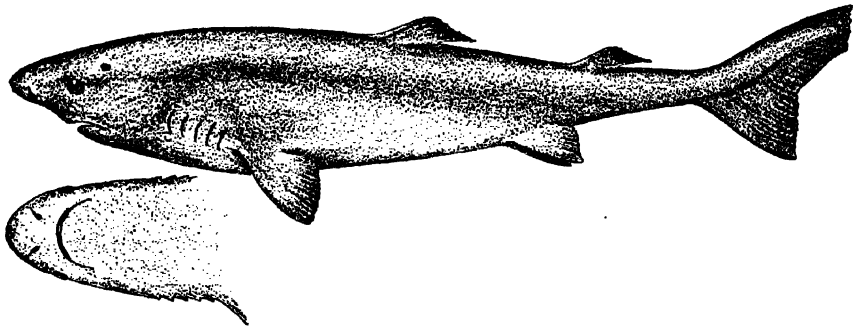


FIG. 22.—Greenland or Sleeper Shark (*Somniosus microcephalus*).

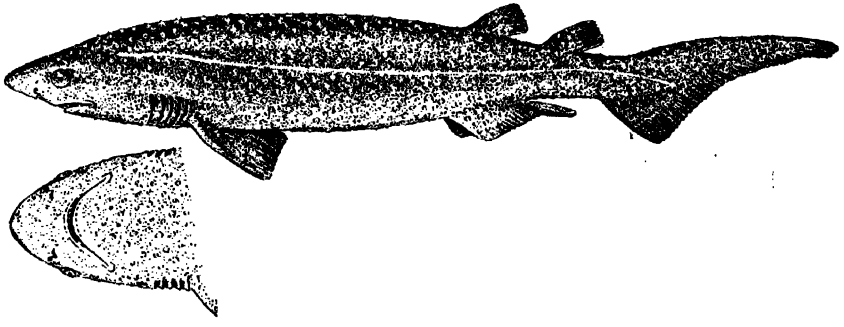


FIG. 23.—Bramble or Spinous Shark (*Echinorhinus spinosus*).

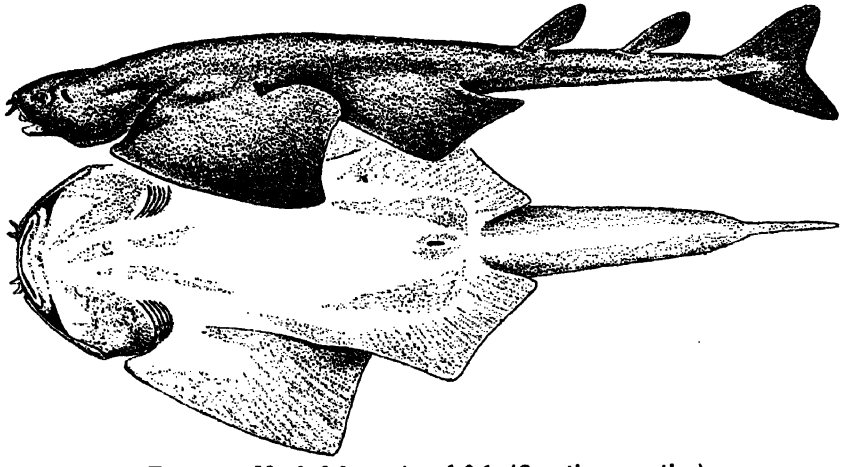


FIG. 24.—Monk-fish or Angel-fish (*Squatina squatina*)

Grows to a length of 10 feet and a weight of about 400 lb.

The single existing species (*E. spinosus*) is found in the Atlantic and Mediterranean, and ranges to South Africa, Australia, New Zealand and Japan. There are a number of records from the British Isles, particularly from the warmer south-western coasts.

The Bramble Shark appears to prefer deep water, but very little is know of its habits. Judging from the contents of the stomachs of captured specimens, the food consists largely of fishes and crustaceans. A female, 9 feet long, which was taken on a conger-line off the Eddystone in 1869, had several dogfish about 3 feet in length in its stomach. The fact that it is nearly always caught on baited lines suggests that the Bramble Shark is a bottom feeder.

Nothing is known of its breeding habits, and it has little economic value.

ANGEL-FISHES OR MONK-FISHES.

(Family SQUATINIDÆ; Genus *Squatina*.) Fig. 24.

Sharks with a broad body, flattened from above downwards, and with a blunt, rounded snout. The eyes are small and placed on top of the head. The mouth is near the end of the head, and is armed with several rows of pointed teeth, which are set well apart from one another. The spiracles are large, crescent-shaped, and placed at a short distance behind the eyes. The external gill-clefts are wide, and are all crowded together in front of the pectoral fins, the bases of which partly hide them. The 2 dorsal fins are without spines, of small size, and situated well back on the tail. There is no anal fin, and the caudal fin is rather small. Each pectoral fin is prolonged forward to form a sort of angular "shoulder", which is quite free from the head and body. The pelvic fins are large. The coloration of the upper surface is generally grey or brown, but varies from yellowish to nearly black, and it is usually blotched and spotted with darker; in addition, there are often some white lines and spots on the back; the lower surface is plain white.

These Sharks are found in most temperate and tropical seas. Fossil remains of *Squatina* date back to the Jurassic

and Cretaceous periods, and the well-preserved remains in the Lithographic Stone of Bavaria reveal fishes which are indistinguishable from their descendants living to-day.

Grow to a length of about 8 feet.

The common Monk-fish or Angel-fish (*S. squatina*) is found in the Atlantic and Mediterranean and is common on the British coasts. Other species (*S. armata, californica, australis, japonica*, etc.) occur in Chile, Mexico and California, Australia and Japan.

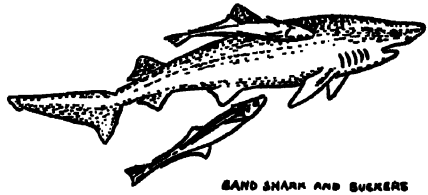
In its general appearance this curious creature is almost exactly half-way, as it were, between the Sharks and the Rays, a feature which is reflected in the local names of " Shark-Ray ", " Mongrel Skate " and so on. A study of its internal anatomy, however, shows it to be a true Shark, related to the Spined Sharks (Squalidæ)—a conclusion that is confirmed by the position of the external gill-clefts on the sides of the head. The flattened body, the extension forward of the pectoral fins, and the backward position of the dorsal fins, are ray-like features, but there seems to be little doubt that these have been independently acquired to fit the shark for a life on the sea bottom, and do not necessarily indicate any close relationship with the true Rays. A further argument in favour of placing the Monk-fish with the sharks rather than with the rays is provided by the method of swimming. Progress is effected by means of a powerful sculling action of the oar-like tail, and it makes little or no use of the pectoral fins for this purpose.

In feeding, however, the Monk-fish is more like a Ray, and its normal diet includes flatfishes, shellfish, crustaceans, and other animals found on the sea floor. One female examined was found to have in its stomach several dabs and plaice, portions of other fish, scales of mullet, not less than 50 fish-eyes, and a fair-sized bundle of a kind of seaweed known as eel-grass. There is a record of a Monk-fish coming to the surface and seizing a living cormorant by the wing, holding it below the surface until it was drowned.

The Monk-fish spends the winter offshore in rather deep water, but approaches the coasts in spring for breeding purposes. The young are born alive, generally in June or July, and 25 have been recorded at a single birth.

The flesh is rather coarse, and was formerly despised as food; nowadays, however, a number of these sharks are landed each year, the majority going to the fried-fish shops. In olden times the rough skin was much used for polishing wood and ivory, as well as for hilts for swords, sheaths for knives, coverings for boxes, etc. It was also dried and crushed up for medicinal purposes, being prescribed as a sovereign remedy for the itch and for other skin complaints.

The name "Angel-fish" refers to the "shoulder" of the pectoral fin, the shape of which is held to resemble the bend of the conventional angel's wing, while the name "Monk-fish" has reference to the supposed appearance of a cowl on its head. Another popular name, "Fiddle-fish", is derived from its general shape. The scientific name, *Squatina*, is a very old name for this shark, but its actual derivation is doubtful.



SAND SHARK AND SUCKERS

CHAPTER III: RAYS.

General features of the Rays. Guitar-fishes. Saw-fishes. Electric Rays. True Rays. Skates and Rays. Sting Rays. Whip-tailed Sting Rays. Eagle Rays. Spotted Eagle Ray. Cow-nosed Rays or Whipparees. Sea Devils or Devil-fishes. Manta or Greater Devil-fish. Small or Lesser Devil-fish.

To most people the term " ray " will conjure up a picture of a much flattened fish, with a rounded or quadrangular disc-like body, from which projects a stumpy tail. Used collectively, the term " Rays " covers all the members of the second great Order of existing Selachians, the order Hypotremata, a group which includes a large number of very diverse creatures, some of them quite unlike the well-known ray already described. Indeed, as will be shown in this chapter, the Order includes an almost complete gradation of types, starting with those which are still almost shark-like in outward appearance, and ending with specialized types that are as far removed from their shark ancestors as any fishes could be.

The principal differences between the Sharks on the one hand and the Rays on the other have been already touched upon in Chapter I, and we may notice at once that practically all these are related to a change in the manner of life. Rays, in other words, are simply sharks that have become specially modified to fit them for a new mode of life—a life spent

almost entirely on the sea bottom. Looked at from this point of view, the changes in the form of the pectoral fins and the position of the external gill-clefts are seen to have a definite meaning. The pectoral fins in the rays have become enlarged (in the more specialized forms enormously so), and have not only extended forward, but have also become joined to a greater or lesser extent to the sides of the body or head. This arrangement, which eventually results in the formation of a flat disc in which the limits of the head, the body, and the pectoral fins are indistinguishable, has led to the restriction in the size of the external gill-clefts, and has also forced them downwards on to the under-side of the fish. Thus, however shark-like in appearance a member of this Order may be, its true character may be at once recognized by the position of the gill-openings on the lower surface.

The Rays have certain other features in common, and some of these may be briefly mentioned. The body is always flattened from above downwards—another characteristic feature of creatures that live on the sea floor. The upper edges of the eyes are never free ; that is to say, the skin of the eye-ball is continuous with that of the head. There are never more than 5 gill-clefts on each side. The dorsal fins are placed well back, the first never being in front of the level of the pelvics, and they are usually much reduced in size and may be altogether wanting. There is never any anal fin.

The spiracles, those vestiges of what were once functional gill-clefts (*see* p. xix), are always large in the Rays, and are generally placed close behind the eyes on the upper surface of the head. In these fishes the spiracles have taken on an entirely new duty, and one which has become necessary in consequence of the change in the manner of life. When breathing, a Shark takes in water through its mouth and expels it through the gill-clefts. When swimming or crawling about, a Ray is able to breathe in the same way, but when resting on the bottom there is a danger of taking in sand or mud with the water and thus of clogging the delicate gills. To obviate this difficulty, when resting the Ray takes in water through the spiracles, which are provided with special movable valves rather like shutters, whose purpose is to regulate the flow of water into the gills.

As in a large number of ground-living animals, coloration of the upper surface of the Rays is in close harmony with that of the ground on which they live, whilst the under-side is usually a dead white. The skin of the upper surface is generally strengthened by the presence of numerous dermal denticles, which often take the form of sharp spines, and that of the lower surface is quite smooth.

The Rays may be looked upon as a comparatively modern offshoot from the Sharks, the earliest forms having made their appearance towards the middle of the Mesozoic Era. They are nearly all sluggish, rather clumsy creatures, and with few exceptions are found in fairly shallow inshore waters. Some are found at considerable depths, however, and a few live fairly near the surface.

GUITAR-FISHES.

(Family RHINOBATIDÆ.) Fig. 25.

Shark-like Rays, with the head and body flattened, but with a thick powerful tail that merges imperceptibly into the trunk. There are 2 well-developed dorsal fins and a distinct caudal fin. The pectoral fins are expanded, but are not continued as far forward as the snout. The pelvic fins have no notch. The upper surface is covered with a uniform shagreen of tiny denticles, and there are usually some larger denticles, especially down the middle of the back. The coloration is variable, but most of them are uniformly brown or grey above.

These rays are found in most warm seas in rather shallow water. Fossil remains occur in rocks of the Jurassic and Cretaceous periods, and reveal fishes extraordinarily similar to their descendants living to-day.

It is impossible to deal here in detail with the various genera of Guitar-fishes, most of which have very similar habits, and the family must be considered as a whole. Three genera (*Rhina*, *Rhynchobatus*, *Rhinobatus*), however, may be specially mentioned, as these include species that grow to a length of 6 feet or more.

The so-called Mud Skate (*Rhina ancylostoma*) is widely

distributed in the Indian and Pacific Oceans. It has a broad, rounded snout, the first dorsal fin is above the pelvics, and there are several rough ridges composed of enlarged denticles on the head and neck. The whole of the upper surface is covered with numerous round, white spots, and there are also some darker and paler bars, but all these markings tend to become obscure in large individuals.

The Ulavi or Plough-headed Ray (*Rhynchobatus*), with one species in the eastern Atlantic and another in the Indian and Pacific Oceans, also has the first dorsal fin well forward, but the snout is rather long and pointed and the enlarged denticles are smaller and confined to the region of the snout, eyes and spiracles, the shoulders, and the middle line of the back. The young have 2 vivid eye-like spots on the body near the bases of the pectoral fins, and there are a number of more or less symmetrically arranged white spots on the body and tail, but these markings are wanting in full-grown examples.

The genus of true Guitar-fishes or Fiddler Rays (*Rhinobatus*) includes a number of species from most warm seas, some small, others growing to a large size. Here the first dorsal fin lies well behind the pelvics, and the tail is much reduced in size, with the lower lobe less evident. The shape of the snout and the coloration varies in the different species.

The Guitar-fishes swim about slowly near the bottom, or lie half buried in the sand or mud. When swimming, the muscular tail is used as the organ of propulsion, the pectoral fins being employed to raise or lower the body or for purposes of turning and banking. Their food seems to consist mainly of small fishes, crustaceans, shellfish and other ground-living animals, which they crush with the tooth-bands made up of numerous small, rounded teeth, set close together in pavement fashion. The bands of teeth in the Mud Skate have a curious shape, that of the upper jaw being alternately hollowed out and swollen, and that of the lower jaw provided with corresponding bumps and depressions to fit into the upper (Fig. 59). The jaws of the Ulavi are much less wavy in outline, a single swelling in the middle of the lower jaw fitting into an indentation in the upper; in the Guitar-fishes the tooth bands are quite straight.

Some of the Indian Guitar-fishes are said to live in large

shoals or droves, and to do great damage to the pearl-oyster beds of Ceylon and elsewhere. The largest individuals, however, are quite harmless to man.

These rays are ovo-viviparous, the eggs being hatched within the body of the mother, and several young are produced at a birth.

The Guitar-fishes are not of any great commercial importance, although their skins provide good shagreen or leather. The flesh of the Ulavi is considered nourishing in parts of India, and is eaten both fresh and salted. The oil from the liver is also much valued. The fins of some Guitar-fishes are treated and exported to China to be used for making soup.

The names " Shovel-nosed Ray ", " Guitar-fish ", " Fiddler Ray ", etc., refer, of course, to the shape of the head and body. The scientific name, *Rhynchobatus*, means literally " snout skate ", and *Rhinobatus*, " shark skate ".

SAW-FISHES.

(Family PRISTIDÆ ; Genus *Pristis*.) Fig. 26.

Shark-like Rays which are very closely related to the Guitar-fishes, but which have the snout drawn out into a long, flat, blade-like rostrum, armed on either edge with strong " teeth ". The pectoral fins are not joined to the head to the same extent, and are of moderate size.

Saw-fishes are found in most warm seas, and may enter fresh water. There is an extinct genus found in Cretaceous rocks, but the genus *Pristis* does not occur in rocks older than those of the Eocene period.

The larger species grow to a length of at least 20 feet, and individuals of 30 feet or more are sometimes encountered.

There are about 6 existing species, mostly occurring in the brackish waters of estuaries or on sandy or muddy stretches close to the shore. The Common Saw-fish or " Pez Sierra " (*P. pectinatus*) is abundant in the Gulf of Mexico and ascends the lower Mississippi. Another species (*P. perroteti*) is found for considerable distances up the Zambesi, Shiré, and probably in other African rivers, and a third (*P. cuspidatus*) ascends the larger Indian rivers to well beyond the influence of the tides.

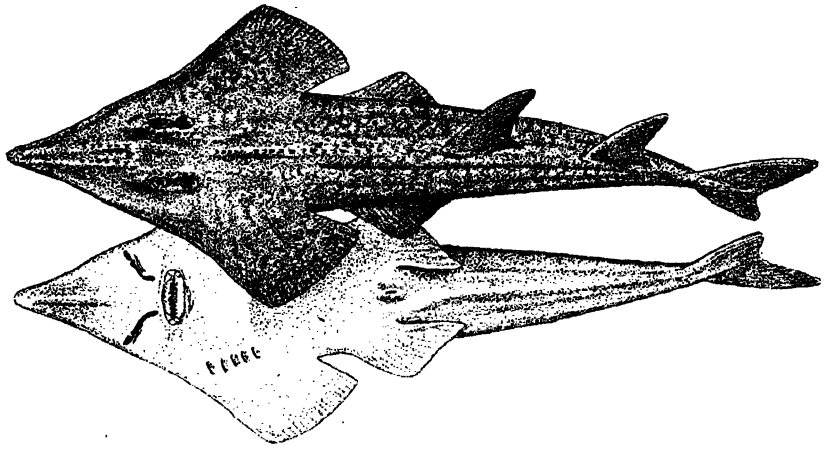


FIG. 25.—Ulavi or Plough-headed Ray (*Rhynchobatis djiddensis*).

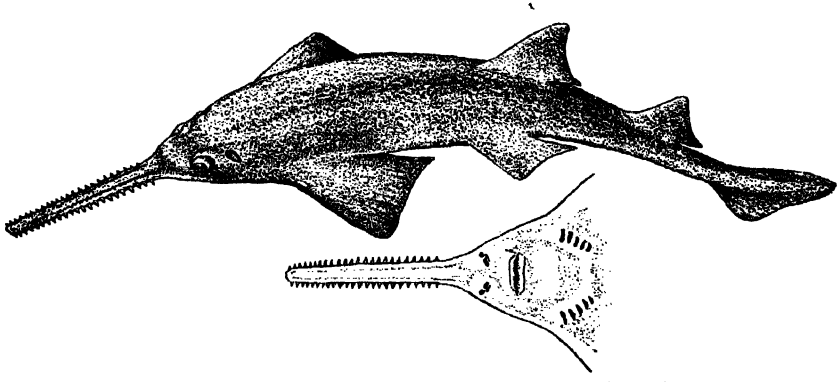


FIG. 26.—Common Saw-fish (*Pristis pectinatus*).

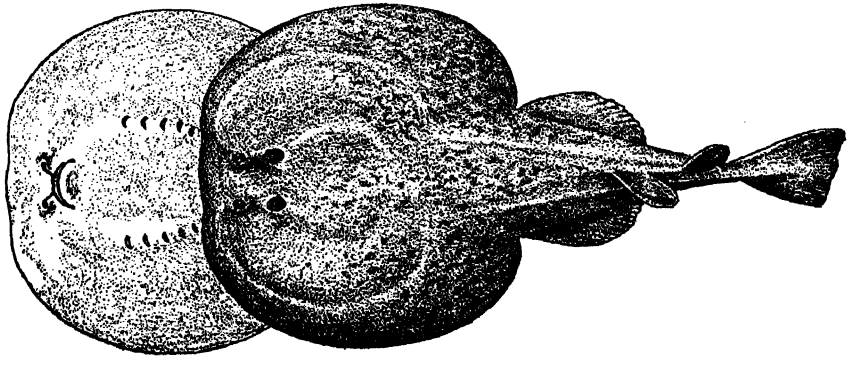


FIG. 27.—Mediterranean Torpedo (*Torpedo marmoratus*).

The remarkable toothed rostrum of these rays is worthy of some attention, as it is a structure found only in one other group of fishes. In a large Saw-fish it forms a formidable weapon, and " saws " 6 feet long and a foot in width across the base are by no means rare objects. The rostrum is supported inside by prolongations of the cartilages of the skull, more or less strengthened by the addition of limy matter, which take the form of from 3 to 5 tube-like structures. It is of interest to note that ignorance of the true nature of these tubes led a scientist to describe one of them as the arm of a giant star-fish, to which he gave the generic name of *Myriosteon*. The teeth along the edges of the rostrum, which are firmly implanted in deep sockets, are actually much enlarged dermal denticles. The true teeth, set in pavement formation in the straight slit-like mouth on the lower side of the head, are small and quite blunt.

The " saw " may occasionally be used as a defensive weapon, but as a general rule its purpose is to obtain food, and this may be done in two different ways. The Saw-fish may grub about in the sand or mud, turning it over in its search for small fishes and other creatures lying buried there, or it may rise among a shoal of fishes swimming in the water, and, by striking rapidly from side to side, create havoc among them, leaving a number of stunned or dead victims to be devoured at leisure. On occasions it may even attack larger fishes, cutting large lumps of flesh from their bodies with the " saw ", but stories of its attacking whales are probably without foundation.

The normal food consists mainly of fishes, mullet and sardines being especial favourites, but crustaceans and other ground-living creatures are also eaten. It is believed that Saw-fish will attack man, but reliable records of this habit are difficult to find. The fact remains, however, that it is held in great dread by the natives in parts of India, and Dr. Day, an authority on Indian fishes, states that, although not personally a witness to the occurrence, he had been informed on native authority that a large Saw-fish had once cut a bather entirely in two.

A glance at the general outlines of the Saw-fish shows at once that it has retained a number of shark-like features.

The body is still long and only partially flattened, the tail is powerful and has a conspicuous caudal fin, the pectoral fins are not very greatly expanded and are comparatively free from the head and body, and the 2 large dorsal fins are placed well forward on the body. Further, the Saw-fish swims, not by means of the pectoral fins, which are used mainly for steering, but by powerful oar-like strokes of its tail. In all essential characters, however, it is a true Ray, and has clearly been derived from ancestral Guitar-fishes.

Like the Guitar-fishes, the Saw-fishes are ovo-viviparous, and a number of young are born at a time. A female estimated to weigh 5300 lb. caught in the West Indies was found to contain several embryos. So powerful was this particular fish that it towed a fair-sized boat for several miles before it succumbed. In another female, 15½ feet in length, caught off the coast of Ceylon, there were 23 young. The "saw" remains more or less soft and flexible until after birth, and this process is rendered easier for the mother by the fact that the teeth at this stage scarcely project through the membrane which envelops them.

The flesh is very coarse and is of little use as food, although it is eaten by some of the lower castes in India. The fins, however, are commercially valuable, being exported to China to be made into soup. The skin provides a handsome shagreen, and, after tanning, a tough and durable leather; the liver yields a valuable oil. The "saw" is a popular curio, and is a familiar sight in the windows of dealers in natural history specimens. Dr. Day records that on the Mekran coast of India the fishermen of all religions presented the saws at a small temple, where they were hung up inside or piled round the outside. The priest was supposed to pray for success in their "catches" and for a safe return to the shore. It is also recorded that when the aboriginal inhabitants of the Andaman Islands wished to make a suitable offering to their superintendent they attacked and harpooned, at considerable risk to themselves, an enormous Saw-fish, and presented him with the rostrum.

The Saw-fish can scarcely be classed among the game fishes, but one of 14 feet and weighing 600 lb. was taken on rod and line on the coast of Florida.

ELECTRIC RAYS.

(Family TORPEDINIDÆ.)

Rays in which the head, trunk and pectoral fins form one almost circular flattened disc, from which projects a somewhat short and stout tail, generally with a keel-like fold running down either side. There are special paired electrical organs between the pectoral fins and the head. There may be 1 or 2 dorsal fins, or these may be absent, but, when developed, they are situated on the tail. A caudal fin is present. The pelvic fins have no notch. The skin is soft and flabby, and there are no dermal denticles.

These rays are found in nearly all warm seas, mostly inshore, but sometimes in quite deep water. Fossil remains occur in rocks of the Eocene period. Only the true Electric Rays, known as Torpedoes, Cramp-fishes or Numb-fishes, grow to any size.

TORPEDOES.

(Genus *Torpedo*.) Fig. 27.

Electric Rays with a very broad disc and a short tail. The spiracles are large, rounded, and placed close behind the eyes; their edges are not fringed. The teeth are small and pointed, and closely set in pavement form. There are 2 dorsal fins and a well-developed caudal fin. The pelvic fins are large and quite separate from each other. The coloration of the upper surface varies from pale yellowish-brown to almost black, and may be uniform or variously spotted and mottled.

The largest species grow to a length of 3 to 6 feet or even more, and a weight of 200 lb.

There are a number of existing species, of which the following four, all attaining to a fair size, may be mentioned. The Cramp-fish or Numb-fish (*T. occidentalis*) of the Atlantic coast of the United States; the Black Torpedo (*T. nobiliana*) of the Mediterranean and the adjacent parts of the Atlantic, which is not uncommon in British waters; the Mediterranean Torpedo (*T. marmorata*), with a similar distribution; and the Californian Torpedo (*T. californica*).

The most interesting feature of these rays is, of course, the electrical organs. Each of these consists of a large, flat body, made up of a number of upright hexagonal tubes or columns, separated from one another by walls composed of fibrous tissue. These tubes are very numerous, and as many as 470 have been counted in each organ. Each column is filled with a clear, jelly-like substance, and is divided up into a number of compartments, each of which contains a flat electric plate. Every plate is connected by fine nerve tendrils with the main nerve supplying the electric organ, which is in turn connected with a special lobe of the brain. The side of the electric plate to which the nerve tendrils are attached has been shown to be negative, the other side to be positive, and the current passes from the upper or positive side of the whole organ to the lower or negative side.

It is of interest to consider the manner in which these complicated organs were acquired. In all animals the contraction of a muscle is accompanied by the generation of a minute amount of electricity, and the electrical organs of the Torpedoes, as may be ascertained by a study of their development in the embryos, are known to have been evolved through the modification of muscular tissue—tissue which would normally go to form muscles connected with movements of one of the gill-arches. What has actually happened is that the electrical properties inherent in all muscles have here been accentuated at the expense of the mechanical properties.

The electrical discharge may be produced as the result of a simple reflex action, or it may be under the control of the fish. It produces all the usual effects of electricity. In order to obtain the full shock it is necessary to complete the circuit by touching the fish at two points, either directly or through the medium of some conducting body. It has been found that a quite powerful sensation of numbness can be produced through the medium of a stream of water, that is to say, by pouring water on to a living fish. The frequency of the shocks is very high, amounting to about 150 per second. Repeated use of the electric organs weakens their power, and a period of rest and feeding is necessary before the fish is fully restored.

In addition to providing the Torpedo with effective protection from potential enemies, there can be little doubt that the electric organs are used to kill or stun its prey. In this connection it may be noticed that of two individuals captured in the estuary of the Tees, one had an eel of 2 lb. and a flounder of 1 lb. in its stomach, the other a salmon of nearly 5 lb., and that none of the victims showed any signs of marks or blemishes on their bodies. The power of the shock probably depends to some extent upon the number of electric plates included in the circuit, and it also varies with the size, strength and general condition of the fish. It may be quite sufficient to knock a full-grown man off his feet when he accidentally steps upon a Torpedo buried in the sand. The electrical powers of these rays were well known to the ancient Greeks and Romans, and Aristotle notes that they catch their prey by means of a stupefying apparatus in their mouths or on the backs of their heads. Plutarch points out that their numbing influence has been known to pass from the net to the fisherman's arms.

The Torpedoes are rather sluggish in their habits, and spend most of their time lying buried in the sand or mud awaiting the approach of suitable prey. The food consists of fishes, crustaceans, shellfish, and all kinds of other ground-living creatures.

The young are always produced alive. The late Prof. Fritsch, who made a careful study of their development, records that the embryos pass first through a shark-like, then through a ray-like, and finally through a torpedo-like stage. As in many other Selachians, the very young embryos have long filamentous processes projecting from the external gill-clefts : these are believed to assist their respiration, and are probably also used for the absorption of nourishment from the mother.

The Torpedoes have no economic value. As food they are practically tasteless, and the flesh is flabby and watery. The classical writers, however, extol the virtues of the Torpedo, not only as an article of food, but as a specific for various human ills. Dr. Radcliffe, in his ' Fishing from the Earliest Times ', has collected a number of classical references to this fish, which was apparently looked upon as a sovereign remedy

for chronic headache and for the gout! "As the German and Austrian watering places are still under a cloud," he writes (in 1921), "we may yet see on the shores of Italy bands of gouty and passionate pilgrims standing bare-legged, awaiting the cure of the νάρκη!"

TRUE RAYS.

(Family RAJIDÆ.)

Rays with the head, trunk and greatly enlarged pectoral fins all united to form a flattened rhomboid disc, well marked off from the somewhat long and stout tail, which has a fold along each edge. There are usually 2 small dorsal fins, placed close to the end of the tail, and sometimes a caudal fin. The pectoral fins extend forward as far as the snout. There is no saw-edged spine on the back of the tail. The skin of the upper surface is more or less roughened with spines or with larger tubercles.

These rays are found in most temperate seas. Fossil remains date back to the Cretaceous period. Only the genus of Skates and Rays (*Raja*) need concern us here.

SKATES AND RAYS.

(Genus *Raja*.) Fig. 28.

The disc is nearly quadrangular or roughly circular in shape. The snout is supported by a rostral cartilage which projects forward from the front part of the skull. The eyes are prominent. The mouth forms a nearly straight slit on the under-side of the head, and is provided with several rows of small teeth in each jaw set in pavement form. Each tooth may end in a point, but is more often worn quite flat. The fairly large spiracles are close to the eyes. There are 2 dorsal fins, but the caudal fin is small or wanting altogether. The pectoral fins are widely separated in front and do not reach the end of the snout. The pelvic fins each have a conspicuous notch in their hinder borders. The skin of the upper surface is more or less roughened with small spines, but rarely with a

close-set shagreen. The coloration of the upper side is very variable, that of the lower side white or grey.

The larger species may grow to a length of anything from 6 to 10 feet and a width across the disc of 7 or 8 feet. Other species only attain a much smaller size.

There are a large number of existing species of Skates and Rays, found in most temperate seas, but more abundant in the northern than in the southern hemisphere. Not only are they mostly cold-water fishes, but they approach closer to the Arctic and Antarctic regions than do any other members of the Order. A few species are found at considerable depths, and some of these deep-water forms may extend into tropical seas. Many of the species are very similar, and experts sometimes have difficulty in distinguishing them. Professional fishermen generally lump them all together, large and small, under the name of "skates". Among the larger species mention may be made of the Common Skate (*R. batis*), from the coasts of Western Europe and from South Africa; the Burton Skate, White Skate or Bordered Ray (*R. alba*), with a similar distribution; the Barn-door Skate (*R. stabuliforis*), ranging along the Atlantic coast of North America from Nova Scotia to Florida; the Californian Ray (*R. binoculata*); and the Japanese Skate (*R. tengu*).

In the Skates and Rays we have fishes that are admirably adapted for a life spent almost entirely on the sea floor. The general shape is essentially that of a ground-living creature, and the coloration of the back is one which harmonizes closely with the ground on which they lie. In this way they are not only protected from attack, but, lying motionless or gliding like ghosts along the bottom, they are able to approach within striking distance of their prey without being observed. The difference in the general shape as compared with a Guitar-fish or Saw-fish is accompanied by a difference in the manner of swimming. The tail no longer forms the principal organ of propulsion, being reduced to a mere appendage used mainly for steering, and, instead, the huge pectoral fins, or "wings" as the fishermen call them, are brought into play. By a series of wave-like movements of these fins a Skate is able to attain to a fair degree of speed.

Normally a Skate is an inactive creature, lying half buried

in the sand or mud, and the only sign of life is the rhythmical movement of the valve guarding each of the spiracles. But, let a small fish, crustacean or other desirable titbit come within reach, and it at once comes to life, revealing an activity almost incredible in a creature of such clumsy build. The position of the mouth makes it impossible for a Skate at once to seize the prey, but with a swift pounce it literally throws itself upon the unsuspecting victim, holds it down and smothers it with its vast body and fins, and finally grasps it in its jaws.

The diet of the Skates and Rays is a very varied one, and includes almost every kind of animal life to be found on or near the sea floor. Among outsizes in meals may be mentioned an angler-fish weighing 6 lb. found in the stomach of one individual, and a stone nearly a pound in weight removed from another.

In almost all Skates and Rays there are more or less marked differences between the sexes, quite apart from the " claspers ", which provide a sure means of sexing all but the very smallest specimens. In some species these differences are so pronounced that the male and female were at one time regarded as distinct forms. In size the females are nearly always larger by about one-third than the males. The number and arrangement of the spines on the upper surface of the disc, and even the shape of the disc itself, differs in the two sexes. All mature males have a patch of curved spines near the edge of each pectoral fin, spines which are entirely lacking in females. It has been suggested that these play some part in holding the female during coition, but it seems more probable that they are offensive weapons, and used in combats between rival males, several of which have been observed to follow a single female and to buffet one another with their pectoral fins. Finally, in certain species the teeth are of a different shape, being pointed in the males and flat in the females.

A curious feature concerning the eyes of these fishes may be mentioned here, since this probably represents another adaptation to their particular mode of life. The upper part of the pupil is covered by a thick dark lobe or veil, rather like a vine leaf in appearance, which can be expanded or contracted at will, and thus controls the amount of light that falls upon

the pupil. In summer months it is not unusual for Skates to come to the surface and to bask in the sunshine, and they frequently leave the bottom suddenly in pursuit of prey; under such circumstances this arrangement of the eyes would be of service in counteracting the sudden increase in the amount of light.

It has been shown that the Skates and Rays are protected from their enemies by their general resemblance to their surroundings, but, should this fail, they are provided with more than one other line of defence. In the first place, there are the spines with which the disc is armed, which are always larger on the head, shoulders, and along the middle of the back and on the tail. When threatened, they have the habit of bending the snout and base of the tail towards each other, making the upper surface of the back concave, and then of lashing about in all directions with the spiny tail. Some of the species in which the spines are particularly strong have been observed to coil themselves up into a ball with the spines projecting in all directions, rather after the manner of a hedgehog. All Skates are also provided with electric organs, situated on either side at the end of the tail, and, although their power is very feeble when compared with that of the complicated organs of the Torpedoes, they probably afford some protection.

All the species are oviparous. The eggs are large and heavily yolked, and are fertilized in the upper part of the oviduct, that passage which leads from the ovary to the vent. As the egg passes down the oviduct it is invested in a special horny capsule or envelope, tough but not brittle, which, in addition to the egg, contains a certain amount of semi-fluid albuminous material similar to the " white " of a hen's egg. The capsules are deposited 1 or 2 at a time, and are roughly oblong in shape, blackish or sea-green in colour, and with each corner produced into a more or less stiff, pointed horn. These capsules, which vary from 3 to 7 inches in length according to the species, are familiar objects of the sea-shore, especially after rough weather, and are popularly known as " skate barrows ", " sailors' purses ", or " mermaids' purses ". They are deposited by the parent on muddy or sandy flats, and, as the more rounded side of the capsule is sticky, this

picks up small pieces of shell, stones or seaweed, which help to anchor it to the bottom. The "horns" of the capsule are hollow and provided with small slits, through which a current of water flows to the growing embryo. Here the young Skate lives for a period of from 4½ to nearly 15 months, deriving its nourishment from the store of yolk in the egg, until it finally forces its way out through a slit in one end of its prison.

At one time the Skates and Rays were of comparatively little commercial importance, but, in the British Isles at least, they are now used extensively for food, and as many as 558,000 cwts. of these fish are landed by British vessels in an average year. The flesh is perfectly wholesome and nutritious, but in large specimens may be rather coarse and tasteless. Much depends on the manner in which it is cooked, and *raie au beurre noire* as served in the best restaurants on the Continent is a dish much appreciated by the epicure. The fishermen catch them both with the trawl and with baited lines. Only the "wings" are used, these being cut off and the remainder of the body thrown away or used for manure. The increasing popularity of Skates and Rays has led to their being overfished on parts of the British coasts, and, in spite of improvements in both boats and gear, the catches show a tendency steadily to decline.

The Common Skate is sometimes fished for with rod and line by the angler, especially off the coast of Ireland, where it is common. It gives relatively poor sport, however, and when hooked goes straight to the bottom and stays there. It is very difficult, indeed often impossible, to raise a large specimen without breaking the tackle, but if its head can be lifted sufficiently the fish comes up like a kite. The record Skate caught by fair angling was taken at Valencia in 1927, and weighed 218½ lb.

STING RAYS.

(Family TRYGONIDÆ.)

Rays with the head, trunk and greatly enlarged pectoral fins united to form a broad, flattened disc, well marked off from the tail, which is usually narrow and whip-like. The

folds along the sides of the tail seen in the Guitar-fishes, Electric Rays and True Rays are usually absent, but there are often folds or keels along the upper and lower surfaces. There is sometimes a single small dorsal fin placed near the root of the tail, and a caudal fin may also be present. The pectoral fins extend to the extremity of the snout, which is actually supported by the union of these fins in front of the skull, which has no rostral cartilage. The pelvic fins have no notch. There is nearly always 1 (sometimes 2 or more) saw-edged spine on the back of the tail. The skin of the upper surface is either smooth or roughened with tubercles. There are no hooked spines at the edges of the pectoral fins in the males, and the two sexes are alike apart from the claspers.

These rays are found in most warm seas. Some of the species enter rivers, and others live entirely in fresh water. Fossil remains date back to the Cretaceous period.

WHIP-TAILED STING RAYS.

(Genus *Trygon*.) Fig. 29 A.

The tail is long and whip-like, without either dorsal or caudal fins. The mouth forms a straight or more or less curved slit on the under-side of the head, and the jaws are armed with several rows of small teeth set in pavement fashion. The spiracles are large and placed close behind the eyes. The coloration is variable.

Some of the larger species grow to a width of 5 or 6 feet across the disc.

There are about 30 species of these Sting Rays, and among the larger forms the following may be mentioned. The Common Sting Ray (*T. pastinaca*), from the Mediterranean and eastern Atlantic; the Stingaree or Clam-cracker (*T. centrurus*), from the Atlantic coast of North America; the Southern Sting Ray (*T. sayi*), ranging from Carolina to Brazil; the Fan-tailed Ray (*T. sephen*), from the Indian and Pacific Oceans; and the Crack-whip Ray (*T. uarnak*), with a similar distribution. The first of these makes its appearance on the British coasts with some degree of regularity every

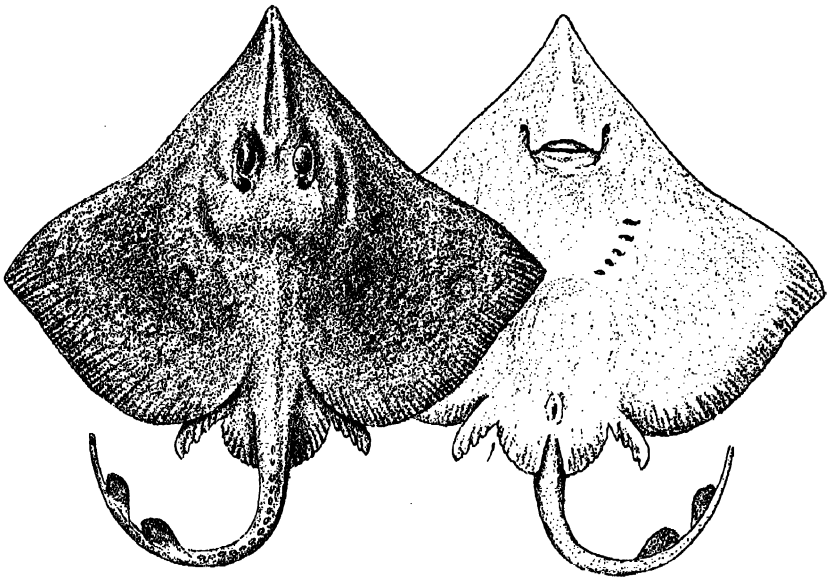


FIG. 28.—Common Skate (*Raja batis*).

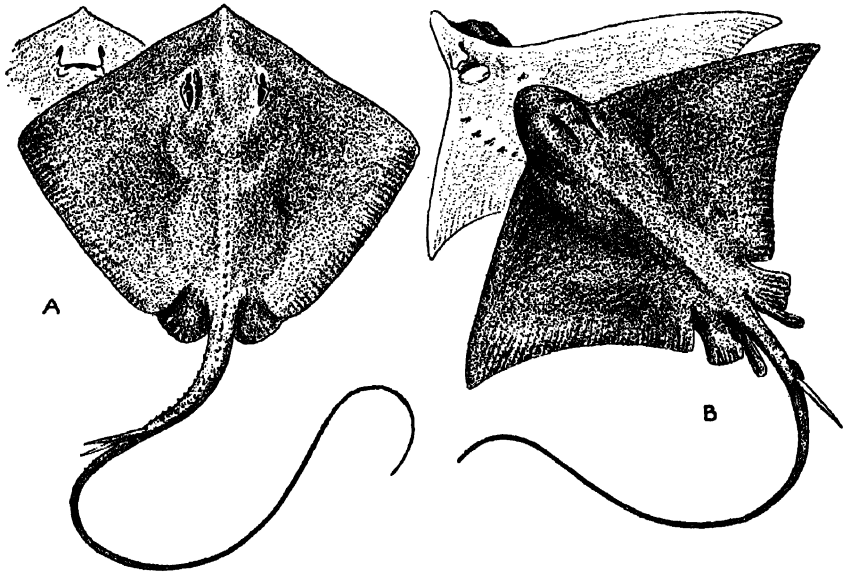


FIG. 29.—A. Stingaree or Clam-cracker (*Trygon centrurus*).
B. Common Eagle Ray (*Myliobatis aquila*).

autumn. The largest British specimen was 3½ feet in length and weighed 56 lb.

With these rays we encounter a further stage in specialization, the tail having become a mere appendage, useless alike for locomotion or for steering.

The principal feature of these fishes, and one from which they derive their name, is the presence of a sharp spine with jagged saw-like edges on the back of the tail. This " sting " may be anything from 3 to 12 or even 15 inches in length, and when worn out is replaced by a new one growing up behind it. Sometimes 2 or even 3 may be present at the same time. There can be little doubt that these " stings " are of essentially the same nature as the dermal denticles, and must have arisen in the first place either through the enlargement and specialization of a single denticle, or through the fusion of several denticles lying close together in the middle line of the back of the tail.

This spine provides a truly formidable weapon, and, when the tail is lashed furiously from side to side, is capable of inflicting a very nasty wound. Normally it would appear to be used as a defensive weapon, but Sting Rays have been observed to encircle prey with their whip-like tails and to cut and pierce them with the spines. Dr. Jordan has described how he saw one Sting Ray thrust the spine through the body of another lying near it in a boat. Dr. Coles mentions an individual weighing 64 lb., caught off the coast of Carolina, which, when prodded with a lance, " exhibited great fury and time and again threw itself on its back as it slashed at me with its barbed tail. It would give forth a loud, harsh, discordant bark of baffled rage at its failure to reach me . . . "

The ancient writers had fearful tales to tell concerning the wounds caused by the *Trygon*, and we read that " Circe armed her son with a spear which she pointed with a *Trygon's* spine as the most formidable weapon she could place in his hands, and with which he subsequently unintentionally slew his father, Ulysses ". " Nothing is more terrible," writes Pliny, " than the sting that arms the tail of *Trygon*, called *Pastinaca* by the Latins, which is five inches long. When driven into the root of a tree it causes it to wither. It can

pierce armour like an arrow, it is as strong as iron, yet possesses venomous properties."

It is of some interest to find Pliny suspecting the presence of venom, for, until a few years ago, almost all writers on fishes were agreed that no specific poison existed, and that the inflamed nature of the wound and the acute pain and paralysis was due merely to the irregular cut made by the saw-edged spine, aggravated by the slime and loose cuticle covering it. Recently, however, it has been shown that the narrow groove running along each edge of the spine contains a fine glandular tissue, that can scarcely be detected without the aid of a microscope. The cells composing this tissue secrete a virulent venom, and when they are ruptured this is squeezed out and runs down the groove and enters the wound.

The effect of the poison on man varies somewhat with the species, as well as with the size and general condition of the fish and the extent of the wound. It may be very severe, and on rare occasions has been known to be fatal. An Italian scientist describes how he saw " a young man become extremely pale and fall down almost senseless for a few minutes, from having received only a very small puncture while he was in the act of passing a Trygon, weighing 3 kgrm., from one person to another ". Dr. Schomburgk mentions a fresh-water Sting Ray found in British Guiana which was responsible for the death in violent convulsions of a colonist, whilst the two natives who accompanied him were wounded in the feet, became seriously ill, and only recovered the use of their feet after a long period of suffering. Many other cases of severe trouble, including gangrene and tetanus, following a wound by one of these " stings " have been recorded. It has been stated that some Malays fastened two spines to a pole and stabbed a horse, which became delirious, and was only saved by having the wounds enlarged and treated with iodine. Treatment of wounds, if carried out at once, is simple and efficacious. The injection of a few minims of a 5% solution of permanganate of potash (or " Condy's Fluid ") will relieve the pain and prevent inflammation.

The food of these fishes is very similar to that of the True Rays, consisting mainly of other fishes, crustaceans and shellfish.

All the species are viviparous, or, more accurately, ovo-viviparous, the eggs being hatched within the body of the mother. Some of the Sting Rays make elaborate provision for the nutrition of the embryo, and there may be developed a complicated connection with the walls of the uterus, recalling the placenta of mammals. The walls sometimes grow out into long, filamentous processes, which are richly supplied with blood-vessels and secrete a creamy nutritious fluid. This fluid may be absorbed by the blood-vessels of the yolk-sac of the embryo, or may be taken directly into its stomach by way of the mouth or spiracles.

None of the Sting Rays are of any value as food, the flesh being generally rank and disagreeable. A few of the rougher kinds provide a good shagreen. In Ceylon the tails were formerly dried and used, after having been treated with oil to make them supple, as whips for punishing criminals, but this is now prohibited by law. It is recorded that the fishermen of Wales believe that the oil from the liver of a Sting Ray is good for burns and other wounds.

EAGLE RAYS.

(Family MYLIOBATIDÆ.)

Closely related to the Sting Rays. The head, trunk and pectoral fins are joined to form a broad, lozenge-shaped disc, from which projects a more or less long, slender, whip-like tail, which has a single small dorsal fin near its base. Behind this fin there is generally 1 (sometimes more) serrated spine, similar to that of the Sting Rays but usually smaller. The pectoral fins are very muscular, and their front edges are much indented, so that they have the appearance of being missing on the sides of the head and of reappearing at the front to form a fleshy pad. The teeth are large, flat, and form a tessellated pavement in each jaw; there is always a row of broad teeth in the centre of the jaw, and usually 3 rows of narrow teeth on each side of the centre row. The skin is almost or quite smooth.

These are all large rays and are found in most warm seas. Fossil remains date back at least as far as the Eocene period.

TRUE EAGLE RAYS.

(Genus *Myliobatis*.) Fig. 29 B.

The fleshy pad at the front end of the head forms a single bluntly pointed or rounded lobe. There is a row of broad teeth in the centre of each jaw, with 3 rows of narrow teeth on either side (Fig. 59). The eyes are on the sides of the head, with the spiracles close behind them. The skin is either entirely smooth or with some tubercles on the upper surface. The coloration is variable, but is usually more or less uniformly grey, brown or black in full-grown individuals; the young may be variegated with paler or darker, and may have blue spots and stripes; sometimes the tail is banded.

The larger species grow to a length of about 15 feet (with the tail), and attain to a weight of 800 lb.

There are about 12 species of True Eagle Rays, all from warm seas. The Common Eagle Ray (*M. aquila*), from the Mediterranean and the adjacent parts of the Atlantic, is an occasional visitor to British waters. Other well-known species include the American Eagle Ray (*M. freminvillei*), which ranges on the Atlantic coast from Cape Cod to Brazil; the Californian Sting Ray or Bat-fish (*M. californicus*), very common on the mud flats of California; the Oriental Eagle Ray (*M. nieuhofi*), from the Indian Ocean and the East Indies; and the Japanese Kite Ray or Flying Ray (*M. tobijei*).

In spite of their apparently clumsy build, the Eagle Rays are graceful and fairly rapid swimmers. On occasions they will break the surface of the sea and skim for a short distance through the air. When captured, they are unpleasant customers to handle, lashing about in all directions with the flexible tail and trying to bring the saw-edged spine into action. As might be expected from the nature of the teeth, these rays feed almost exclusively upon shellfish, and they are particularly destructive to clams and oysters.

The Eagle Rays are viviparous, and their breeding habits are more or less the same as those of the Sting Rays. Captured individuals lying in the bottom of a boat have been known to give premature birth to 6 or more young. Dr. Coles, who

has studied their habits on the Carolina coast, notes that the species found there " gives birth to its young in pairs of two folded together with head and tail in reverse position, there being three pairs ". It is of interest to note that in the very young ray the teeth are all of about the same size, and it is only as it grows older that the centre teeth become broader.

The flesh is of somewhat poor quality, but is eaten in some parts of the world. Dr. Jenkins remarks concerning the Indian species that, when eaten fresh, the flesh is by no means to be despised.

SPOTTED EAGLE RAY.

(Genus *Aëtobatus*.) Pl. II c.

Very like the True Eagle Rays, but with a single row of long, bar-like teeth, arranged one behind the other, in each jaw (Fig. 59). The ground-colour of the upper surface is brown or grey, and there are numerous round, bluish-white or yellow spots, which are fainter on the head and the front part of the disc.

Grows to a very large size, the disc sometimes being 6 feet or more in width.

There is probably only one existing species (*A. narinari*), which is almost cosmopolitan in tropical and subtropical seas.

Very little is known of the habits of this ray, but there is little doubt that it feeds almost exclusively upon oysters and clams. It may do tremendous damage to the pearl-oyster beds, and those of Ceylon have occasionally been ruined by its depredations. " I have known beds, containing many bushels of planted clams," writes Dr. Coles, " being attacked by schools of these rays and every clam in them destroyed in less than a week. . . . The muscular development of the jaws of this fish is truly wonderful. I have found in these rays clams which with their shells on must have weighed more than 3 pounds, and to crack which a pressure of perhaps a thousand pounds would be required." Dr. Coles has also observed these rays using their snouts for rooting in the sand for shellfish, after the manner of a drove of hogs.

The Spotted Eagle Ray is not feared by fishermen to nearly

the same extent as the big Sting Rays. It does not offer so much resistance when captured, and the smaller spine, being placed much nearer to the base of the tail, forms a less effective weapon. It has been denied by many that there is any specific poison gland associated with the spine, but glandular tissue similar to that described in the spine of the Sting Ray is almost certainly present. Dr. Coles states there are many authenticated cases in which permanent disability, loss of leg or arm, or even death, has resulted from a wound caused by the " sting ", and gives a vivid description of his personal experience of its effects. " On the morning of July 12, 1910," he writes, " while handling a large specimen . . . it suddenly threw its body against me and drove its poisoned sting into my leg above the knee for more than two inches, striking the bone, and producing instantly a pain more horrible than I had thought possible that man could suffer. . . . I braced myself against the body of the creature and tore its barbed spine from my flesh." Luckily, he had a hypodermic syringe handy, and was able to inject a strong antiseptic solution into the wound: the effect was magical, the pain stopped instantly, and the wound rapidly healed.

The Spotted Eagle Ray is viviparous, and the growing embryo is nourished in the uterus of the mother in much the same way as that of the Sting Ray. When the young are ready to be born, the mother repeatedly leaps high into the air, and the curled-up embryos are thrown one at a time from her body.

The flesh of this ray is eaten in the West Indies, India, East Indies, the Hawaiian Islands and elsewhere, and is said to be white, and, if properly prepared, highly palatable. Apart from its use as food, it appears to have no economic value.

COW-NOSED RAYS OR WHIPPAREES.

(Genus *Rhinoptera*.) Fig. 30.

Very similar in appearance to the True Eagle Rays, but the fleshy pad at the front of the head is more or less divided into 2 lobes, and, as it is placed below the level of the pectoral fins, the snout has the appearance of being 4-lobed. The

teeth are in several rows in each jaw, those forming the middle row usually being broader than those at the sides. The coloration of the upper surface is more or less uniformly brown or black.

The larger species grow to a width of 3 or 4 feet or even more across the disc.

A number of species have been described, but as specimens

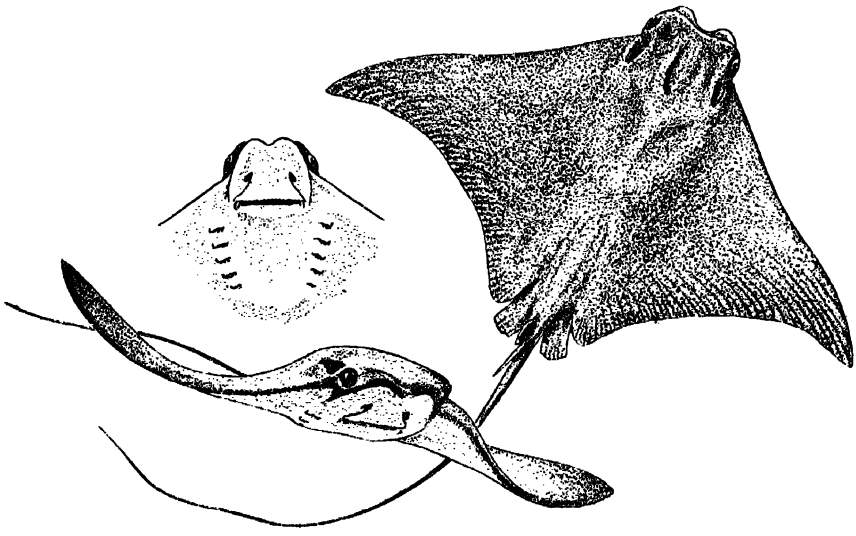


FIG. 30.—Cow-nose Ray (*Rhinoptera quadriloba*).

are very rare in museums, it is difficult to find out how far these forms are really distinct. All occur in tropical seas. The Cow-nose Ray (*R. quadriloba*) ranges on the American coast from Cape Cod to Florida; the Gabilan (*R. steindachneri*) occurs in the Gulf of California; another species (*R. marginata*) is found in the Mediterranean, and others in the Indian and Pacific Oceans.

Like the True Eagle Rays, these creatures live mainly upon oysters, clams and other shellfish, and they have been seen rooting up the bottoms of shallow bays like a drove of pigs. Practically nothing is known of their mode of life, and they appear to be of no economic importance.

SEA DEVILS OR DEVIL-FISHES.

(Family MOBULIDÆ.)

Closely related to the Eagle Rays. The disc is broader than long, and the tail comparatively short, slender and whip-like. The front parts of the pectoral fins are separated off to form distinct cephalic or head-fins, which project forward as a pair of horn-like appendages on either side of the mouth. The eyes are at the sides of the head. The mouth is wide, and is placed either at the end of the head or somewhat on its lower surface. The teeth are numerous, very small, set in many rows, and have the form of flat tubercles. There is a small dorsal fin at the base of the tail, but, at the most, only a very rudimentary spine. The skin is more or less rough.

These are the largest of all the Rays, and are found in tropical and subtropical seas. No extinct forms have yet been discovered.

MANTA OR GREATER DEVIL-FISH.

(Genus *Manta*.) Fig. 31.

The mouth is very wide, and is placed at the square-cut front end of the head. The teeth are present only in the lower jaw. The skin is roughened with small tubercles. The coloration of the upper surface is brown, and becomes darker as the fish grows old.

Grows to a width of more than 20 feet across the disc, and attains to a weight of more than 3000 lb.

There are believed to be several species of Mantas, but only one (*M. birostris*) is at all well known. This one seems to have a wide distribution.

Unlike the generality of rays, this enormous creature has to a large extent given up a life on the sea bottom, and spends most of its time swimming at or near the surface, although it does not go very far into the open sea. Mantas are often seen singly or in pairs, but occasionally small schools are encountered. In spite of its somewhat clumsy build, its

movements in the water are graceful enough, and partake of the nature of flying through the water rather than swimming. At the surface it moves along comparatively slowly, turning

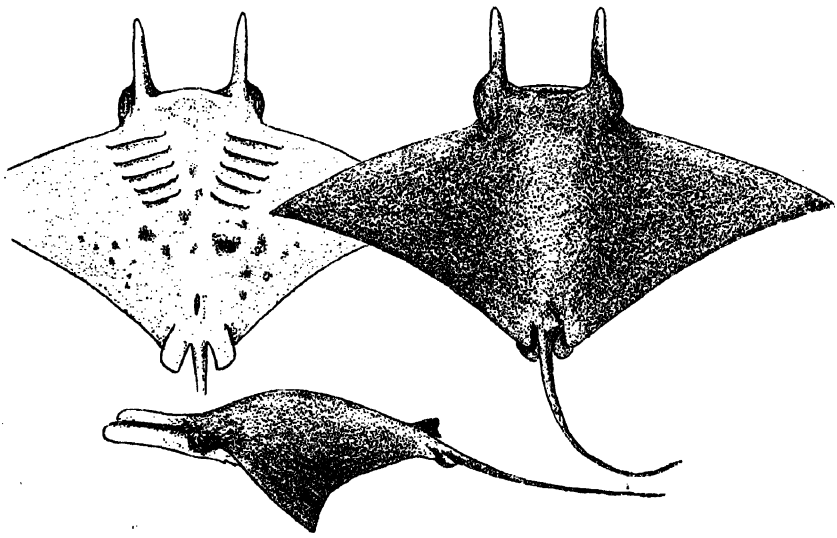


FIG. 31.—Manta or Greater Devil-fish (*Manta birostris*).

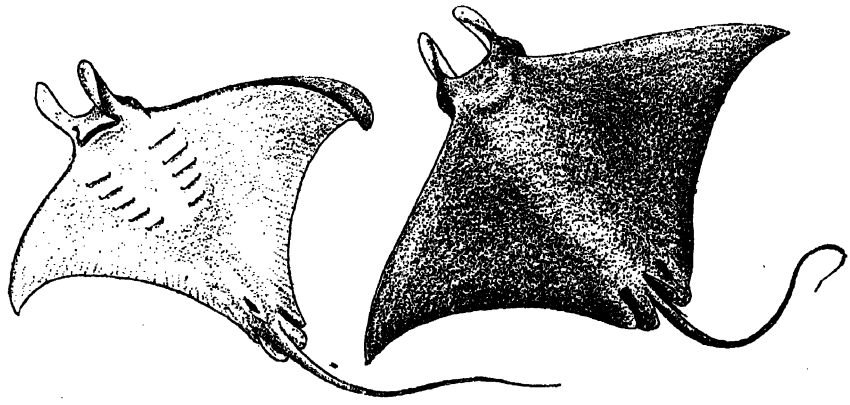


FIG. 32.—Mobular (*Mobula mobular*).

the body from one side to the other, with the mouth wide open and the cephalic fins stretched out on either side. A common habit is to curl the tip of one or both of the wing-like pectoral fins upwards, so that these project above the surface, and in this attitude to bask in the sunshine. At times these

rays appear to turn complete somersaults in the water, and they will leap into the air to a height of several feet, returning to the water with a tremendous noise. Mr. Holder thus describes the jumping of a big Manta: "There came out of the darkness, near at hand, a rushing, swishing noise; then a clap as of thunder, which seemed to go roaring and reverberating away over the reef, like the discharge of a cannon." Travellers have reported that the noise made by these creatures when jumping can be heard several miles away.

It was frequently stated in older natural history books that the cephalic fins were used for grasping objects, and that a Devil-fish was capable of seizing the anchor of a vessel and of running away with both boat and anchor, "to the wonder and fear of the sailors". Such feats are now believed to be impossible, and it seems likely that the primary use of these fins is to assist in the scooping of the food into the mouth. The diet consists of small crustaceans, young and small surface fishes, and other creatures forming the plankton, and these are pushed towards the wide-open mouth by the action of the cephalic fins. There are peculiar organs within the mouth, known as præbranchial appendages, and these, together with the branchial apparatus, act as strainers in much the same way as the gill-rakers of the Basking Shark or Whale Shark, which feed in the same manner.

The Manta is said to be much feared by the pearl divers, who believe that it will cover them with its vast "wings" and then devour them. This belief is, of course, without foundation, and, in spite of its bulk, this ray is quite harmless to man. A blow from one of its pectoral fins, nevertheless, is sufficient to crush or capsize a small boat, and so great is its strength that, when harpooned, it will tow a fair-sized boat at great speed. More often than not, it will dive straight to the bottom when struck, and there defy capture by sheer weight. It can only be captured as a rule after a prolonged battle, and fishing for Sea Devils provides exacting and at times dangerous sport. If, however, a lance can be skilfully planted just behind the brain the fish will speedily succumb. Its vitality when wounded is amazing, and Mantas have been known to escape capture "after being harpooned, lanced, and shot at with rifles of heavy calibre".

The Manta brings forth living young, and it seems probable that one only is produced at a birth. The full-grown embryo is of considerable size, and one cut out of a pregnant female 15 feet in width was itself 5 feet across the disc and weighed 20 lb.

The flesh of the Manta is quite wholesome, and is eaten by natives of various parts of the world. The liver provides a quantity of valuable oil, and the skin makes excellent sand-paper when dried. As already mentioned, it gives exciting sport to the fisherman, and the record fish ever harpooned seems to have been one captured at Bimini in the Bahamas, in 1919, which was more than 17 feet long and weighed over 3000 lb.

The name *Manta* is a Spanish word meaning " blanket ", and *birostris* is derived from two words meaning " two " and " snout "—a reference to the cephalic fins. The species is also known popularly as " Devil Ray ", " Vampire Ray ", " Sea Bat " and " Bat-fish ".

SMALL OR LESSER DEVIL-FISH.

(Genus *Mobula*.) Fig. 32.

This Ray differs from the Manta in having the mouth smaller and placed on the lower side of the head, and the teeth either developed in both jaws or in the upper jaw only. The cephalic fins tend to be rolled outwards. The coloration of the upper surface is brown or black.

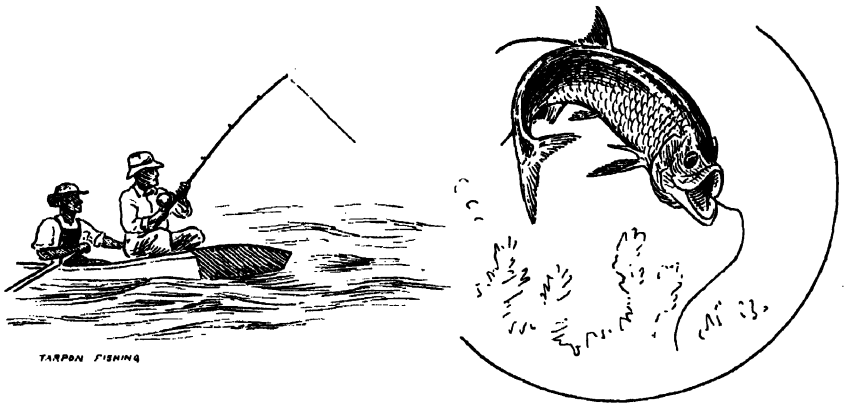
Grows to a very large size, attaining to a weight of at least 2000 or 3000 lb.

Several species of *Mobula* have been described, but it is open to doubt whether these are all distinct. The Mobular (*M. mobular*), of the Mediterranean and adjacent parts of the Atlantic, and the Small Devil-fish (*M. hypostoma*), of the Western Atlantic, are the best known forms. The former has been once recorded from the southern coast of Ireland, and is well known at the Azores and at the Canaries, where it is called " Horned Ray ", " Ox Ray ", or " Diable des Caraibes ". Other species (*M. japonica, M. diabolus, M. kuhlii*) are found in the Indian and Pacific Oceans.

The habits of these rays seem to be very similar to those of the Mantas, but, instead of roving the seas singly or in pairs, they move about in small shoals, which break up into groups of from three to five individuals each for feeding purposes. Dr. Coles has observed them feeding off the coast of Carolina, and states that " they carry the cephalic fins tightly curled to a sharp point until a school of small " minnows " are sighted ; then the group swings round in a semicircle and rushes them to the beach, and at that instant these fins flash open, and, meeting below the mouth, form a funnel through which the minnows are carried to the mouth ". The Small Devil-fishes are great leapers, and spend a lot of their time jumping from the water at frequent intervals. When taken from the water they are said to make a musical bell-like barking noise, quite unlike the harsh grunt or bark made by some other Rays.

Dr. Coles was lucky enough to observe two of these Rays in sexual union, and tells us that they were belly to belly, the female underneath on her back, with the pectoral fins curled upward and closely embracing those of the male, which were curved in the same direction. " Copulation was not accomplished," he writes, " by a vertical motion, but by a graceful, serpentine lateral curvature of the spine, as the male alternately advanced one of the mixopterygia [" claspers "] as he withdrew the other." The process lasted for some time, but was not continuous, being interrupted by periods when the two separated and either swam about in graceful curves or leaped into the air.

FISHING IN NORWAY XVI CENTURY.



TARPON FISHING

CHAPTER IV: SOFT-RAYED BONY FISHES.

General features of Bony Fishes. Sturgeons. Tarpon. Conger Eels. Morays or Painted Eels. Gar-fishes or Needle-fishes. Flying-fishes. Opah or Moon-fish. Ribbon-fishes. Deal-fishes. Oar-fishes.

AT the beginning of Chapter I it was pointed out that the Bony Fishes (Pisces) form a class of backboned animals quite distinct from the Sharks and Rays (Selachii), and the principal differences between a Selachian and a Bony Fish were briefly indicated. Before beginning our survey of the larger members of the class Pisces it will be best to consider some of the more important features characteristic of the Bony Fishes as a whole.

The internal skeleton may be composed of gristle (cartilage) or it may be bony, but there are always a number of more superficial plate-like bones known as dermal or membrane bones. Typical bones of this type are those forming the greater part of the roof and floor of the skull and those supporting the gill-covers. Actually, these bones have been derived from scales, which at some time or other sank inwards and came into more or less intimate contact with the box-like cranium. Many of the dermal bones of fishes persist in the higher vertebrates, and the large frontal bones of our own skull had their origin in some of the bony scales on the upper surface of the head of the ancestral fishes.

The skeleton supporting the mouth has likewise undergone

some marked changes. The original gristly upper jaw of the Shark no longer functions as such, but has become modified almost out of recognition, and, in association with some new bones, forms part of the bony palate or roof of the mouth in the Bony Fish. To replace it there has been formed an entirely new upper jaw made up mainly of 2 dermal bones—a præmaxillary in front and a maxillary behind on each side—bones that originated in the tissues of the upper lip. The lower jaw of the Shark still retains its original function, but has become entirely invested or even replaced by bones.

The body of a Bony Fish is nearly always covered with scales, and the dermal denticles have disappeared. In the earliest Bony Fishes these scales took the form of 4-sided, shining, enamel-covered, bony plates, all in close contact one with the other, and together forming a complete investing armour. Such ganoid scales, as they are called, are still found in certain primitive Bony Fishes existing to-day, but in the vast majority of living forms they have been replaced by thin, rounded scales, which overlap one another like the tiles on a roof.

As in the Selachians, there are a series of internal gill-clefts on each side in the walls of the gullet, and these are supported by similar hoop-like gill-arches, although the latter are here composed of bone. The partitions between the clefts have been reduced to such small proportions that the delicate red gill-plates or lamellæ project outwards as filaments. Instead of each opening separately to the exterior, the internal clefts open into a common branchial chamber on each side, which has a single external gill-opening at the back of the head. The outer wall of this chamber is provided by the movable gill-cover or operculum, which forms so characteristic a feature of most Bony Fishes (see p. xix).

The organs associated with the sense of smell are paired, and are placed on the sides of the snout. In most Bony Fishes each nasal organ is provided with 2 external nostrils. Finally, in the majority of Bony Fishes an air-bladder is present, which generally functions as a hydrostatic organ: this is never developed in any Selachian.

The class Pisces is split up into a number of orders, which most modern authorities group into three great sub-classes;

Palæopterygii ("ancient fins"), Crossopterygii ("fringed fins"), and Neopterygii ("new fins"). The technical differences between these groups need not bother us here, but it may be mentioned that they are concerned with the form of the skeleton and scales, and the structure of the fins. It must be noted, however, that, as far as existing fishes are concerned, these groups are of vastly different sizes. The first and second of the sub-classes together include some 10 living genera and less than 50 species, whereas the sub-class Neopterygii contains some hundreds of genera and at least 15,000 species.

Since the larger Bony Fishes dealt with in this book are necessarily scattered through a number of different Orders, it will be impossible to treat them in quite the same way as the Sharks and Rays were dealt with in the foregoing chapters. Sometimes we shall be dealing with a family of fishes, sometimes with a genus, and at other times with a single species picked out from a genus. In the present chapter are included nine different kinds of fishes, belonging to five orders, but all agreeing in having none of the rays supporting the fins transformed into true spines. As a result, they may be conveniently, although somewhat unscientifically, grouped together as Soft-rayed Bony Fishes.

STURGEONS.

(Family ACIPENSERIDÆ; Genus *Acipenser*.) Fig. 33.

The body is long and roughly circular in cross-section, and the snout is produced and pointed. The head is covered with closely approximated bony plates. The eyes are small, and above each eye is a small spiracle. The mouth is small, rounded, placed on the under-side of the head, and capable of being protruded to a remarkable extent; the jaws are quite toothless. On the lower side of the snout, a little in front of the mouth, is a transverse row of 4 barbels or feelers. The single dorsal fin is placed far back on the body, slightly in front of the anal fin and a little behind the pelvic fins, which are also situated well back. All these fins have thick fleshy bases where they join the body. The pectoral fins are placed low down on the sides, and the front rays of each fin are fused

together to form a strong spine. The axis of the tail is bent upwards, so that the upper lobe of the caudal fin is reduced to a row of spines and the lower lobe is well developed. The body is armed with 5 lengthwise rows of large bony scutes or bucklers, 1 along the back, 1 along the middle of each side, and 1 along the lower part of each side; between these scutes are small scattered denticles. The upper lobe of the tail is covered with rhombic scales, representing the vestiges of the primitive ganoid scales. There is a large air-bladder, which is connected with the gullet by a duct. The coloration is usually olive green, greyish, or brownish purple on the back, replaced by white below the row of scutes along the side. The young sometimes have some small dark spots.

Sturgeons are found in the seas, estuaries and rivers of Europe, northern Asia and North America. Fossil remains (scutes, pectoral spines and fragmentary bones) date back to the Eocene period.

The largest species, the Russian Sturgeon or Beluga (*Acipenser huso*), grows to a length of more than 14 feet and a weight of more than 2000 lb.

About twenty species of *Acipenser* are recognized, but only a few of these are of large size. The Common Sturgeon (*A. sturio*) inhabits the coasts and rivers of eastern North America and of Europe from Scandinavia to the Black Sea; the Russian Sturgeon or Beluga (*A. huso*) is common in the Black Sea, Sea of Azov and the Caspian Sea; the Transmontane, White, Oregon or Sacramento Sturgeon (*A. transmontanus*) is found on the Pacific coast of North America from Monterey, California to Alaska, and ascends the Sacramento, Columbia and Fraser Rivers. These three represent the largest species.

Most of the Sturgeons are found both in salt and in fresh water, spending the greater part of their lives in the sea and entering the rivers only for spawning purposes. In some of the large lakes and rivers of North America, however, there are species that have become permanent residents in fresh water. They are an extraordinarily variable group of fishes, and also undergo considerable changes with growth. Further, the different forms tend to cross with one another at times, so that considerable difference of opinion exists among experts as to the number of species that should be recognized.

From a scientific point of view the Sturgeons are of considerable interest, representing as they do the specialized and to a great extent degenerate survivors of a very ancient and primitive group of Bony Fishes that flourished during the Palæozoic Era. These ancestral forms had their bodies completely covered with ganoid scales, and their heads and mouths were of the normal type.

Sturgeons are clumsy and somewhat sluggish fishes, most abundant on sandy or muddy stretches, where they swim about slowly, close to the bottom. If disturbed, however, they are capable of sudden, rapid bursts of speed, and not infrequently come to the surface of the sea and leap clear of the water. When captured in nets or on hooks they offer little resistance, although large individuals are very powerful and may be awkward customers to handle. The sharp-edged scutes make the muscular tail a nasty weapon, which has been known to cut a man's leg to the bone. There is a curious old North Sea proverb to the effect that leaping Sturgeons and dancing girls are both hard to hold !

They are normally ground-feeders, but may at times seize fishes swimming freely in the water. They might well be described as mud-grubbers, for they root about in the sand or mud with their snouts, and feel for their prey with the sensitive feelers in front of the mouth. Having located this, the mouth is pushed out like a funnel, and the food is sucked up along with considerable quantities of mud. The diet consists mainly of worms, shellfish, crustaceans and other small ground-living creatures, but aquatic plants are also eaten, as well as various kinds of fishes. Like the salmon, the Sturgeon almost ceases to feed when it enters the rivers to spawn. In cold weather these fishes go into a sort of winter sleep, remaining quite torpid for a considerable time.

The breeding migration takes place in the spring or early summer, and, as far as is known, spawning takes place mainly in May, June and July. The parent fish make their way slowly upstream to deposit their eggs beyond the influence of the tides, but it is believed that some may spawn in brackish water. Under the stress of sexual excitement, these great clumsy fishes will sometimes leap right out of the water. In the British Isles Sturgeons do not enter the rivers in any

numbers, and it is doubtful whether any spawn in our waters to-day. In the past, however, when the rivers were less polluted than they are now, Sturgeons were more common, and there is a record of an 8-foot fish in the Severn near Shrewsbury in 1802, and another from the Trent as high as Nottingham. Even the Thames had its Sturgeons, and a 7-foot specimen was caught in the spring of 1832, two or three miles below Kew, and in July, 1883, a large but almost lifeless fish was found floating down the river, apparently poisoned by sewage. To-day, however, the Sturgeon, like the salmon, is quite unknown in the Thames.

A single female fish may produce as many as 2,000,000 or even 3,000,000 eggs during a single breeding season. Each egg is enclosed in a sticky gelatinous envelope, so that the eggs not only stick to each other, but also to the river bed, where they lie in large masses. The eggs hatch after from 3 to 7 days, and the larvæ which emerge are less than half-an-inch in length. These tiny creatures have minute teeth in their jaws, but these are lost as they grow up. At the end of a month they are from 4 to $5\frac{1}{2}$ inches long. Some of the young seem to make for the sea when about a year old or even earlier, but others stay for 2 or 3 years in the rivers in which they were born. By the time they have grown to a length of 3 feet, however, all of them are either in the sea or in the estuaries.

Sturgeons are of considerable economic importance. The flesh is somewhat firm and hard and rather coarse, but is used as food in many places. Much, apparently, depends upon the cooking, and it has been asserted that a good cook can turn Sturgeon meat into beef, mutton, pork or poultry! It is of interest to note that on the Pacific coast of America the White Sturgeon has always been esteemed as an article of food, whereas the closely related Green Sturgeon is looked upon with distaste, its flesh being dark and with a disagreeable taste and unpleasant smell. Both the White Sturgeon and the Common Sturgeon were once caught in numbers in America, but the catches have steadily declined owing to over-fishing. In the British Isles the Sturgeon is of little commercial importance, and a large fish on the fishmonger's slab is sufficiently rare to be regarded as a novelty. In Great Britain it is a "Royal Fish", for by an unrepealed law of the reign of

Edward II it is enacted that " the King shall have the wreck of the sea throughout the realm, whales and great sturgeons . . . except in certain places privileged by the King ".

Apart from the flesh, the two most valuable commodities derived from the Sturgeon are, of course, caviare and isinglass, the former being obtained from the eggs, the latter from the air-bladder. The preparation of caviare from the roes is an important industry, carried on principally round the Black and Caspian Seas, where these fishes are numerous, and at one of the fishing stations in these regions as many as 15,000 fish have been caught in a single day. Caviare is also prepared in the United States. The eggs are first sieved to separate them from the surrounding membranes, then washed in vinegar or white wine, and afterwards spread out to dry; salt is then rubbed in well by hand, the eggs are put into bags and slightly pressed to remove the fluid, and they are finally packed into wooden casks or into cans for the market.

The preparation of isinglass is another important industry. The air-bladders or " sounds ", as they are known to the trade, are split open, thoroughly washed, and spread out to dry in the air with the silvery-white inner membrane uppermost. This lining, which is nearly pure gelatine, is then stripped off and, after being specially treated, is dried to form the commercial product, which is marketed as " cake ", " pipe ", " leaf ", or " book " isinglass. This is used for the clarification of wines and beers, for making jellies, etc., and in the preparation of certain cements.

The name " Sturgeon " seems to have been derived from the German word " Stör ", perhaps from the verb " stören ", which means to poke or rummage about—an allusion to its method of feeding. In old books it was sometimes spelt " storgin " or " sturjoun ".

Before leaving the Sturgeons, mention may be made of two freshwater relatives, which differ in having naked bodies, very small eyes, long snouts, and rather large mouths. The Paddle-fish or Spoon-bill Sturgeon (*Polyodon spathula*) is found in the lowland streams of the Mississippi Valley and rivers of the southern United States, and grows to a length of about 4 or 5 feet. The Sword-bill Sturgeon (*Psephurus gladius*) is found in the larger rivers of China, and grows to a somewhat larger size.

TARPON.

(Family ELOPIDÆ; Genus *Megalops*.) Fig. 34.

A large, herring-like fish, with an oblong, compressed body, covered with large, smooth, silvery scales and a bony, naked head. The eyes are large. The mouth is large, oblique, with the lower jaw projecting beyond the upper, which extends backwards to behind the level of the eye. There is a long bony plate between the two halves of the lower jaw. The jaws are provided with bands of fine pointed teeth, and there are similar teeth on the roof of the mouth and on the tongue. The single dorsal fin is placed in front of the anal fin and behind the pelvic fins; the last ray is drawn out to form a long filament. The anal fin is longer than the dorsal and has a distinctly concave margin. The caudal fin is deeply forked, and its basal part is more or less covered with scales. The pectoral and pelvic fins are rather long, and each has a special pointed scale above it. The lateral line, running along the side of the body, is nearly straight. An air-bladder is present, and is connected with the gullet by a duct. The coloration is a brilliant silver, with the back darker; in life the upper part of the back has a metallic blue hue, which appears green in the water.

The family Elopidæ dates back to the Cretaceous period, and the genus *Megalops* has been found in rocks of the Eocene period.

The Tarpon grows to a length of 6 to 8 feet and a weight of more than 300 lb.

Only one species of Tarpon (*M. atlanticus*) is known, which ranges on the Atlantic coast of America from Long Island to Brazil, being especially abundant in the Gulf of Mexico and in the Caribbean Sea; it is also found occasionally at Bermuda, and crosses the Atlantic to the West Coast of Africa. There is a second species of the genus *Megalops*, however, the so-called Ox-eye or Ox-eyed Herrung (*M. cyprinoides*), found in the Indian and Pacific Oceans, but this is a much smaller fish, rarely exceeding a length of 3 or 4 feet.

The Tarpon is essentially a coastal fish, but often ascends the rivers of Florida, Texas and Mexico, sometimes for considerable distances, and may also be found in fresh-water

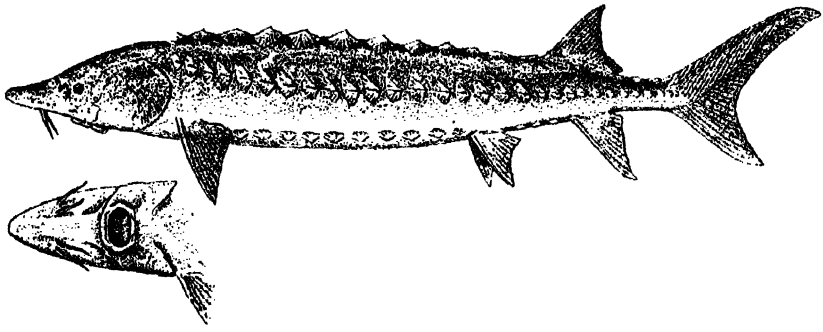


FIG. 33.—Common Sturgeon (*Acipenser sturio*).

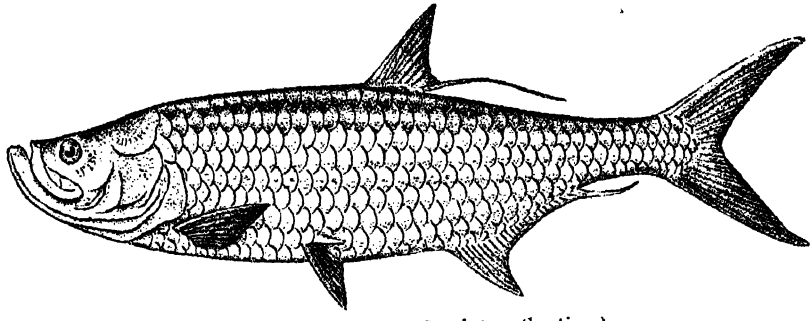


FIG. 34.—Tarpon (*Megalops atlanticus*).

FIG. 35.—Common Conger (*Conger conger*).

lakes such as Lake Nicaragua in Central America. In tropical American waters it occurs at almost any time of the year, but only extends to its northern and southern limits in the warmer months. It is very sensitive to sudden changes of temperature, and during a cold wave which invaded Florida in 1905 some 40 or 50 Tarpon were found so benumbed with cold that they could easily be harpooned from boats.

As might be expected from its beautifully streamlined form and powerful forked tail, the Tarpon is an active, speedy fish, capable of pursuing shoals of smaller fishes with untiring energy and tremendous vigour. It will follow a shoal of mullet, its favourite food, for days on end, chasing them into estuaries and pursuing them up the rivers. Often it will leap clear of the water, and, with its gill-covers spread out and its blood-red gills plainly visible, the " silver king " provides an inspiring spectacle. It has been suggested that the Tarpon will leap to avoid a shark or to rid itself of a sucking-fish, but Dr. Gill is of the opinion that the leaps, " like those of the salmon, seem to be mostly in sportive manifestation of its intense vitality and not for food or entirely from fear ".

Mr. Babcock has recently described lung-like bands of tissue in the air-bladder of the Tarpon, and concludes that this fish breathes atmospheric air on occasions.

Opinions differ as to the extent of the jumps, but a clean vertical leap of about 8 to 10 feet would seem to be the Tarpon's limit. Horizontal leaps of 20 feet or more have been observed by reliable witnesses. The initial power for the jump is provided by an extra strong stroke of the tail, made just before the fish leaves the water. While in the air the body is held in a curve, and the fish naturally falls towards the concave side. Mr. Babcock, in his interesting little book, ' The Tarpon ', tells us that " it has been known to jump upon a man sitting in a chair on the deck of a steamboat. One knocked a negro guide out of a boat . . . the man was stunned and drowned. In Galveston Bay a tarpon leaped and broke a boatman's neck." One authority has suggested that the long filamentous ray at the end of the dorsal fin plays an important part in determining the course of a leap, but this is denied by others.

The breeding habits of the Tarpon have long been a matter

of dispute, but it now appears to have been more or less definitely established that spawning takes place in the Gulf of Mexico along the coast of Florida, and probably elsewhere. During March, April and May ripe male fish have been observed to school in large numbers in shoal waters about half-a-mile or a mile offshore in these regions. The eggs may be pelagic or may sink to the bottom, but it may be assumed that the newly hatched larvæ are of the same type as those of the Ten-pounders and Lady-fishes, especially in view of the fact that this type of larva has been identified as belonging to the Ox-eye from the East Indies. Such a larva is of the type known as a *Leptocephalus*, and is an elongate, ribbon-like creature, quite translucent and colourless, and with a very small head and tiny fins. This larva goes on feeding and growing for a certain period and then undergoes a sudden change or metamorphosis, in the course of which it is transformed into a young fish recognizable as a baby Tarpon. The larvæ probably drift gradually inshore, for numerous young Tarpon, perhaps about a year old, have been found in brackish pools, bays and estuaries on the coast of Florida. Texas, Cuba, Porto Rico, Haiti and elsewhere in the Caribbean,

Opinions seem to differ as to the edible qualities of the Tarpon, some affirming that it is useless as food, others that, if properly cooked, the flesh is of good quality. It would appear that it is only the very small fish that are at all good as food, the large specimens being tough, tasteless, and full of bones. The commercial fishermen have no use for it, and cordially dislike it owing to the damage that it may do to the seine nets if accidentally enclosed in them. There is, however, some demand for Tarpon scales, each of which may be more than 2 or 3 inches in diameter, and beautifully silvered, and it is said that these can be sold at from 5 to 25 cents apiece. They are used for fancy work, being made up in various ways by the curiosity dealers to attract the fancy of the winter visitors to Florida.

As a game-fish, of course, the Tarpon is nearly supreme, with its world-wide reputation for activity and fighting powers. Every lover of the sport has heard of the " silver king ", and its capture on rod and line requires considerable strength and skill, coupled with endless patience and determination. The

favourite bait on the Florida coast is the Blue Crab. The record fish was taken in the Panuco River, Mexico, in 1934; it was 7½ feet long and weighed 242½ lb. This fish, however, is considerably smaller than one that was netted by native fishermen in Florida in 1912, which was more than 8 feet in length, and was estimated to weigh 350 lb.

It is of interest to note that living Tarpon have been kept in the aquarium at New York on at least three occasions, and have survived in captivity for as long as two months.

The Tarpon has received a number of vernacular names. In Marcgrave's 'History of Brazil' (1648) it is called "Camari-puguacu"; in 1675 it is referred to by Dampier as the "Tarpom", a name that was also used by Roman in 1775. Among other names may be mentioned "savanilla", "savale", "savalo" (or "sabalo"), "caffum" (in Barbados), "grand écaille", and "silver king". The name Tarpon (or Tarpom or Tarpum) is perhaps of Indian origin.

CONGER EELS.

(Family CONGRIDÆ. Genus *Conger*.) Fig. 35.

Eels with a long, scaleless body, which is rounded in front and compressed behind, and with a large head, pointed in front and flattened above. The eyes are large. The mouth is wide, extending at least as far as the level of the middle of the eye. The teeth are arranged in several rows in both jaws, those of the outer row being set so close together that they form an almost continuous cutting edge; there is a short band of teeth on the roof of the mouth. The tongue is free in front. The gill-openings are rather large and extend well downwards. The dorsal, caudal and anal fins are all joined to form a single continuous fringing fin, which begins above the pectoral fin and extends round the end of the tail. The pectoral fins are rather large, but, as in all living eels, there are no pelvic fins. A lateral line runs along the middle of each side. An air-bladder is present, and is connected with the gullet by a duct. The coloration is usually uniformly greyish or blackish, becoming pale grey or white on the belly, but it may be dark brown or black all over. The edges of the fringing fins are black, except in very large specimens. Young

individuals are much paler, being almost pink in colour, on account of the small amount of pigment in the skin.

Grow to a length of 6 to 8 feet.

Several species of *Conger* are known, of which the Common Conger (*C. conger*) from Western Europe is perhaps the most familiar. The American Conger (*C. oceanicus*) is found on the Atlantic coast of the United States and in the West Indies, and other species occur in South America, as well as in the Indian Ocean and Archipelago. The first-named species is fairly common round the British Isles, especially on the west coasts and in the English Channel.

The Conger is one of the largest members of the order of Eels (Apodes), and prefers deep water, where the bottom is rocky, although it is also to be found in patches of sand surrounded by rocks which are covered with weeds. Here it is able to bury itself or to creep into convenient holes or crevices, and in such a situation it is not infrequently left stranded by the receding tide for an hour or so, apparently without suffering much inconvenience. It lives almost entirely in the sea, and only enters fresh water on rare occasions. The Conger is very sensitive to changes of temperature, and becomes quite inert during a spell of severe weather.

Congers become particularly active at night and feed almost exclusively during this period. The diet includes other fishes, cuttlefishes, crustaceans, worms, and almost any other form of animal life. They are particularly destructive to pilchards, herring, hake and flatfishes of all kinds, and will enter lobster- or crab-pots and devour the contents. Cannibalism is common, the smaller or weaker fish being eaten by their larger brethren, or the smaller males becoming victims to the larger females. They are also ready scavengers, and are speedily attracted to decomposing carcases. Stones up to half-a-pound in weight have been taken from their stomachs, and were probably swallowed for the sake of the animal life attached to them.

When caught and placed in the bottom of a boat a Conger may be seen to feel about with its tail, and if it can do so it will get hold of the gunwale with it and so lift itself back into the sea. It is able to support life out of water for a considerable time, and fishermen nearly always kill it by a blow on the head or belly. It is extraordinarily tenacious of life, and even when

seemingly dead will suddenly lash out and make a vicious snap with its jaws. Even when the head has been severed, the mouth will close firmly upon any foreign body thrust between the jaws, and Mr. Paterson has recorded how a boy was rash enough to put his toe into the mouth of a Conger-head left on the beach by the fishermen; "his yells", he adds, "soon brought assistance and release!" When taken from the water a Conger will sometimes make a harsh barking sound, caused by the sudden expulsion of air from the air-bladder.

The breeding habits of the Congers have not yet been elucidated to the same extent as those of the Common Eel, but preliminary researches were being carried out by the Danish investigator, Dr. Johannes Schmidt, at the time of his death a few years ago. He has shown that the European species has a wide breeding area, and spawns in the Mediterranean, in the eastern Atlantic between the Azores and Gibraltar, and probably elsewhere. The breeding season probably varies in the different regions. The larva, when newly hatched, is quite unlike its parents, being long, ribbon-like, translucent, and quite colourless; the head is tiny, and the small mouth is armed with needle-like teeth. Such a larva is known as a *Leptocephalus*, and is characteristic, not only of all the eels, but also of the tarpons and their allies the ten-pounders and lady-fishes. The larva of the European Conger was first discovered by William Morris in 1763, near Holyhead, but was not described until 1788, when the Swedish naturalist, Gmelin, named it *Leptocephalus morrissii*. It was nearly 100 years later that it was definitely established that this larva became transformed into the Conger, for a French scientist was able to keep one alive in an aquarium and to observe the whole process. During the transformation or metamorphosis the larval teeth are shed, the body shrinks in size and becomes rounded instead of flattened, the shape of the head changes, and the pigment in the skin is developed.

The European Conger is fairly important as a food-fish, more than 50,000 cwts. being landed by British fishing vessels in an average year. Much of the "stock" for turtle soup is said to be made from its flesh, which is wholesome and quite tasty. It is caught mainly by means of long lines baited with pieces of fish or cuttlefish. In medieval times the Conger

was more appreciated than it is to-day, and at a later date dried fish were exported to Spain and Portugal, where they were ground into powder and used for thickening and flavouring soups. In 1879 a Conger was received in the London Market which weighed 128 lb., and in the 'Illustrated London News' for September 17th, 1904, there was published a photograph of one measuring 9 feet in length and weighing 160 lb.

Congers are sought for by the sea angler, but, according to one authority, they are annoying fish to hook, "for they do not bite sharply, but generally nose the bait and take little pulls at it for some time before they take it properly". A Conger weighing 84 lb. was caught on rod and line off Dungeness in 1933.

The name "Conger" is derived from the Latin *conger* or *congrus*, meaning a sea-eel.

MORAYS OR PAINTED EELS

(Family MURÆNIDÆ.) Pl. III D.

Eels with a long, rounded or flattened body, covered with a thick, leathery, scaleless skin. The mouth is wide, and the jaws, which are usually narrow, are armed with strong teeth, sometimes knife-like, sometimes crushing, which are also present on the roof of the mouth. The gill-openings are small and rounded. The dorsal, caudal and anal fins are often very indistinct, and may be entirely hidden under the skin. There are no pectoral or pelvic fins. The coloration of the various species differs enormously, some being uniformly black, brown, green or yellow, others variously barred, spotted, blotched or mottled with paler or darker.

The largest species grows to a length of more than 10 feet, and several others attain to at least 6 feet.

About 120 species are known from tropical and subtropical seas. The Indo-Pacific Moray (*Thyrsoidea macrurus*) from the Indian and Pacific Oceans is probably the largest living eel. The Common Moray or Murry (*Muræna helena*) is found in the Mediterranean and adjacent parts of the Atlantic, and is a very rare visitor to the British Isles. Other large forms include the West Indian Moray (*Channomuræna vittata*), the

Painted Eel (*Enchelynassa bleekeri*) of the South Seas, the Common Spotted Moray or Hamlet (*Lycodontis moringa*) from the West Indies and Brazil, and the Green or Black Moray (*L. funebris*) from the Pacific coast of tropical America.

The Morays are nearly all coastal fishes, and are abundant in the neighbourhood of coral reefs, where they are in the habit of coiling themselves into crevices in the reef and of striking out at their prey after the manner of snakes. They are very voracious, and feed mainly upon other fishes, but some forms, especially those with rounded molar-like teeth, include crustaceans and other hard-shelled creatures in their diet, and others eat squids and cuttlefishes. In some Morays the jaws are so much curved and the mouth so crowded with knife-like teeth that it can never be properly closed, but even so there is little chance of the prey escaping, as the teeth are adapted for holding as well as for cutting. Fishermen often relate stories of unprovoked attacks by large Morays, sometimes resulting in nasty wounds. A live Moray has even been known to drive men from a boat. When caught, they cling tenaciously to life, but may be despatched by a blow on the tail. According to Mr. Carrington, writing in the 'Zoologist' for 1876, the Murry can be domesticated and is capable of showing affection for its owner!

Little is known of the breeding habits of these eels, but, like other members of the Order, they pass through a *Leptocephalus* stage.

As food they are not greatly esteemed, although eaten in many parts of the world. The late Professor Jordan tells us that the flesh is "rather agreeable in taste, but usually oily and not readily digestible, less wholesome than that of the true eels". The Murry was a very great favourite with the ancient Romans, and its fame has been sung by Horace, Martial and other classical writers. Large numbers were reared in specially constructed reservoirs near the sea, and were reputed to have been fed at times upon the corpses of slaves. Mr. Radcliffe tells us that, according to Seneca and Pliny, "a slave, for breaking a crystal decanter at a banquet given to Augustus, was ordered to be thrown instantly into a *piscina*, there to be eaten alive by the nibbling voracious *Murænæ*". The Romans believed that the bite of the Murry

was poisonous. There is a fine and clearly recognizable picture of this fish in a Pompeian mosaic in the Naples Museum, and it is often depicted upon the Græco-Roman "fish-plates".

GAR-FISHES OR NEEDLE-FISHES.

(Family BELONIDÆ.) Fig. 36.

Soft-rayed Bony Fishes with a long and very slender body, covered with small, thin scales. Both the jaws are drawn out to form a long "beak", the lower being the longer, and each is armed with a band of small, sharp teeth, as well as with a row of long needle-like teeth set well apart. There are special plate-like bones (pharyngeals) in the throat, also armed with teeth. The dorsal and anal fins are rather long, and are placed opposite to each other at the hinder end of the body. The caudal fin is short and forked, with the lower lobe longer than the upper. The pectoral fins are of moderate size. The pelvic fins are small, and are situated behind the middle of the body. The lateral line runs very low down, and forms a fold along the edge of the belly, but rises to the middle of the side in the tail region. An air-bladder is present, but is not connected with the gullet. The coloration is generally sea-green or bluish-green on the back, becoming more or less shot with blue or purple on the sides, and silvery white beneath; there is often a silvery stripe along the middle of the side.

Some of the larger species grow to a length of 5 or 6 feet.

The Gar-fishes are found in most warm seas, and sometimes enter rivers. Fossil remains date back to the Eocene period.

About fifty species are known, and are generally grouped into four genera. The Common Gar-fish (*Belone belone*) is found on the coasts of Europe from Scandinavia to the Mediterranean, and is common on the southern coasts of the British Isles. Among other large forms may be mentioned the American Gar-fish or Agujon (*Tylosurus marinus*), which ranges on the Atlantic coast from Cape Cod to Texas; the Hound-fish or Guard-fish (*T. raphidoma*), abundant from Florida to Brazil; and the Ribbon Gar-fish (*Athlennes hians*), with a distribution similar to the Hound-fish.

The Gar-fishes are very active creatures, spending most of

their time at the surface or in the upper layers of the sea. Ordinarily they swim with wave-like motions of their long bodies, but, when startled, will skim along the surface at an extraordinary speed. They are mostly seen in shoals, often of considerable size, and live inshore during the warmer months and retire to deeper water as winter approaches. When chased by tunny or other large fishes, they will scud rapidly along the surface with the major part of the body out of the water. When engaged in chasing smaller fishes they have the appearance of springing over the waves after the prey, and they will jump over any floating substance or other obstacle and alight in the water again tail first. A large Gar-fish may be a danger to man when indulging in one of these leaps, and one has been known to pierce the naked abdomen of a native fisherman during its headlong flight.

FIG. 36.—Common Gar-fish (*Belone belone*).

Gar-fishes are very voracious, their food consisting almost entirely of other fishes. At times, however, they have been known to feed indiscriminately upon all kinds of animal substances.

The time of breeding varies, of course, in different parts of the world. The Common Gar-fish spawns in shallow water from April to June. The eggs, which are about 3 mm. in diameter, are usually deposited in seaweed, and have a curious form, each egg being provided with a number of sticky threads springing from its outer envelope, which serve to anchor it to the bottom, to seaweed or rocks, as well as to other eggs. When the little fish is first hatched the jaws are both quite short, and curiously enough it is the lower jaw that grows out first. For a time this is longer than the upper, and the young fish resembles the adults of another family of fishes, the Half-beaks (Hemirhamphidæ), in which only the lower jaw is drawn out. Later, however, the upper jaw commences to grow. While these changes take place the young remain

inshore, but at the end of their first summer they congregate into shoals and move out to sea.

As food the Gar-fishes are quite good, and considerable numbers appear in the fish-markets. A curious feature of all these fishes is the bright green colour of the bones, which remains even after cooking. Some people object to eating them on this account, but such fears are quite groundless, as the flesh is quite wholesome and well-flavoured. When first captured, Gar-fishes emit a very strong and peculiar smell, but this soon passes off after death.

The Common Gar-fish has been given a number of popular names, of which " sword-fish ", " green-bone ", " horn-fish ", " needle-fish ", " long-nose ", " gore-bill ", and " mackerel-guide " may be mentioned.

FLYING-FISHES

(Family EXOCŒTIDÆ.) Pl. IV A, B ; fig. 37.

Soft-rayed Bony-fishes belonging to the same Order as the Gar-fishes and Half-beaks. The body is never very long, and is covered with smooth scales of moderate size, that may be rather easily detached. The head is blunt in front, the mouth is of moderate size, and the jaws are never drawn out to form a " beak ". The teeth are small and feeble. The dorsal and anal fins are placed more or less opposite to each other on the hinder part of the body. The caudal fin is forked, and the lower lobe is always longer than the upper. The pectoral fins are placed high up on the sides, and are greatly enlarged, sometimes reaching as far back as the tail. The pelvic fins are placed a little behind the middle of the length of the body, and are sometimes enlarged to a considerable degree. The lateral line runs low down along the side of the belly. There is a very large air-bladder. The coloration of the adults is metallic blue or bluish-green on the back, shading to silvery white beneath ; the fins are more or less transparent, but the pectorals and pelvics are often barred, blotched or spotted with black or brown, and dark spots or blotches may be present on one or more of the other fins.

Flying-fishes are found in all warm seas, mostly in the

open ocean at considerable distances from the nearest land. No fossil members of the family are known.

About fifty species are recognized, and are grouped into some four or five genera. At least one species occasionally visits the coasts of the British Isles, more especially during the summer months.

Being of comparatively small size, it may well be asked why these fishes find a place in this book. Since, however, they may be met with in every tropical and subtropical sea, and so commonly attract the attention of the ocean voyager, space may be found for a brief account of their form and habits. Moreover, they play an important part in the

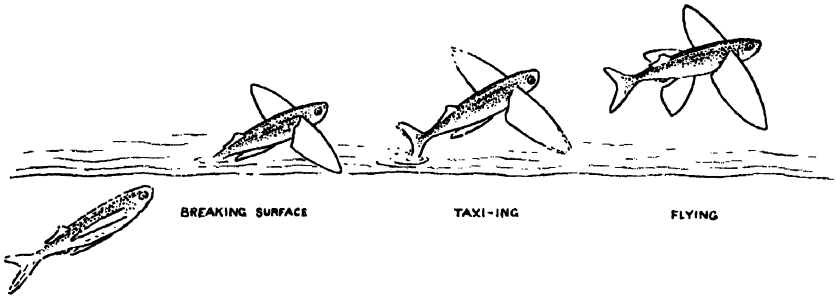


FIG. 37.—How a Flying-fish flies.

economy of many giant oceanic fishes, being the principal food of such fishes as the dolphins, tunnies, bonitoes and albacores.

All the Flying-fishes are gregarious—that is to say, they keep together in schools, sometimes of considerable size. They mostly swim at or near the surface, and often spring out of the water and skip or glide through the air for some distance. They feed mainly upon small crustaceans and tiny fishes of all kinds.

There can be little doubt that the prolonged flight of the Flying-fish represents an improvement upon the spasmodic leap of the Gar-fish or Half-beak, and it is from fishes very like the latter that the true Flying-fishes must have originally sprung. It may be noted that the most primitive member of the family, the Sharp-nosed Flying-fish (*Fodiator acutus*), has comparatively short pectoral fins and small pelvics, and

the snout is pointed. Further, in the young stage the lower jaw is drawn out just like that of the adult Half-beak, and shortens only as the fish grows up. Among the other Flying-fishes two main types may be recognized: the so-called " two winged " Flying-fishes, in which only the pectoral fins are enlarged, and the " four-winged " Flying-fishes, in which the pelvic fins are also much larger than usual and, like the pectorals, play an important part as organs of flight.

The actual mode of flying must be briefly considered, since this has for many years been the subject of acute controversy. The flights are made primarily as a means of escape from enemies, or when the fish is alarmed by an approaching ship, but at times they appear to be taken for no apparent reason. It must be clearly understood that the flight is quite unlike that of a bird or bat, since there is no actual movement of the " wings " (pectoral fins), which are held rigid, and act after the manner of the planes of a " glider ".

In order to demonstrate the nature of the flight, the different phases in a typical flight of a fish of the " four-winged " type (the Flying-fish *par excellence*) may be described (see Fig. 37). The fish first swims rapidly towards the surface, with both its pectoral and its pelvic fins folded against the body. It next breaks the surface of the sea, and the pectoral fins are spread out to support the front part of the body, whilst the pelvic fins remain folded. The fish then gains power for the flight by " taxi-ing " or skimming along the surface, the propulsive power for this movement being supplied by violent side-to-side movements of the tail, the long and strong lower lobe of the caudal fin being kept in the water. During this " taxi " movement, which is comparable to that of an aeroplane just before it leaves the ground, the whole body of the fish shakes, and the tips of the pectoral fins vibrate, giving a false impression of a flapping of the " wings ". At the end of it the fish is shot into the air at a speed which has been estimated at not less than 35 miles per hour. The pelvic fins are now spread out, thus lifting the tail from the water, and both pairs of fins are held out rigid and motionless during the flight.

The length of time occupied by each flight rarely exceeds 30 seconds, and in the majority of cases is much shorter. During a flight the fish may cover as much as two or three

hundred yards, although it is difficult to judge these distances at sea with any degree of accuracy. At the end of a flight the fish either dives gracefully into the water, or again starts sculling movements with its tail preparatory to taking off for another leap. The flight of a fish of the " two-winged " type is essentially similar to that already described, but here the fish appears to dart directly from the sea into the air, and to return to it with a splash instead of with a graceful dive.

The breeding habits of the Flying-fishes are as yet imperfectly known, but, in some species at least, the eggs are deposited in a rough kind of nest in a mass of drifting sargassum weed. Like those of the Gar-fishes, the eggs are provided with sticky, hair-like threads, which serve to anchor them one to the other and to the weed. The newly hatched young are of a yellowish-orange colour, and are said to bear a remarkable resemblance to the berry-like " floats " of the sargassum. They soon take on a variegated livery, which serves to conceal them from enemies, while they lurk among the weed, but which is quite unlike the blue and silvery coloration of the full-grown fish. A curious feature of the young of some Flying-fishes, but by no means of all, is the presence of a single or double barbel or feeler hanging from the chin, which may be quite large and elaborately fringed. The purpose of this structure, which is discarded as the little fish grows up, has not yet been explained.

As food, Flying-fishes are regarded by those who have tried them as great delicacies, the flesh being firm and palatable. One species is looked upon as a food-fish of importance in California, and is sometimes caught in its thousands off Santa Barbara. In the island of Barbados there is a regular fishery, which extends from December to July, and reaches its peak in the spring.

OPAH OR MOON-FISH.

(Family LAMPRIDIDÆ ; Genus *Lampris*.) Pl. I A.

Soft-rayed Bony-fishes with a deep, compressed, but rather plump body, roughly oval in shape, and with a small, smooth head. The body is covered with very small and smooth

scales. The mouth is small and toothless, and can be protruded by a curious mechanism, the maxillary bones being pulled away from the head by the movement of the lower jaw. There is a single long dorsal fin, with a high lobe at its front end, and a long, low anal fin; both dorsal and anal fins can be folded back into deep grooves. The pectoral fins are long and sickle-shaped, placed high up on the sides, and their bases are set horizontally on the body. Each pelvic fin is supported by from 15 to 17 rays, and is placed just behind the pectoral. The caudal fin is moderately forked, and is set at the end of a short, slender peduncle; there is a pit above and below at the root of the fin. The lateral line is much arched in front. There is a large air-bladder, but this is not connected with the gullet. The coloration of the back varies from steel blue to bottle-green, the sides are bluish or greenish, with brilliant reflections of purple and gold, and the lower parts are rose red; the whole of the body is covered with round silvery spots. The jaws and the fins are bright scarlet.

The Opah grows to a length of at least 6 feet and a weight of 500 or 600 lb.

The single known species (*L. luna*) is widely distributed in the warmer parts of the Atlantic and Pacific. It is rare in the Mediterranean, but is a not infrequent visitor to the coasts of the British Isles during the warmer months.

Fossil remains, believed to be those of a fish very like the Opah, have been found in California in rocks of Miocene age.

This fish must be regarded as comparatively rare, and very little is known of its manner of life. It is apparently solitary in its habits, and is mainly an inhabitant of warm water, but during the summer months in the Atlantic it wanders as far north as Newfoundland, Iceland and Finland. It probably spends a good deal of its time fairly close to the surface, but there is no doubt that at times it descends into deeper water. At Madeira the Opah is taken on lines baited with scad or mackerel at depths varying from 50 to 100 fathoms, and the late Professor Jordan notes that the "long liners" often capture this fish when working west of the Shetlands. From its general build it may be confidently inferred that the Opah is a slow swimmer.

The small, toothless mouth is quite unsuited for the capture of prey of any size, and, judging from the evidence provided by the examination of stomach contents of captured specimens, the food of the Opah consists mainly of small cuttlefishes, crustaceans, shellfish and young fishes.

Nothing at all is known of its breeding habits, and neither the eggs nor the young stages have yet been described. The eggs are probably of the buoyant type, and are perhaps shed in deep water.

The Opah is an excellent food-fish, the flesh being red, tender, full of oil and of a delicate flavour, not unlike that of the Tunny.

This remarkable fish is known by a number of names, among which the following may be mentioned: " sun-fish ", " king-fish ", " Jerusalem Haddock ", " Mariposa ", " cravo ", " San Pedro Fish ", " soho ", " glance-fish " and " gudlax ". The generic name, *Lampris*, is derived from a Greek word meaning radiant; the specific name, *luna*, of course, simply means " moon ".

RIBBON-FISHES.

(Family TRACHYPTERIDÆ.)

These fishes belong to the same Order as the Opah, and their protrusible mouths are actuated by a similar mechanism.

The body is long and very much compressed, and the skin is either naked or provided with scattered spines or tubercles. The eyes are large. The mouth is toothless or provided with feeble teeth, which may also be present on the roof of the mouth. The dorsal fin is very long, extending the whole length of the back, and is supported by many flexible rays, of which the first is sometimes rather stiff and spine-like; the front part of the fin often forms a high lobe or crest, and may be more or less detached from the remainder. There is no anal fin. The caudal fin is either absent altogether, or is placed out of line with the rest of the body. The pectoral fins are small and their bases are set horizontally on the body. The pelvic fins are close together and never have more than 9 supporting rays. There is no air-bladder. The skeleton contains very little limy matter, all the bones being thin and fragile.

These are oceanic fishes, found in most of the seas of the world, and probably live mainly in the upper layers of the water.

No fossil remains of Ribbon-fishes have yet been discovered.

DEAL-FISHES.

(Genus *Trachypterus*.) Fig. 38.

The body is moderately long, and the caudal fin is usually present. The pelvic fins are generally developed, and are supported by from 5 to 9 rays. The lateral line is provided with bony plates, each of which is armed with a spine, and gradually slopes downwards from the head to the lower edge of the body, and joins that of the opposite side beneath the end of the tail. The general coloration is brilliant silvery, but dark spots and blotches may be present on the sides of the body ; the fins are generally rosy in hue.

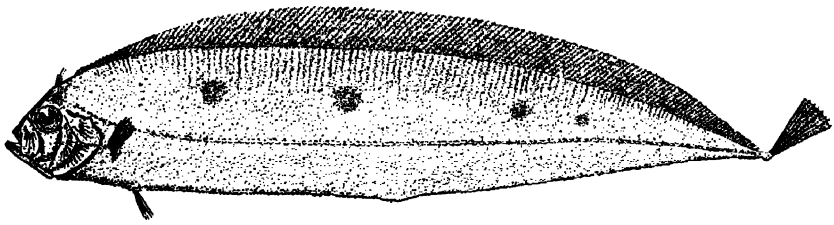


Fig. 38.—Northern Deal-fish (*Trachypterus arcticus*).

The larger species grow to a length of at least 8 feet.

A number of species have been described from Arctic, temperate and tropical seas, but it is doubtful whether more than about ten of these are really valid. Owing to the fragility of these fishes, and the consequent extreme rarity of well-preserved specimens in museums, it is almost impossible to ascertain the distinguishing features of the species, and their separation is further complicated by the fact that all these fishes change their form considerably with age. The Northern Deal-fish (*T. arcticus*) is widely distributed in the North Atlantic, and specimens are sometimes washed ashore in the northern parts of the British Isles, especially in the Shetlands.

Among other better-known species are *Trachypterus iris*, from the Mediterranean; *T. rex-salmonorum*, from the Pacific coast of America; and *T. ishikawæ*, from Japan.

The Deal-fishes are among the rarest of the inhabitants of the open sea, and our very limited knowledge of these curious creatures is derived almost entirely from the occasional specimens found in a dead or dying condition at the surface or cast up on the beach after a storm. They have never been taken in the trawl or in any other kind of deep-water net. So fragile are their bodies that the individuals cast ashore are almost invariably damaged, and as the tide recedes the carcase shrivels up and almost disappears, both flesh and bones being made up largely of water. We know, however, that as a general rule fishes living in the upper layers of the sea have large eyes and a silvery coloration, whilst those from the deeper layers have small eyes and uniformly black bodies. From this fact it may be inferred that the Deal-fishes are not inhabitants of great depths, as is sometimes stated, but probably live in water from the surface down to 200 or 300 fathoms.

Nothing is known of their normal food or of their breeding habits, but young Deal-fishes, 2 to 4 inches long, have been captured from time to time, and in the case of the Mediterranean species a nearly complete series of growth stages has been seen. This reveals that the young fish are quite unlike their parents, and that three or more stages have been erroneously regarded by earlier writers as representing distinct species. In the youngest stage known (about 16 mm. long) the front rays of the dorsal fin, all those of the pelvics and those of the lower lobe of the caudal fin are drawn out into fine streamer-like filaments, which may be many times longer than the body and are ornamented with lappet-like skinny processes. It may be noted that in these very young fish the caudal fin is of the normal type, but later on this becomes divided into a smaller and quite rudimentary lower part and a larger upper one, which projects obliquely or even vertically upwards. As growth proceeds the filamentous fin-rays become progressively shorter and the lower lobe of the tail disappears. It may be assumed that the young Deal-fishes live at some considerable depth, where the water would be reasonably still, as the

currents found at or near the surface would soon damage their delicate appendages.

In Scandinavia and elsewhere the Northern Deal-fish is known as the Vaagmaer or Vogmar, an Icelandic word meaning " maid of the bay ". The species from the Pacific coast of America is sometimes referred to as " King of the Herrings ". To the Makah Indians west of the Straits of Fuca it is known as " King of the Salmon ", and they are said to have a saying that when the " king " is killed the salmon will cease to run. The scientific name, *Trachypterus*, is derived from two Greek words meaning " rough " and " fin ".

OAR-FISH.

(Genus *Regalecus*.) Pl. I B.

The body is very long and ribbon-shaped, and studded with numerous hard, but not bony, tubercles. The caudal fin is a mere rudiment or is absent altogether. Each pelvic fin is represented by a single long ray, which is usually broadened out at its tip. The lateral line runs along the lower part of the side, and is not provided with spiny plates. The coloration is silvery, with a bluish tinge on the head, and the body is ornamented with irregular short and obliquely placed dark streaks, and sometimes with series of dark spots; the fins are all coral red.

Grows to a length of more than 20 feet, perhaps very much longer, and may weigh as much as 600 lb.

Several species have been described, but as specimens of these fishes are even rarer than those of the Deal-fishes, it is very difficult to decide whether these are really distinct. It seems likely that there is only one species (*R. glesne*), which is almost world-wide in its distribution.

Like the Deal-fishes, the Oar-fishes probably live in the upper or intermediate layers of the oceans, where they swim about by wave-like movements of their long bodies. Occasionally individuals have been found floating at the surface, sometimes lying passively on their sides—a position probably adopted only by a sick or dying fish. Now and then specimens are cast up on the beach after a storm, where they excite great

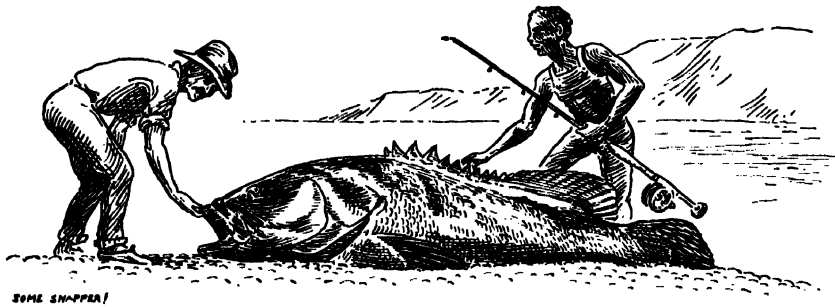
curiosity. The usual fate of these fish is to be carried round and exhibited as " sea serpents ", but their fragile, watery bodies soon shrivel up, and unless they are carefully preserved without delay, they are useless as museum specimens. On two occasions an active living Oar-fish has been seen by man, and in each case the observer was very greatly impressed by its vivid hues and curious serpentine movements. One was a small specimen, not more than 2 feet long, and was seen by Mr. Holder, at Avalon Bay, Southern California ; the other was 11 feet 9 inches long without the tail, which had been bitten off, and was seen alive, and subsequently captured by Professor Wood Jones in the Indo-Australian Archipelago.

It was noticed that when excited or touched with a hook or rope the Oar-fish erected the crest-like front end of its dorsal fin, and this fact is of some interest. There can be little doubt that stories of " sea serpents ", which describe the monster as having the head of a horse with a flaming red mane, have as their basis a large Oar-fish seen swimming at the surface of the sea with its scarlet dorsal crest erect.

Little is known of the breeding habits of the Oar-fishes, but the eggs are of the buoyant type, and some of the young stages have now been recognized and described. These have the front rays of the dorsal fin and those of the pelvics drawn out into long streamers, ornamented with small tags or processes.

The flesh is quite useless as food, and it is recorded that in Scandinavia even dogs refused to eat it, whether offered raw or cooked.

The Oar-fish is also known as " King of the Herrings ", as it was at one time believed to precede or accompany the herring shoals. The scientific name, *Regalecus*, is a combination of two Latin words : *regalis* (from *rex*, a king), and *halec*, fish-sauce (herring). An ancient belief was that to harm this fish would be to drive the herring away. The name " Oar-fish ", of course, refers to the form of the long pelvic fins, and " Ribbon fish " is self-explanatory. The Japanese call it " Dugunonatatori ", which translated literally means " Cock of the palace under the sea ".



CHAPTER V: PERCH-LIKE FISHES.

Sea Perches. Stone Bass or Wreck-fishes. Jew-fishes. Groupers or Rock-fishes. Pampanos. Amber-fishes or Yellow-tails. Pilot-fishes. Leer-fish. Dolphins. Croakers or Roncadors. Escolars or Oil-fishes. Snoek. Cutlass-fishes or Hair-tails. Scabbard-fish.

THE fishes dealt with in this chapter are all Spiny-rayed Bony Fishes, and all belong to the great Order of Perch-like Fishes (Percomorphi). The members of this Order agree in never having more than 6 rays supporting each pelvic fin, and not more than 17 principal rays in the caudal fin. An air-bladder is present, but is never connected with the gullet. The Order Percomorphi is subdivided into a number of sub-orders, of which the first or Percoidea is by far the largest. The Percoids all agree in having the pelvic fins placed below the pectorals and composed of a spine and 5 soft-rays, in having the spinous dorsal fin well developed, with the spines usually stiff and sharp, and, as a rule, in having scales with prickly edges.

SEA PERCHES.

(Family SERRANIDÆ.)

Percoids with an oblong and more or less compressed body, covered with closely adhering scales of small or moderate size. The head is usually entirely scaly, and each gill-cover has from 1 to 3 flat spines. There are 2 nostrils on each side of the

snout. The mouth is protrusible, of large or moderate size, and the jaws are armed with rows or dense bands of pointed teeth, which are usually present also on the roof of the mouth. The dorsal fin has a spinous portion in front, which either merges into the hinder soft portion or is separated from it by a more or less deep notch. The caudal fin is usually supported by 17 principal rays, of which 15 are branched. The pectoral fins are rounded or pointed, with narrow bases. There is no scaly process at the root of each pelvic fin. A lateral line is present, which does not extend on to the caudal fin. The air-bladder is usually small.

The Sea Perches represent a large and varied family, and are found in almost all tropical and temperate seas. A few members live in brackish or fresh water. Fossil remains date back to the Eocene period.

STONE BASS OR WRECK-FISHES.

(Genus *Polyprion*.) Fig. 39.

Sea Perches with a robust body, covered with very small, rough scales, with prickly edges. The head is armed with rough spiny crests, and there is a strong bony ridge across each gill-cover, which ends behind in a stout spine. The mouth is large, and the lower jaw projects beyond the upper. There are broad bands of small, pointed teeth in the jaws, but no larger canine teeth in front; there is a patch of teeth on the tongue. The single dorsal fin has 11 or 12 stout spines and a like number of soft-rays; the spinous part of the fin is longer than the soft. The anal fin is short, with 3 spines and 8 or 9 soft-rays. The hinder edge of the caudal fin is rounded or square-cut. The pectoral fins are short, and the pelvic fins are situated below the bases of the pectorals. The full-grown fish are greyish-brown or stone-coloured, and the caudal fin is edged with white; young individuals are irregularly marbled with large pale blotches.

Grow to a length of 6 or 7 feet and a weight of more than 150 lb.

Two species are known: the Common Stone Bass or Wreck-fish (*P. americanus*), from the North and Middle Atlantic and

the Mediterranean, which occasionally approaches the southern coasts of the British Isles; and the Groper or Hapuku (*P. oxygeneios*), from Tasmania, New Zealand, and the islands of Juan Fernandez.

The large Stone Bass live at the bottom where the ground is rocky, in water of a depth of 300 or 400 fathoms, and appear to be more or less solitary in their habits. The young fish, up to 20 lb., however, live in the upper layers of the sea, and from their habit of following ships and floating wreckage in shoals, perhaps to feed on the barnacles, they have received the name of " Wreck-fish ". The normal food of full-grown specimens appears to consist mainly of other fishes, but shellfish and crustaceans are also eaten.

Practically nothing is known of the breeding habits of these fishes, but in the Mediterranean spawning takes place during the summer. In the case of the Hapuku the breeding season is in July and August.

The flesh is reputed to be good for food, being white and tender, although without any special flavour. In Madeira the big fish are caught by means of long lines, each weighted with a large stone and baited with mackerel or scad. Mr. Lowe tells us how on being pulled up from the depths, " the fish become so distended with gas, expanding upon the removal of the vast pressure below, that it rises to the surface, not indeed entirely dead, but wholly powerless, and in a sort of rigid cataleptic spasm; the stomach is usually inverted, and protruded into the mouth; and the eyes in general are forced so completely from their sockets, sticking out often like two horns, that ' eyes like a Cherne ' is a common phrase among the fishermen for a prominent-eyed person ". Sometimes the distended fish is so light that as it comes to the surface it rises faster than the line can be pulled in and shoots right out of the water!

The Stone Bass is known in the south of France as " Cernia " or " Cernier ", and the Madeiran names of " Sherny " or " Shern " represent other forms of the same names. The natives of Madeira call the young fish " Chernotta ", and, according to Mr. Lowe, the adults are known to English visitors as " Jewfish ". In South Africa the Stone Bass is sometimes called " Bafaro ". The scientific name, *Polyprion*,

is derived from two Greek words meaning "many" and "saw" —referring to the numerous serrations on the head and on the spines of the fins.

JEW-FISHES.

(Genus *Stereolepis*.) Fig. 40.

Closely related to the Stone Bass. The scales are small, with fine spines at their edges, but are not rough. There are no spiny ridges on the head. The tongue is quite smooth. Each gill-cover has 2 blunt spines. The dorsal fin consists of a long spinous portion with 11 spines, separated by a deep notch from the short soft part with 10 rays. The pelvic fins are placed just in front of the bases of the pectorals. The full-grown fish are nearly uniformly greenish-black or grey; the young are brownish, with large black blotches or dusky stripes, and the dorsal, anal and caudal fins have a conspicuous pale edge. The pelvic fins are more or less black.

Grow to a length of 5 to 7 feet and a weight of 600 to 800 lb.

Two species are known: the California Jew-fish (*S. gigas*), found on the coast of California; and the Rock-fish or Japanese Jew-fish (*S. ischinagi*), from Japanese seas.

Little is known of the manner of life of these huge and somewhat clumsy-looking fishes. They are known to be sluggish in their movements, and to live almost entirely among rocks on the sea bottom, where they prey voraciously upon other fishes of all kinds. The late Professor Holder, the famous American writer on sporting fishes, thus describes his first California Jew-fish: "What a wonderful creature it was! The experience of the moment, the sensations, could not have been purchased. It was worth going a long way to accomplish. Imagine, you casters of the black bass fly, a small-mouthed black bass lengthened out to six feet, bulky in proportion, a giant black bass—one that you would dream about after a good day's fishing,— . . .! Imagine this, and you have the jewfish, black sea-bass, or *Stereolepis gigas*, of the Pacific coast—a noble fish, a gamy fellow, especially adapted to the man who desires animated dumb-bells, or who, sedentary in his habits, requires violent exercise combined with much excitement."

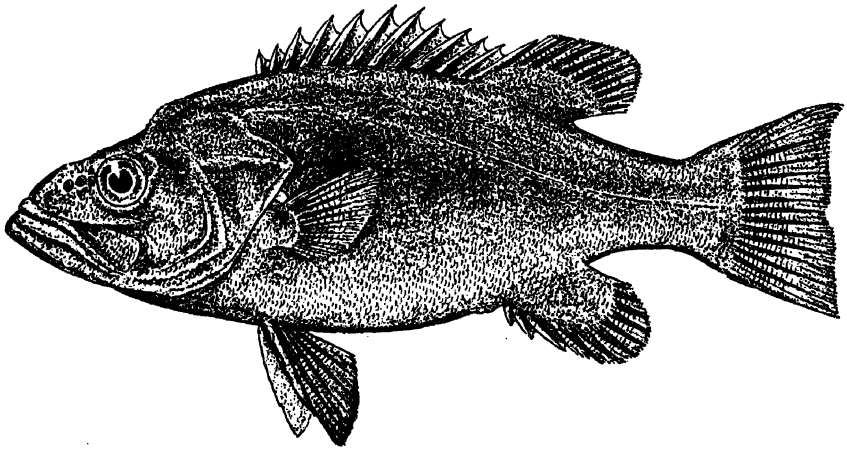


FIG. 39.—Common Stone Bass or Wreck-fish (*Polyprion americanus*).

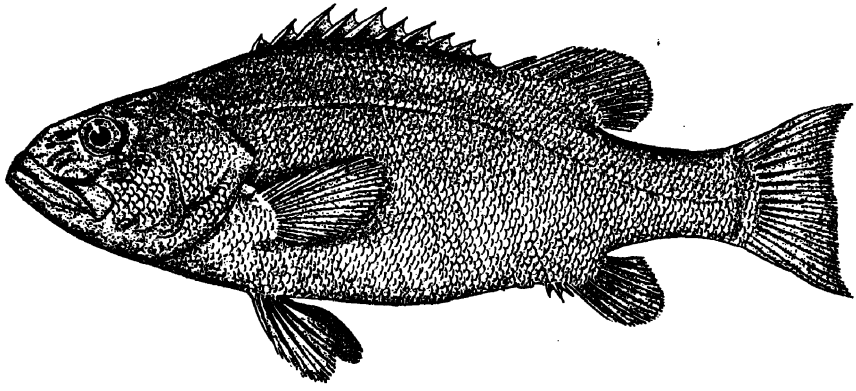


FIG. 40.—California Jew-fish (*Stereolepis gigas*).

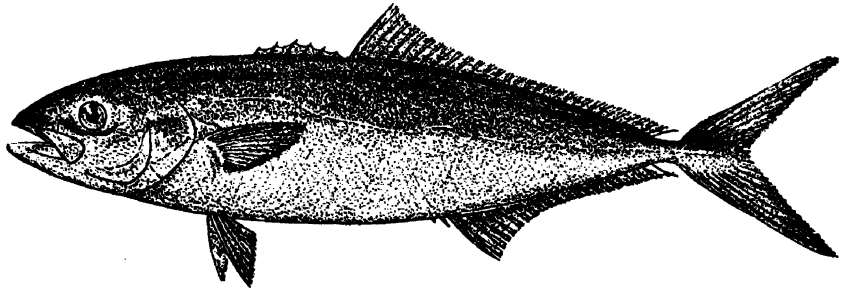


FIG. 41.—New Zealand Yellow-tail (*Seriola grandis*).

Practically nothing is known of the breeding habits of the Jew-fishes.

As food-fishes they are of rather minor importance, although both species are sold as food. It is as a sporting fish that the California Jew-fish is best known, being one of the prizes at the famous angling resort of Santa Catalina. It can be taken all the year round, and is fished for with live bait. Professor Holder tells us that it is " fished for on the edge of the kelp in 30 or 40 feet of water. The strike comes as a nibble, but when hooked the fish is away with a rush that has been known to demoralize experienced anglers. . . . I have seen a 200-pound fish snap the largest shark-line like a thread, and large specimens straighten out an iron shark-hook; yet the skilled wielders of the rod catch these giants of the tribe with a line that is not larger than some eye-glass cords ". The record California Jew-fish caught on rod and line was taken at Santa Catalina in 1916 and weighed 515 lb.

The California Jew-fish is commonly referred to as " Black Sea Bass ", and is also known as " Giant Bass ". The Japanese call their species " Ishinagi " or " Oiwo ", names meaning " rock bass " and " huge-fish " respectively. Concerning the name " Jew-fish ", Dampier writes in 1729: " The Jew-fish is a very good Fish, and I judge so called by the English, because it hath scales and Fins, therefore a clean Fish, according to the Levitical law." The scientific name, *Stereolepis*, is derived from two Greek words meaning " firm " and " a scale "; *gigas*, of course, means simply " giant ".

GROUPERS OR ROCK-FISHES.

(Genus *Epinephelus*.) Pl. III c.

The body is more or less compressed, and is covered with small, smooth or prickly scales. The mouth is large. The teeth are set in rows in the jaws, the inner ones being hinged at their bases, so that they can be pressed downwards towards the inside of the mouth; usually there are some larger canine teeth at the front of the jaws; teeth are present on the roof of the mouth, but there are none on the tongue. Each gill-cover is armed with 1, 2 or 3 spines. The single dorsal fin

has 8 to 12 spines and 12 to 21 soft-rays ; the spinous part of the fin is as long as, or longer, than the soft portion. The anal fin is short, with 3 spines and 7 to 12 soft-rays. The hinder edge of the caudal fin is rounded, square-cut or concave. The pectoral fins are rounded, and the pelvics are situated below the bases of the pectorals. The coloration varies enormously in the different species, but nearly all the giant forms are uniformly olive, grey, brown or black when full-grown

The largest species (*E. lanceolatus*) is said to grow to a length of 12 feet, and several others attain to a length of 5 or 6 feet, and a weight of at least 400 or 500 lb.

More than 100 species are known from tropical and sub-tropical seas, but only a few of these grow to a large size. Of the giant Groupers, the following are perhaps the best known : the Black Grouper or Black " Jew-fish " (*E. nigritus*), from the South Atlantic and Gulf coasts of the United States, ranging southwards to Brazil ; the Guasa, Spotted " Jew-fish " or Mero (*E. guttatus*), from both coasts of tropical America, ranging northwards to Florida and the Gulf of California and southwards to Brazil and Panama ; the Variegated Rock Cod or Malabar Grouper (*E. tauvina*), found from East Africa through the Indian Ocean and Archipelago to Australia and the islands of the Pacific ; and the Indian Grouper or " Jew-fish " (*E. lanceolatus*), with a similar distribution. One species of fair size, the Giant Perch or Dusky Perch (*E. gigas*), is an occasional visitor to the southern coasts of the British Isles.

These fishes abound in most warm seas, but there is little to be said concerning their mode of life. They are all voracious, carnivorous fishes, preferring other fishes and crustaceans, but also eating shellfish, cuttlefishes and other marine creatures. The huge Spotted Grouper is not infrequently found with curious hard, irregular blackish lumps, lying free in the body-cavity or bound by tissue to the viscera. On examination one of these lumps was found to contain the mummified body of a Sharp-tailed Eel, and it is believed that the eel must have been swallowed by the Grouper and in its death paroxysms plunged its sharp tail through the wall of the stomach or some other part of the digestive tract, and thus found its way into the body-cavity. Similar cases of the supposed penetration

of the food tract by eels have been recorded among other large Perch-like fishes from Ceylon, and dried and shrivelled specimens of Blennies and Butter-fishes have been taken from the body-cavities of Cod landed at Grimsby and elsewhere. Generally speaking, an accident of this nature might be expected to cause peritonitis, resulting in the death of the swallower, but sometimes the intruder becomes shrivelled up or walled off by membranes and reduced to a mummified mass, without doing any harm to the " host ".

Most of the smaller species of Grouper are remarkable for their power of changing their colours almost instantaneously, a power which has earned for them the title of " Chameleons of the Sea ". Specimens of the Nassau Grouper, for example, which have been kept in the aquarium at New York, have been seen to show as many as eight different phases of coloration, and the ability of this and of other species of Grouper to assume half a dozen different liveries within the space of a few moments is truly remarkable, and a source of constant wonder to visitors. These colour changes are usually undertaken in order that the fish may be able to harmonize with its surroundings and thus escape detection. Colonel Alcock, in his book, ' A Naturalist in Indian Seas ', records how he was in a boat with a native fisherman who speared one of these fishes, which, when wounded, took shelter in an adjacent clump of coral and there lay concealed. Its close-set, hexagonal red spots bore an almost exact resemblance to the surface of the coral and the fish refused to leave its shelter, and was eventually captured. Dr. Beebe has described a Grouper of a shining blue colour with three broad vertical bands of brown, which swam into a clump of coral, emerging a few minutes later " clad in brilliant yellow, thickly covered with black polka-dots ".

Little is known of the breeding habits of these fishes, but most of the species seem to deposit their eggs in fairly shallow water in spring or early summer.

The flesh is pale and of fair quality, and, on account of their abundance, most of the Groupers are of considerable economic importance. Many of the species possess good fighting qualities when hooked, and consequently give good sport to the sea angler. A Spotted " Jew-fish " of 750 lb. weight has been taken on rod and line off Florida.

The name Grouper or Groper is a corruption of the Portuguese name "garrupa", given to some of the species of *Epinephelus*. These fishes are also known as Rock-fishes, Hinds, Nigger-fishes, Coneys, etc. The name "Jew-fish" is properly reserved for the genus *Stereolepis*, but is popularly used for a number of large Sea Perches, as well as for one of the Croakers (p. 131). The scientific name is derived from a Greek word meaning "clouded over", referring to the membrane which is supposed to cover the eye in some of the species.

PAMPANOS.

(Family CARANGIDÆ.)

Percoids related to the Sea Perches, but differing from them in the following characters: The spinous dorsal fin is shorter, with the spines either slender or quite short, and the soft portions of both the dorsal and the anal fins are longer. The first 2 spines of the anal fin are detached from the rest of the fin; sometimes these spines are hidden under the skin. The caudal fin is more widely forked and is placed at the end of a more slender peduncle.

The Pampanos represent a large and varied family, and abound in all warm seas, often moving northward during summer months. Many of the species have a wide distribution, and most of them are valued as food. Fossil remains of fishes which appear to belong to this family have been found in rocks as old as the Cretaceous period.

AMBER-FISHES OR YELLOW-TAILS.

(Genus *Seriŏla*.) Fig. 41.

The body is oblong and moderately compressed, and is covered with small, smooth scales. The mouth is fairly wide. The first dorsal fin has 6 or 7 weak spines, which are connected with one another by membrane; the second dorsal fin is very long, and its front part forms a more or less raised lobe. The anal fin is much shorter than the second dorsal, and the 2 detached spines disappear in adult fish. The pectoral fins are

short and broad, the pelvic fins usually longer. The lateral line is scarcely arched in front, and forms a keel on the base of the tail. The coloration is usually blue or bluish-black on the back, shading to silvery or yellowish-white on the lower parts; often there is a yellow or golden band running along each side from the snout to the tail. The hues of the fins vary in the different species, but the caudal fin is nearly always yellow. Young individuals often have more or less distinct dark cross-bands.

The larger species grow to a length of 5 to 7 feet and a weight of more than 100 lb.

Several species may be recognized, but only about three of these attain to any size. The California Yellow-tail (*S. dorsalis*) ranges from Point Concepcion to Panama; the Great Amber-fish, Amber Jack or Coronado (*S. lalandi*), is found in the tropical and temperate parts of the Atlantic, being well known in South Africa and on the coast of America from Florida to Brazil; the New Zealand Yellow-tail (*S. grandis*) occurs in the seas of Australia and New Zealand.

The Yellow-tails are handsome, active fishes, generally to be found in large shoals, and feeding mainly upon other fishes and upon crustaceans of various kinds. In South African waters, where these fishes are known as "Albacores", the shoals arrive in October and remain throughout the summer. The Californian Yellow-tail may be caught at almost any time of year, but is most abundant from July to October, when shoals swarm around Coronado Island and Santa Barbara Islands. Writing of the Cape "Albacore", Mr. Biden says: "When the fish are in great shoals, the attention of fishermen, putting out to sea in the night's darkness, is attracted to a glow on the ocean resembling the luminosity of distant search-lights. . . . When night falls, the scene reveals what at first sight appears an immense quantity of phosphorus on the sea. The reflection of this wonderful light is seen in low-lying mists and is visible for miles. When the fish are disturbed, one school excites another, in turn, till the foam of the ocean sparkles with lights of blue, crimson and violet, scintillating in a maze of fire . . ."

The spawning season of the Cape Yellow-tail is from January to July, that of the Californian species from July to the

autumn. Almost nothing is known of the very young fish, and it is believed that spawning takes place in the open sea.

As food the larger Yellow-tails are of poor or moderate quality, but they are of some considerable commercial importance, and the Californian species is extensively canned. The fish are caught with hook and line, with live bait, as well as with nets.

The Yellow-tails are among the gamest of fighters and are much sought after by anglers. Dr. Regan relates an account given by the late Professor Holder of the hooking of a large fish at Avalon. The fish dashed out to sea for about 200 feet, then turned and came straight in to the pier on which he was standing, ran beneath it, and broke the line. Professor Holder argued that this showed some intelligence, and that if the fish had had any delicacy of feeling he would have retired for the day; instead he paraded up and down, towing about 6 feet of line, and in about 20 minutes took another hook. This time he did not bother to run out to sea, but took a turn round a pile of the pier, broke the line at once, and appeared soon after trailing two lines. The record Yellow-tail taken by fair angling methods seems to have been one caught in New Zealand by Mr. Zane Grey, a fish weighing 111 lb.

The name "Coronado" is a Spanish word, and refers to the yellow streak running obliquely across the head. The scientific name, *Seriola*, is the Italian name for a species of Amber-fish found in the Mediterranean; *lalandi* was given in honour of Mr. Delalande, a well-known naturalist who collected fishes in Brazil for Baron Cuvier.

PILOT-FISHES.

(Genus *Naucrates*.) Pl. III B.

Closely related to the Amber-fishes or Yellow-tails, but the spinous dorsal fin has only 4 or 5 weak spines, which are not connected by membrane. The coloration is bluish or greyish above, becoming paler beneath, with 6 or 7 dark cross-bands, which extend on to the fins and tend to become less conspicuous with advancing age. The caudal fin is blackish, with white tips to the lobes.

Grow to a length of about 2 feet.

There is probably only one species of Pilot-fish (*N. ductor*), with a wide distribution in the open seas of the warmer parts of the globe. It is a somewhat rare visitor to the British Isles during the summer months. Some authorities hold that the Southern Pilot-fish (*N. angeli*) from Australia, New Zealand and elsewhere, represents a distinct species.

The inclusion of this comparatively small fish in this book perhaps requires justification, but, since it is so familiar an inhabitant of the open oceans and is so often to be found accompanying ships or large fishes, it may well find a place here. The name " Pilot-fish " is derived from its habit of accompanying ships across the sea and from its frequent association with some of the larger sharks. It has been known to follow a vessel for as long as 80 days. It will generally leave the ship as it approaches land, but has been known to accompany it into harbour. For many years the accepted explanation of its association with the shark was that it acted as a pilot to its companion, which it guided to its food, enjoying in return for this service a degree of protection from its enemies afforded by the presence of its formidable partner. It was also said to share the shark's meal and to feed on the latter's excrements. The fact that small fishes have been found in the stomachs of Pilot-fishes suggests that at times they feed actively on their own account. The association of Pilot-fish and Shark is certainly a very intimate one, and it is a little difficult to understand how this curious partnership comes about. The Pilot-fish seems almost loath to leave its large companion, and, when the shark has been hooked and hauled half out of the water, a number of Pilot-fishes have been described as swimming round and round its tail in an agitated manner. At times they have been observed to retain a more or less constant position near the body of the shark, keeping within a few inches of the base of the pectoral fin. " Fishermen have also noticed," writes Dr. Gilchrist, " that they have the habit of darting away from the shark towards any strange object, and then returning to their former position." Two American authors have stated that when accompanying a shark, " they follow their unconscious protector closely, rarely leaving it for many seconds at a time. Occasionally they

dart aside for a morsel of food, but hurry back again like children afraid of losing their nurse ".

Dr. Gilchrist has made the striking suggestion that the eggs of the Pilot-fish, each of which, according to him, is provided with a long, fine filament, are actually attached to the rough skin of the shark or to the bottom of a ship, and that the behaviour of the fish is due to a natural solicitude for their safety. This explanation does not appear to have been generally accepted, however, and another authority who has examined the eggs of the Pilot-fish failed to find any trace of the filaments. On the whole, the most reasonable explanation of the association is that the Pilot-fish accompanies the shark in order to obtain a share of its meals, and that it is not itself eaten by its companion on account of its small size and exceptional agility.

The Pilot-fish is common in the Mediterranean, and was well known to the ancient Greeks and Romans as *Pompilus*. Curiously enough, nearly all the classical accounts refer to an association with whales or dolphins rather than sharks, and Aristotle calls the fish the " Dolphin's Louse ". According to Aelian, these fishes were supposed to be kindly disposed towards sailors, and they therefore liked to approach ships, which they guided across the ocean and finally announced the proximity of land by their sudden disappearance. Oppian celebrated the interesting habits of the Pilot-fish in verse.

Spawning seems to take place in the open ocean during the early summer, and at this season the young may be encountered in large numbers. These are so unlike their parents, both in form and coloration, that they were originally regarded as quite distinct fishes. They are in the habit of swimming about in small bands under and in the neighbourhood of large jelly-fishes, Portuguese Men-of-War (creatures related to the jelly-fishes), bunches of Sargasso weed, pieces of floating wreckage and so on.

As food the Pilot-fish is of no importance, and the flesh has been described as resembling a " dry mackerel ".

The Pilot-fish is sometimes known as the " Romero ". The scientific name, *Naucrates*, is derived from a Greek word meaning " ruler of the ships " ; the name *ductor* is a Latin word meaning " a leader ".

LEER-FISH.

(Genus *Lichia*.) Fig. 42.

Closely related to the Amber-fishes and Pilot-fishes. The spinous dorsal fin has 7 or 8 spines, which in the adult fish are not connected by membrane, and the second dorsal and the anal fin are nearly equal in size. The pelvic fins are shorter than the pectorals. The lateral line has an upward curve above the pectoral fin, then a downward curve in the middle of the side, and then runs straight to the tail. The coloration is more or less greenish or bluish on the back, becoming grey on the sides, and passing into cream or white on the belly. The lateral line is black. The fins are mostly grey, but the pectorals and pelvics are paler. Young individuals have several more or less distinct dark cross-bands, which are sometimes replaced by oval or rounded black spots.

Grows to a length of 6 feet.

The single species (*L. amia*) is found in the Mediterranean and the Eastern Atlantic, extending southwards to the Cape and along the east coast of Africa to Natal.

Very little is known of the habits of this migratory fish, which makes its appearance at different places on the African coast at various seasons. It apparently feeds almost exclusively upon fishes, especially pelagic fishes, such as the sardines and mullets.

The Leer-fish is used for food, young individuals being sun-dried and sold as " bokkums ". Some regard the larger fish as good for the table, but others describe them as coarse. They provide good sport for the sea angler.

The scientific names, *Lichia* and *amia*, are both derived from ancient names for fishes. The *Amia* is mentioned by Pliny, but it is not certain whether he was referring to this species.

DOLPHINS.

(Family CORYPHÆNIDÆ ; Genus *Coryphæna*.) Pl. IV c.

The body is long, compressed, tapers behind and is covered with small, smooth scales, The head is curiously shaped in the full-grown fish, being high and with a nearly vertical

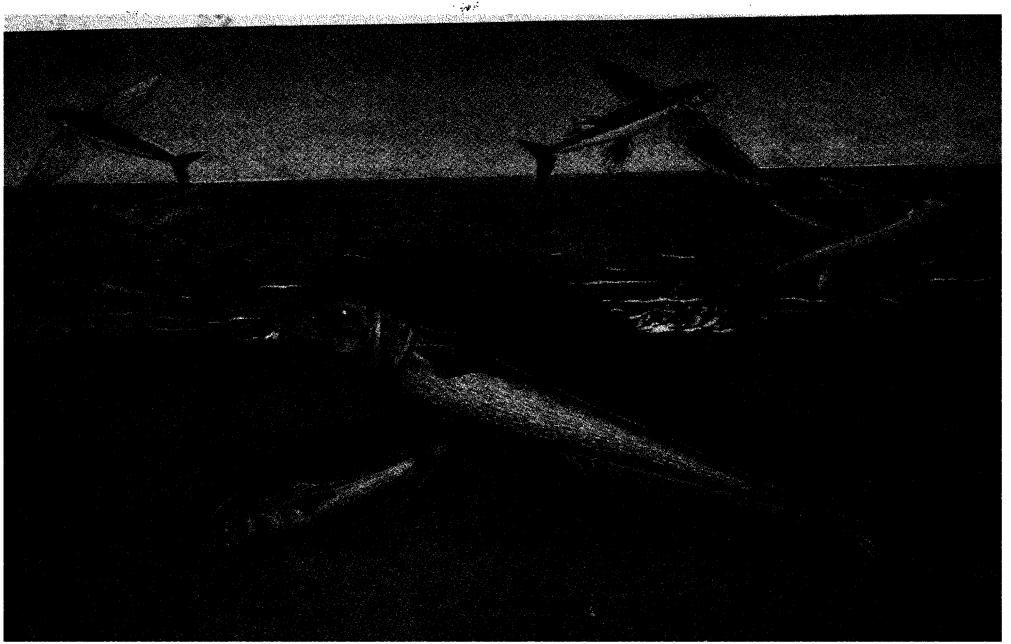
cutting-edge in front. The mouth is wide, and the jaws are provided with bands of small, curved, pointed teeth, which are also present on the roof of the mouth and on the tongue. There is a single dorsal fin, supported by many rays, which extends from the nape nearly to the tail. The anal fin is similar, but shorter. Neither of these fins has any true spines, but the rays in front are unbranched and undoubtedly represent degenerate spines. The caudal fin is long and widely forked. The pectoral fins are short and sickle-shaped. The longer pelvic fins are placed below them, and lie partly in a groove in the belly when folded back; there is no scaly process at the root of each pelvic fin. The lateral line is irregularly bent above the pectoral fin, but then runs straight to the tail. The coloration is a brilliant green or blue above, shading to silvery white below, with purple and golden reflections, and with a series of bright blue spots on the head and back. The dorsal fin is purplish-blue, with paler oblique lines, and the other fins are tinged with blue; the caudal fin is yellow.

Grows to a length of 6 feet.

The Common Dolphin or Dorado (*C. hippurus*) is probably the only species, and is found in most tropical and subtropical seas. A second but smaller species (*C. equisetis*) has been described, but this may prove to be merely the young stage of the Common Dolphin. Fossil members of this family are known from rocks of the Eocene period.

The Dolphin is an oceanic fish, a strong and speedy swimmer, and is looked upon as one of the most rapid of fishes. It is found mostly near the surface, is a voracious predatory fish, and has a marked partiality for flying-fishes, which it pursues relentlessly. It is a curious looking creature, famous for its brilliant hues, which, however, fade rapidly after death. It is almost cosmopolitan in its distribution, but is nowhere very abundant. Off Cape Hatteras, on the coast of North Carolina, however, there has been found to be an abundance of crustacean life brought to those waters by the Gulf Stream; these provide food for the flying-fishes, which concentrate there in considerable numbers, and these are followed by the Dolphins, which are likewise numerous.

Nothing is known of the breeding habits of the Dolphin. A female fish weighing 5 lb. was estimated to contain 500,000



A. Two-winged Flying-fish (*Exocœtus volitans*). B. Four-winged Flying-fish (*Cypsilurus lineatus*).
C. Dolphin (*Coryphæna hippurus*).

eggs. These eggs are almost certainly of the buoyant type, and are probably shed in the open sea. The young fish are more slender than the adults, and the characteristic crest on the head is at first little marked; as growth proceeds, the shape of the head alters considerably.

The Dolphin is said to provide good eating, but it is not taken in sufficient numbers to be of commercial importance. A curious custom is to test the flesh before eating by putting a piece of silver into the vessel in which this has been cooked; if the flesh is poisonous the silver is said to turn black. The Dolphin has been taken on rod and line, but is not much sought after by sportsmen. The record fish seems to have been one caught in 1930 by Mr. Zane Grey near Papeete (Tahiti), which turned the scale at 63 lb.

The name "Dolphin" is perhaps an unfortunate one, as this has always been held to belong to certain small Cetaceans. The scientific name, *Coryphæna*, was first used by Aristotle, and is derived from two Greek words meaning "helmet" and "to show"—presumably an allusion to the steep forehead; *hippurus* means "horse tail".

CROAKERS OR RONCADORS.

(Family SCIÆNIDÆ.) Fig. 43.

Percoids with an oblong or rather long, compressed body, covered with thin scales, which are either smooth or with somewhat finely toothed edges. The head is covered with scales, and its upper surface has a more or less spongy texture, due to the presence of large mucous cavities in the bones. The snout often has some conspicuous pores or slits, which are nearly always present on the chin. There are two nostrils on each side of the snout. Each gill-cover has two small flat points. The mouth varies greatly both in size and shape. The jaws are usually provided with bands or rows of small, pointed teeth, and there may be an outer row of larger teeth in one or both jaws, and sometimes some large canine teeth in front; there are no teeth on the roof of the mouth or on the tongue. The dorsal fin is either deeply notched in the middle or is divided into two separate parts, the front portion being

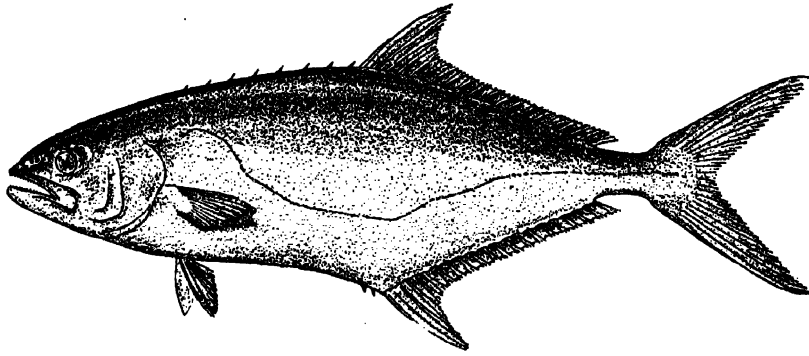


FIG. 42.—Leer-fish (*Lichia amia*).

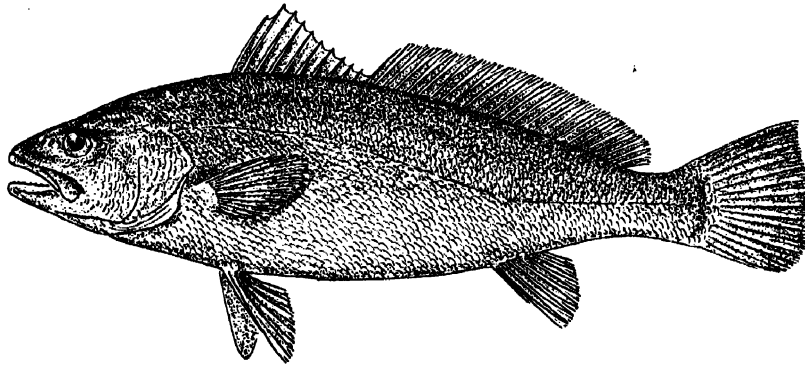


FIG. 43.—Meagre or Kabeljau (*Sciæna hololepidota*).

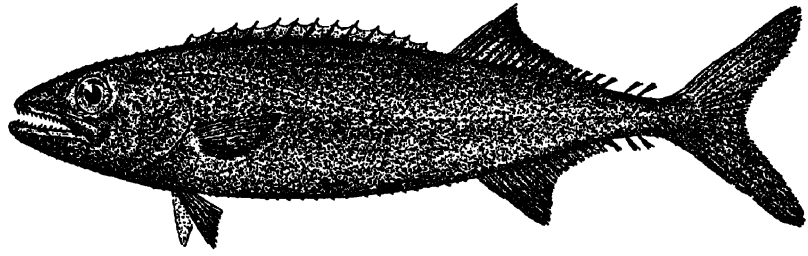


FIG. 44.—Common Escolar or Oil-fish (*Ruvettus pretiosus*).

supported by rather weak spines that can usually be folded back into a more or less deep groove; this part is always shorter than the soft portion. The anal fin is nearly always shorter than the soft dorsal and never has more than two spines. The caudal fin is variously shaped, but is never forked. The pelvic fins are placed just below or behind the pectorals, and there may be a scaly process at the root of each pelvic fin. The lateral line is complete, and extends on to the caudal fin. The air-bladder is large, and usually has a number of appendages on each side. Most of the members of the family are nearly uniformly silvery; none of them are brightly coloured or strongly marked.

This is a large and important family, and includes some thirty or more genera and at least 150 species of fishes, which are variously known as Croakers, Roncadors, Grunts, Drums, Weak-fishes, Squeteagues, Corvinas, Mademoiselles and King-fishes. The great majority of these are of small or moderate size. Fossil remains, supposed to belong to fishes of this family, date back to the Miocene period. The existing Croakers are found in all the warm seas of the world, some of them entering rivers and others being permanently resident in fresh water. A number of Croakers grow to a fair size, but it will be impossible to deal with these in detail here, and the family Sciænidæ must be considered as a whole.

The larger species grow to a length of 6 or 7 feet and a weight of about 150 lb.

The following forms, all attaining to a fair size, are perhaps worthy of special mention. The Meagre or Kabeljau (*Sciæna hololepidota*), also known as "Salmon" or "Salmon Bass" in South Africa, is found in the North and South Atlantic, the Mediterranean, South Africa, Madagascar and Mauritius; it is a somewhat rare visitor to British waters. The so-called "Jew-fish" (*S. antarctica*) is a very closely related species found in Australia. The Geelbek or "Cape Salmon" (*Atractoscion æquidens*) is another South African Croaker. The White Sea Bass (*Cynoscion nobilis*) is a famous Californian fish, and the Common Weak-fish (*C. regalis*) is a closely related species on the Atlantic and Gulf coasts of the United States. The Drum (*Pogonias cromis*) is a very large fish found on the Atlantic coast of America from Long Island to the Rio Grande,

the Red Drum or Channel Bass (*Sciænops ocellatus*) occurs in the same region, and the Fresh-water Drum (*Aplodinotus grunniens*) ranges from the Great Lakes to Texas. Among large species found in the seas of India and the Malay Peninsula may be mentioned *Parma parma*, *Sciæna diacanthus* and *Sciæna coibor*.

The Croakers are mostly found in shoals of considerable size, and they abound on sandy stretches of coast. They avoid places where the bottom is rocky and are never to be found in waters of any depth. On the whole, they seem to show a preference for muddy rather than clear water. Some of the Croakers are slender, active, predaceous fishes, preying almost entirely upon smaller fishes; others, of more stocky build, live rather more sluggish lives and feed upon small fishes, crustaceans, shellfish, worms and other ground-living creatures. Some of these bottom-living Croakers are provided with one or more short barbels or feelers on the chin, which are highly sensitive, and aid in the search for food buried in sand or mud.

Many of these fishes are renowned for their ability to produce sounds, that have been variously described as grunting, purring, humming, whistling, croaking, snoring, bellowing, drumming, etc.—an accomplishment to which many of the popular names refer. The noises produced are quite audible at considerable distances, and a person standing on the deck of a ship is able to hear the sound made by a fish swimming several fathoms below the surface. A French author tells us that a certain sea captain going up the Gironde when he first heard the " song " of the Meagre was much alarmed, believing that his vessel had sprung a leak and that water was flowing into the hold. The vocal powers of the Meagre were well known to classical writers, and it is possible that the Greek myth of the song of the Sirens had its origin in the sounds made by a shoal of these fishes. The native fishermen in various parts of the world make use of this peculiarity to locate the shoals of fish, one of their number listening-in, as it were, and instructing his companions where to cast their nets. Curiously enough, some Roncadors seem to make no sound at all, in other species it is only the males, and in others again both sexes seem to indulge in vocal efforts. The noises are produced

chiefly at the breeding season, and probably serve as signals for the assembling of the shoals.

The sounds are produced through the agency of a special muscle, which is attached either directly to the air-bladder or close to it. The rapid expansion and contraction of this muscle causes the walls of the bladder to vibrate, and, as the latter has a complicated structure, it acts after the manner of a resonator and amplifies the sound. An American investigator, experimenting with living Croakers, found that if the air-bladder was deflated or removed the sounds ceased altogether, but that if an artificial rubber bladder was then introduced the drumming started again.

Another peculiarity of the Croakers is the large size of the otoliths or ear-stones, which are usually finely sculptured and provided with curious grooves and markings. These otoliths are contained within the auditory organ on each side of the head, and play an important part in preserving the equilibrium of the fish. Small boys in America call the ear-stones of one species " lucky-stones ", as each otolith has the rough impression of the letter " L " on its surface. In olden times the otoliths of the Meagre were regarded as a sovereign specific for the colic, and were worn suspended from the neck.

There is little to be said about the breeding habits of the Croakers. The numerous small, buoyant eggs are shed in the open sea, and, as in the majority of Bony Fishes, after being fertilized by the males, they are left to the mercy of the wind and waves. In South Africa the Kabeljau spawns from October to December, and the young fishes are abundant in the bays and estuaries during the summer months.

Nearly all the members of this family are valued as food, and, although in some cases the flesh is coarse and somewhat tasteless, in others it is of superior quality. The name " Weakfishes " given to some of the species refers to the tender flesh, which is easily torn ; the word " Meagre " is a corruption of the French " Maigre ", meaning " spare " or " lean "—an allusion to the white and bloodless appearance of the flesh. The air-bladders of some of the larger Croakers, particularly in India and Malaya, provide a rough isinglass of some commercial importance. The scales of certain American forms are used in Florida in the manufacture of sprays of flowers

and other ornamental articles, which are sold as " fish-scale jewelry ". The scales are large and silvery, and are said to be so hard that they have to be removed with an axe.

Many of the Croakers are highly esteemed for their sporting qualities, and such forms as the Kabeljau, Geelbek, Weak-fish and California White Sea-Bass are prime favourites with sea anglers. Among records for rod and line may be mentioned a White Sea-Bass of 60 lb., a Channel Bass of 74 lb., a Black Drum of 90 lb., a Weak-fish of 17 lb. 3 oz., and a Kabeljau which turned the scale at something between 130 and 140 lb.

The scientific name, *Sciæna*, is the ancient name for a species (*S. umbra*) common in the Mediterranean, and is derived from a Greek word meaning " shade ".

ESCOLARS.

(Family GEMPYLIDÆ.)

With the Escolars we pass on to another suborder of Perch-like fishes, the Trichiuroids, a group which includes certain fishes that can fairly be described as giants. The Trichiuroids all agree in having the upper jaw formed by fixed, beak-like præmaxillary bones, which are firmly attached to the maxillaries, and in having both jaws armed with sharp teeth, of which those in front are large and canine-like. The pectoral fins are always placed low down on the sides of the body.

The Escolars are Trichiuroids with a moderately long and more or less compressed body, covered with minute scales. The lower jaw projects a little beyond the upper, and there are some strong canine teeth at the front of both jaws. There are no spines on the gill-covers in the adult fish. The dorsal fin is long, with a notch or narrow space separating the front part, which is supported by weak spines, from the soft part, which has a distinct lobe in front. The anal fin is similar to the soft dorsal. The caudal fin is always present, and is forked. The pelvic fins are small and are placed below the pectorals ; each fin is supported by a spine and 5 soft-rays or is reduced to a spine only. An air-bladder is usually present.

These fishes are widely distributed in the open ocean, and

some may descend to considerable depths. Fossil remains have been found in Oligocene and Miocene deposits.

ESCOLARS OR OIL-FISHES.

(Genus *Ruvettus*.) Fig. 44.

The belly is keeled, and the whole of the head and body is covered with minute smooth scales and also with sharp, forked prickles. The spinous dorsal fin, with 13 to 15 spines, is close to or touches the soft dorsal. There are two detached finlets (much branched single rays) behind both the dorsal and the anal fins. The general coloration is grey, black or purple-brown, becoming paler on the lower parts; the inside of the mouth is dusky.

Grow to a length of 6 feet and a weight of 100 lb.

The Common Escolar or Oil-fish (*R. pretiosus*) is found in deep water in the warmer parts of the Atlantic and the Mediterranean, and there is one record from quite near the British Isles. A closely related species, the "Palu" or Pork-fish (*R. tydemani*), occurs in the Indian and Pacific Oceans.

Practically nothing is known of the habits of this interesting fish, which is abundant in certain localities, and is normally found at depths of from 200 to 400 fathoms. It is of importance commercially, and is caught on long lines off Madeira, about Cuba and elsewhere. The late Professor Jordan remarks that the Cuban fishermen go "a scholaring" ("á escolarear"), after fishing for the Spear-fish has finished and before that for the Red Snapper begins. In the South Seas the natives set out to catch these fishes on nights when there is no wind and no moon, using a peculiar and very characteristic fish-hook. Dr. Gudger tells us that the "Palu-hook", as it is called, "is made from the fork of a bush or tree, the trunk furnishing the shank leg, the branch the barb leg. . . . The barb is separately made from a nearly right-angled fork. It and the top of the barb leg are spliced to fit and the barb is lashed on to the top of the barb leg. It is fitted to point obliquely inward and downward, but slightly to one side of the shank". The bait is a flying-fish or other delicacy, and

the curious barb catches the fish either in the corner of the jaw or along the gill-arches and holds it securely.

The flesh is white and flaky, and is said to be palatable at times, although at other times it is so rank as to be uneatable. The fish is heavily charged with oil, which has a strongly purgative action—a circumstance that has given it the name of " Castor-oil Fish ". Being aware of this fact, the natives of some parts of the world boil the flesh and decant the oil, after which it can be eaten with impunity.

The name " Escolar " does not mean " scholar ", as was at one time supposed, but, according to Mr. Lowe, is derived from the Spanish " assacolar ", " açacolar " or " açicolar ", meaning to scour or burnish. " Scour-fish " may, of course, refer to the prickles covering its body, but, in view of the purgative qualities of the oil, this popular name may have quite another significance. The scientific name, *Ruvettus*, is from " Roveto " or " Ruvetto ", the Italian name for the Escolar.

SNOEK.

(Genus *Thyrsites*.) Fig. 45.

Closely related to the Escolar, but there are no prickles on the head or body and the belly is not keeled. The spinous dorsal fin is set in a groove in the back, and is close to the soft dorsal; it is supported by 20 spines. There are 6 detached finlets behind both the dorsal and anal fins. The general coloration is silvery, with the upper parts steely or bluish-black. The eye is pale golden.

Grows to a length of 3 or 4 feet and a weight of 20 lb. or more.

There is only one species (*T. atun*), which is widely distributed in the Southern Hemisphere. It occurs in the seas of South Africa, Tristan d'Acunha, Argentina, Patagonia, Chile, Australia and New Zealand.

The Snoek is found in large shoals at all depths, from the surface down to about 40 fathoms. Although not of great size, it is an active, predaceous fish, with a voracious appetite. It feeds almost entirely upon small surface fishes, and is not averse to making a meal of the young of its own kind. Mr.

Biden states that the Snoek " singles out a small fish and pursues it for as long as half a minute at a time. . . . The motive for singling out an individual fish is apparent. A big fish has greater speed and stamina than a very small one, and in the prolonged chase the prey's powers of endurance naturally weaken. . . . Fishermen often see a sardine leap 2 or 3 feet, and the pursuing snoek also leap and continue the chase immediately both have fallen into the water. The snoek does not leap voluntarily ; the impetus carries it clear of the water. At times the sight is common when scores and sometimes hundreds of snoek behave in this peculiar way ; and there are authentic instances of a snoek following a sardine and leaping right into the fishermen's boat ".

The strong jaws and formidable array of teeth make a living Snoek a nasty customer to handle, and the fishermen treat it with respect, nearly always despatching large fish by a blow on the head with a baton of wood. It is said that a bite from this fish produces profuse bleeding that may last for a day or more, and it has been suggested that this fact may be due to the presence of something in the nature of an anti-clotting ferment in the secretions of the mouth.

Nothing is known of the breeding habits of the Snoek, and the very young fish are rarely seen.

It is a valued food-fish and the object of extensive fisheries conducted by means of hook and line. As it takes a bait readily, large hauls are sometimes made during the Snoek season. Few of the fish are eaten fresh, as the flesh is soft, and, unless cooked carefully, not particularly palatable. The bulk of the catch is salted and cured. Snoek are not good sporting fishes, for, although they bite readily, their fighting qualities are poor.

In Australia and New Zealand this fish is known as " Barracouta "—a name generally reserved for a totally different fish (see p. 169)—and in Chile as " Sierra ". The name " Snoek " in Holland is used for the common fresh-water Pike, and was given to the South African fish by the early Dutch settlers, who saw in it a resemblance to the Pike of their own country. The scientific name, *Thyrsites*, means " like a goad or straight staff or a wand ", according to Mr. Biden ; that is to say, " a sharp-nosed or pointed fish ".

CUTLASS-FISHES OR HAIR-TAILS.

(Family TRICHIURIDÆ.)

Trichiuroids with a very long, band-shaped body, and with a completely scaleless skin. Sometimes the spinous part of the dorsal fin is not distinct from the soft part, but if they are separated the spinous portion is never the longer. The anal fin has numerous short spines. The caudal fin is either small or is wanting altogether. The pelvic fins are either reduced to a pair of scale-like appendages or are absent. An air-bladder is present.

These are surface fishes found in all warm seas, some inhabiting coastal waters, others the open sea.

SCABBARD-FISH.

(Genus *Lepidopus*.) Fig. 46.

There is a row of minute teeth on each side of the roof of the mouth. A single dorsal fin extends along the whole of the back, supported by about 100 rays. The anal spines are numerous, but they are very small or hidden beneath the skin. The caudal fin is present, and is forked. The pelvic fins are represented by a pair of scale-like appendages, and are placed behind the pectorals. The coloration of the head and body is uniformly silvery, the fins being pale grey, dashed with yellow.

Grows to a length of 6 feet.

There is probably only one species (*L. caudatus*), widely distributed in all the warmer seas. It is a very occasional visitor to the British Isles during the summer months.

This is a surface fish, remarkable for the speed with which it is able to swim. Practically nothing is known of its manner of life, but its food appears to consist mainly of other fishes. Accustomed to living in tropical and temperate seas, it is very sensitive to cold, and in New Zealand it sometimes swims ashore in its thousands on frosty nights, apparently in a state of temporary insanity. This habit has earned for it the local name of " Hiku " or " Frost-fish ".

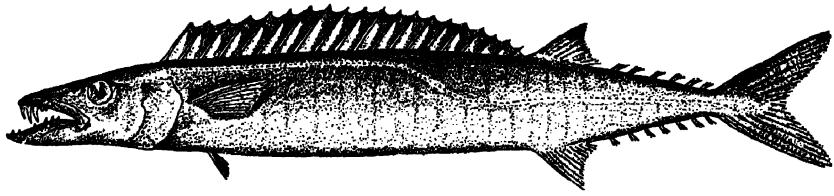


FIG. 45.—Snoek (*Thyrsites atun*).

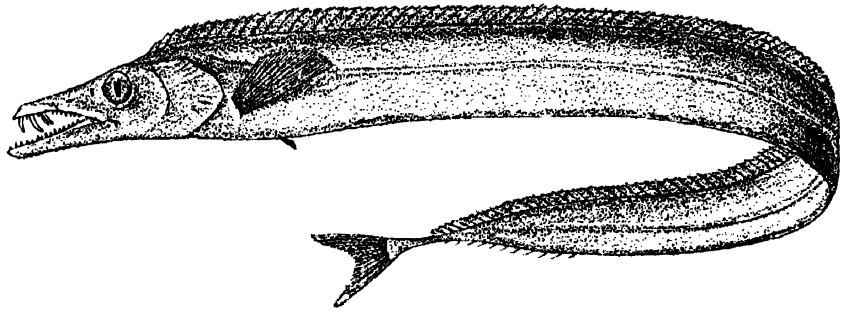


FIG. 46.—Scabbard-fish (*Lepidopus caudatus*).

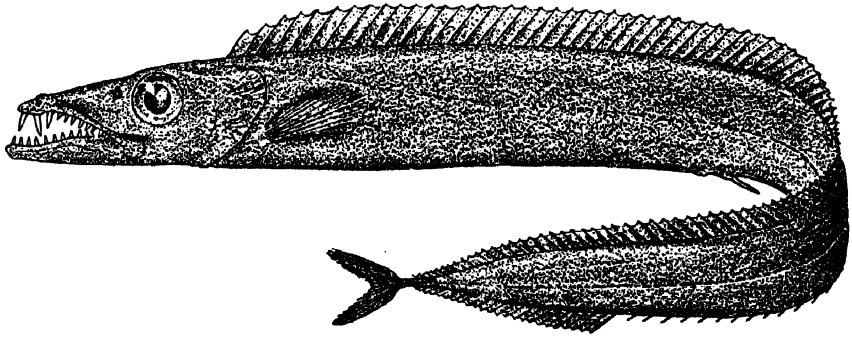


FIG. 47.—Black Scabbard-fish (*Aphanopus carbo*).

It is believed to move from the open sea to inshore waters for spawning purposes, but little is known of its breeding habits.

Although of no commercial importance, this fish provides wholesome and palatable food.

The name *Lepidopus* is derived from two Greek words meaning " scale " and " foot "—a reference to the scale-like pelvic fins.

BLACK SCABBARD-FISH.

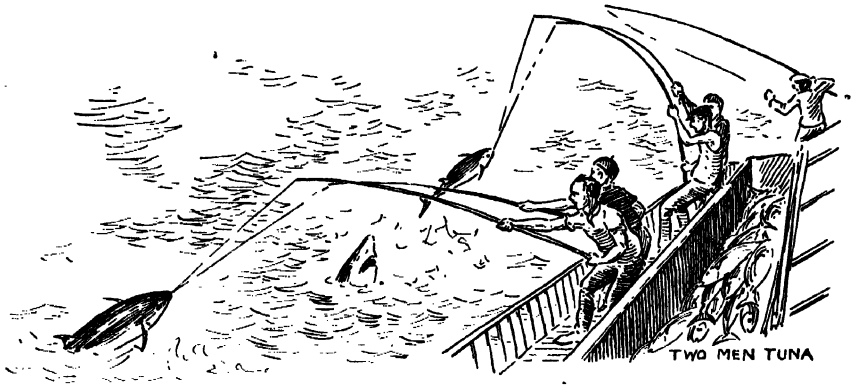
(Genus *Aphanopus*.) Fig. 47.

Before concluding this chapter, mention may be made of a close relative of the Scabbard-fish—the large dark-brown or black fish, known as the Black Scabbard-fish (*Aphanopus carbo*), found in rather deep water in the Mediterranean and Atlantic. Apart from the colour, this fish may be easily recognized by its huge eyes, the absence of teeth on the roof of the mouth, the division of the dorsal fin into two nearly equal parts, the absence of pelvic fins, and by the presence of a curious dagger-like spine behind the vent. This fish, which is often caught on long lines off the coast of Portugal and in the neighbourhood of Madeira, is not uncommon in the fish markets of the Mediterranean, and occasionally finds its way to the London market, where it is generally regarded as a great curiosity.

HAIR-TAILS OR BLADE-FISHES.

(Genus *Trichiurus*.)

Also belonging to the family of Cutlass-fishes are the true Hair-tails or Blade-fishes (*Trichiurus*), very slender, brilliantly silvery fishes, of moderate size, in which the caudal fin is wanting and the tail ends in a hair-like filament. Several species are recognized, all from warm seas, and one is an occasional visitor to the British Isles. They are much esteemed as food.



CHAPTER VI: PERCH-LIKE FISHES (*continued*).

Scombroids. Mackerels and Tunnies. Tunnies. Albacores. Yellow-finned Albacores. Spanish Mackerels or King-fishes. Peto. Spear-fishes and Sail-fishes. Spear-fishes or Marlins. Sail-fishes. Sword-fish or Broadbill.

ALL the fishes dealt with in this chapter belong to another suborder of Perch-like Fishes, namely, the Scombroids. The members of this group are closely related to the Trichiuroids described in the previous chapter, but differ in the arrangement of the bones and rays supporting the powerful, widely-forked caudal fin. The Scombroids include such giants as the Tunnies, Albacores, King-fishes, Sword-fishes and so on, as well as the smaller Bonitoes and Mackerels.

MACKERELS AND TUNNIES.

(Family SCOMBRIDÆ.)

Scombroids with a shapely, spindle-shaped body, tapering behind to a slender peduncle, and more or less covered with minute, closely adherent, smooth scales. The head is bullet-shaped and sharply pointed in front. The mouth is rather large, and the jaws are armed with sharp teeth of varying size; there are no large canine teeth. The gill-covers are

smooth and are not provided with spines. The spinous part of the dorsal fin is separated from the soft portion, and is supported by slender spines that can be folded back into a groove in the back; this part is always shorter than the soft dorsal. The anal fin has from 1 to 3 feeble spines. Both the soft dorsal and the anal fins are made up of short, pointed front portions, with the fin-rays all crowded together, followed by a series of detached and much-branched rays or finlets. The slender fleshy peduncle of the tail is keeled on either side. The pectoral fins are placed high up on the sides. The pelvic fins are well-developed, each having a spine and 5 branched rays. A lateral line is present, and often follows a somewhat wavy course along the side of the body. The air-bladder is either small or absent altogether.

These fishes form an important family, and are all rapid swimmers, living at or near the surface of the sea. Most of them have a wide distribution, some being nearly cosmopolitan. The Mackerels and Tunnies are well distinguished by their general shape and metallic coloration, as well as by the characteristic finlets behind the dorsal and anal fins. Most of them are valued as food, the flesh being firm, oily, and usually of a red colour. Fossil remains of fishes of this type abound in rocks of the Eocene and Miocene periods.

TUNNIES.

(Genus *Thunnus*.) Fig. 48.

The body is oblong and robust, and the slender peduncle of the caudal fin has a single keel on each side, in addition to the pair of keels at the base of the fin. The whole of the body is covered with small scales, and those of the "shoulder" region are larger, thicker, and form a kind of corselet. Each of the jaws has a single row of pointed teeth, and there are bands of very small, pointed teeth on the roof of the mouth. The first dorsal fin has 13 or 14 spines, and there are 8 to 10 finlets behind the soft dorsal and anal fins. The pectoral fins are of moderate length. The coloration is a dark metallic blue on the back, becoming greyish on the sides, with or without silvery spots, and silvery-white on the belly. The caudal fin

is brownish, the soft dorsal reddish-yellow, and the finlets yellow with black edges.

Grow to a length of 12 feet or more and a weight of 1500 lb.

Several species have been described, but, since specimens of these fishes are comparatively rare in museums, it is almost impossible to make accurate comparisons of examples from one part of the world with those from another, except by means of measurements, sketches and photographs—always an unsatisfactory method. It seems likely that at least two species should be recognized, one from the Mediterranean, the Atlantic and the Pacific coast of America, the other from Japan, Australia, New Zealand, Hawaii and elsewhere in the Pacific. The first of these is the Short-finned Tunny, Common Tunny, Great Tunny, Tuna, Atun, Great Albacore or Blue-fin Tunny (*T. thynnus*); the other is the Oriental Tunny (*T. orientalis*), known in Australia as " Bonita ", and in Japan as " Black Tunny ", " Maguro " or " Kuroshibi ".

The Tunnies are easily the largest members of the Mackerel family, and are among the most powerful and speedy of oceanic fishes. Every line of their bodies is suggestive of rapid motion, and their form is perhaps more perfectly adapted for swift progress through water than that of any other fish. It is the admiration of those interested in the mechanics of marine objects, and might well serve man as a pattern for his submarines, racing yachts, and other vessels.

The body of a Tunny is beautifully streamlined, and its smooth, rounded contours are admirably adapted to slip easily through the water, there being a complete absence of irregularities or projections calculated to hinder progression. The finely moulded, bullet-shaped head forms an efficient cut-water, and the closely fitting jaws and flat gill-covers, and the firm smooth eyes, set flush with the surrounding surfaces of the head, are features that suggest a fish capable of great bursts of speed. The fins might perhaps be expected to impede progress to some extent, but the spinous dorsal, the pectorals and the pelvics all fit into grooves or depressions in the body so as not to interrupt the contour. The soft dorsal and anal fins, as well as the little finlets, act as balancers and ensure stability, while the powerful crescent-shaped caudal fin, actuated by muscular movements of the whole body, provides

the motive power to propel the fish forward. The skin, with its tiny scales, offers practically no resistance, and the chances of friction are further minimized by the presence of a copious supply of slimy mucus which covers the surface of the body.

The Tunnies are essentially fishes of the open sea, but frequently approach the coast when the weather is calm and comparatively warm. They are great wanderers, and roam far and wide in search of prey, sometimes travelling for considerable distances at high speeds. It has been noticed that a Tunny can keep alongside a ship travelling at 8 knots without apparent effort. These great fishes may often be observed leaping about at the surface in pursuit of their food, or swimming along leisurely with the tips of their fins projecting from the water. They are always on the move, roving in every direction and relentlessly chasing surface fishes like the herring, sardine, flying-fish or mackerel, which, with squids and cuttle-fishes, provide their favourite diet. " Savage and predatory," writes Professor Roule, " they give chase ceaselessly to the smaller fishes. . . . In this domain, which extends in depth as well as in area, they are the wolves, the foxes of the steppes and forests, only more in number and swifter in movement. They display the same supremacy in gluttony, though upon a greater scale, and only yield the palm to the sharks, which are even more powerful than themselves". There is, however, one other monster of the sea which is greatly feared by the Tunny, and that is the Killer Whale, which has been known to seize and devour these great fishes.

The Tunnies, and perhaps a few of their relatives, are unique among fishes in possessing a body temperature which is three degrees or more above that of the surrounding water—that is to say, they are warm-blooded fishes. This peculiarity is perhaps associated with their tremendous muscular activity.

From the time of Aristotle the migrations of the Common Tunny have always been a subject of interest and speculation. It was early observed that the shoals made their appearance in a given locality with great regularity at a certain season, and, after a stay varying from a few weeks to several months, departed almost as suddenly as they had arrived. Whence they came and where they were going was a mystery, and many theories, some of them quite unsupported by any sort of

evidence, were advanced to account for their seasonal movements. Most of the classical writers, however, as well as those of medieval times, agreed in looking upon the Tunny as an Atlantic fish, that entered the basin of the Mediterranean in the spring, passed eastwards to the Black Sea, where it spawned, and then turned back and regained its oceanic home. Modern methods of research have done much to elucidate the whys and wherefores of the movements of the Tunny, but much of the picture still remains to be completed. Enough is known, however, to show that the ancient idea outlined above was far from correct.

Concentrations of Tunnies take place for spawning purposes, but the main migrations are firmly linked up with the movements of the shoals of fishes on which they prey, which in their turn are dependent upon the movements and concentrations of the small planktonic animals on which these smaller fishes subsist. The Common Tunny is present in the Mediterranean throughout the year, and probably also in the warmer parts of the Atlantic, but in the more northerly parts of the Atlantic its occurrences are distinctly seasonal. In April, May and June the fishes congregate for spawning, such gatherings taking place in the area between Sicily, Sardinia and Tunis, in the Atlantic just outside the Straits of Gibraltar, and probably in other places where conditions are suitable for the development of the eggs. Spawning is at once followed by a recuperative feeding migration, the spent and hungry fishes, which have not taken food for some time, dispersing in all directions, intent upon nothing but obtaining nourishment. In European waters there is a definite northerly movement during the summer months, and Tunny are only to be found in such places as the North Sea and the Norwegian coast from July to about October. Exactly the same thing happens in the western Atlantic, where the shoals arrive on the coasts of Nova Scotia during July.

The Tunny that make their appearance in the North Sea during the latter part of the summer may be observed in shoals consisting of 20 or 30 individuals, feeding ravenously on herrings escaping from the nets of the fishermen. These fish have taken a long journey from the breeding-grounds. They appear at the mouth of the English Channel at the end

of June, then move rapidly up the west coast of Ireland and right round the north of Scotland, where they appear to split up into two main groups, one of which makes for the coast of Norway and the other moves southwards again into the North Sea, getting to about the coast of Yorkshire. The approach of winter, with the consequent fall in the temperature of the sea, sees another migration of Tunnies in the reverse direction, the fish returning to warmer waters to await another gathering for spawning purposes in the following spring.

It is not certain whether or no there is an interchange between the populations of Tunny in the Atlantic and Mediterranean respectively, but this is a question that may be settled when a satisfactory method of marking individual fish has been devised. Another matter of dispute is whether the Tunny actually crosses the Atlantic, or whether the fish found on the American coast form a separate race. The fact that a broken hook found in a fish caught near Sardinia seemed to have been manufactured in America suggests that at least one Tunny has made this stupendous journey.

The presence of two more or less definite spawning areas has been already mentioned, and further investigation will doubtless reveal others. The eggs of the Common Tunny have now been recognized, but a full series of larval and young stages has still to be discovered and properly described. The eggs are small and buoyant, and the larval fishes, which hatch out in about two days, are less than a quarter of an inch in length. The young fish are said to grow very rapidly, and individuals hatched in June have reached a weight of about 12 to 18 ounces by September. They probably become mature during the third year of life, when they have attained to a weight of about 33 lb. It may be noted that small and large fish are rarely, if ever, found in the same shoal, and that the largest fish of all are quite often solitary in their habits.

Tunnies are food-fishes of importance, and, although the flesh is not often consumed fresh, it is rich in oil and very suitable for canning. In the Mediterranean the Tunny has been of great economic importance for centuries, and, as Dr. Jenkins remarks, " there can be little doubt that it played a part in the food-supply of the Greeks and Romans and other Mediterranean peoples similar to that of the Herring for

northern folk ". Many of the classical writers sang the praises of this fish as an article of food, and certain parts of its flesh, notably the abdomen, were reckoned among the most highly appreciated delicacies at Roman banquets.

Various methods are employed for catching Tunnies, including the use of seine nets, baited hooks, and harpoons. The net fishery of Europe has existed for many years, and a brief description of the nets and the methods of operation may be of interest. The net is known as a " madrague ", " thonnaire ", " tonnara ", " armacoe ", or " almadraba " in the various countries in which it is employed, and is a very large affair of complicated structure. Essentially it consists of a system of walls of netting, anchored to the bottom of the sea, and sometimes miles in length. This is so arranged as to intercept the migrating shoals of fish, and is divided into a number of compartments communicating with one another, into which the fish are guided. All these lead into a final compartment, the " death chamber ", the floor of which is formed of further netting. Here the fish are imprisoned, and, at a given signal, the floor is raised, the surrounding boats close in, and the hapless victims, massed together in the enclosed space, are clubbed and speared by the fishermen. As soon as the slaughter is over, the huge fish are dragged into the boats and taken ashore, where they are hung up in sheds to allow the blood to drain from their bodies. After hanging for several hours the flesh is cut up, and either soaked in brine and packed into tubs or boxes, or cured and canned.

These huge nets can, of course, be used only in certain places and at specified times, their operation depending upon the movements of the migrating shoals. They are used mainly in Sicily, Sardinia, Tunis and just outside the Straits of Gibraltar, and are brought into operation between May and July. That is to say, they are intended to catch the shoals on their way to and from the spawning areas, and the professional fisherman distinguishes between " Thons d'arrivée " and " Thons de retour " respectively. At other times of the year the Tunny in the Mediterranean are caught by means of hooks baited with fish, maize, or merely with a tuft of feathers. Similar methods of capture are adopted in more northerly European waters, but recently the harpooning of individual

fish, a method widely employed on the Atlantic coast of America, has been practised in Norway. The vessels used in the American fishery are from 20 to 35 feet in length, and each has a small platform in the bows from which the harpoon is launched. Small fish can generally be brought alongside without difficulty, but large ones are said sometimes to fight for several hours. On a bad day one of these boats may not succeed in killing a single fish, but on a good day as many as 8 or 10 are often taken.

On the Atlantic coast of America the Tunny has never been held in much esteem as a sporting fish, but the Californian variety, the Blue-fin or Leaping Tuna, is regarded as a game-fish *par excellence*, and is one of the prizes at the famous Santa Catalina resort. The late Professor Holder has described this fish as " the tiger of the California seas, a living meteor which strikes like a whirlwind, and when played with a rod that is not a billiard cue or a club in stiffness, will give the average man the contest of his life ". A fish in good condition will fight for hours, perhaps towing the angler's boat for some miles before succumbing to exhaustion, and it requires some strength, coupled with not a little skill and patience, to bring a large Tunny to the gaff.

The occurrence of Tunny in the North Sea during the late summer has, in recent years, led to the development of this exciting sport on the Yorkshire coast, and many fine fish are taken on rod and line each year off Whitby and Scarborough under the auspices of the British Tunny Club. The world's record fish was one of 851 lb. caught by Mr. Mitchell Henry in 1933. Incidentally, the same sportsman has harpooned a Tunny in South African waters that turned the scale at 1500 lb.

The names *Thunnus* and *Thynnus* are simply the ancient names for the Tunny, and such names as Tunny, Tuna, Thon and so on have been derived from them.

ALBACORES.

(Genus *Germo*.) Fig. 49.

Essentially similar to the Tunnies, but the pectoral fins are very long and sabre-shaped, reaching as far as the level of the front part of the anal fin. The coloration is steely

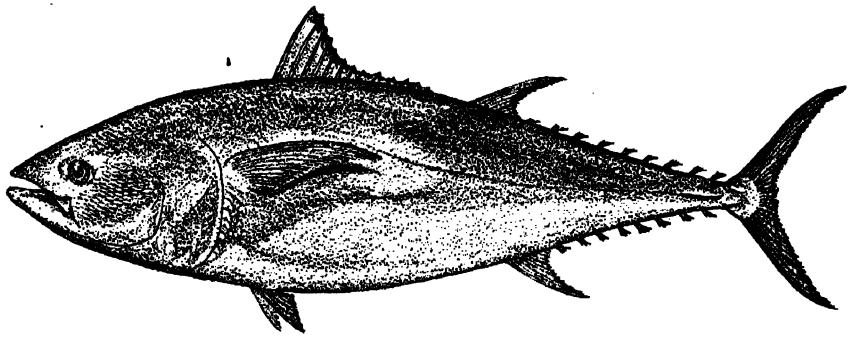


FIG. 48.—Common Tunny (*Thunnus thynnus*).

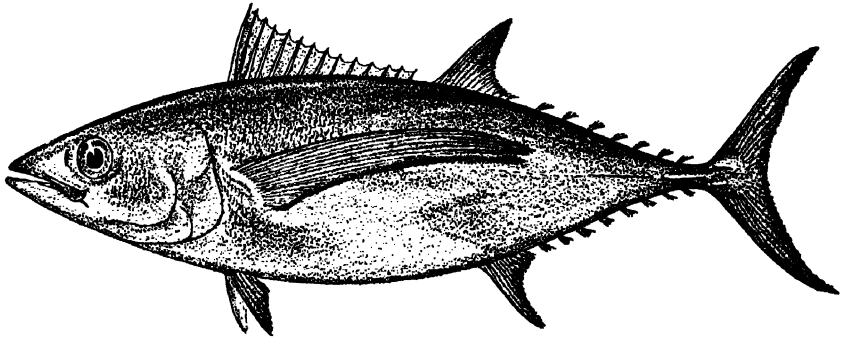


FIG. 49.—Atlantic Albacore (*Germo alalunga*).

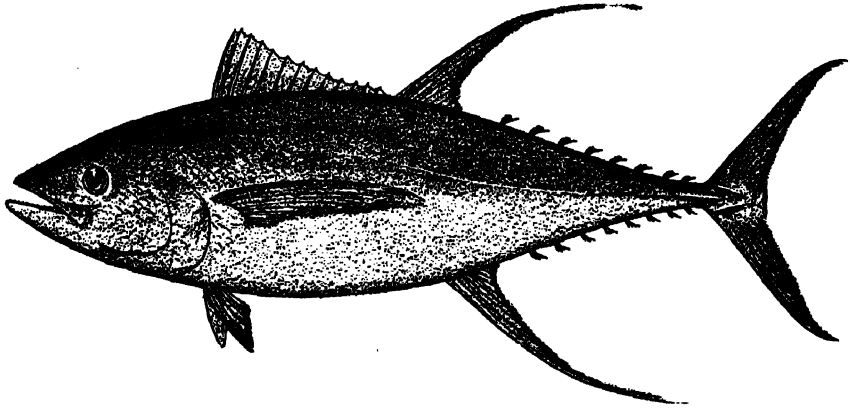


FIG. 50.—Atlantic Yellow-finned Tuna (*Neothynnus argentivittatus*).

blue on the back and silvery on the belly, with faint traces of pale stripes on the sides; the soft dorsal and the anal fin, as well as the finlets, are lemon yellow, and the other fins are more or less dark.

Grow to a much smaller size than the Tunnies, rarely exceeding a length of 3 or 4 feet and a weight of 65 lb.

Two species are recognized, but these are so very similar in appearance that it is open to question whether they are really distinct. The Atlantic Albacore (*G. alalunga*), which is also known as the Long-finned Tunny or Alalunga, is a rare visitor to the British Isles, and occasionally gets as far north as the Orkneys. The other species is the Pacific Albacore (*G. germo*), which is especially abundant on the coast of California, at Hawaii, and in Japan.

The Albacores, like the Tunnies, which they resemble both in appearance and habits, are essentially warm-water fishes, living mainly close to the surface in the open sea. They favour a mixed diet of crustaceans, cuttlefishes and small fishes of all kinds, the latter predominating, and they play havoc among the shoals of flying-fishes.

The flesh is said to be inferior to that of the Tunnies, and the Albacores are not much valued as food. In parts of Japan, however, the natives eat it raw, and in California and Hawaii it is now extensively canned, along with other Mackerel-like fishes, and marketed under the general name of " Tuna ". The Albacore is common in the Mediterranean, and was well known as a food-fish to the ancient Greeks and Romans, being depicted on coins, vases, fish-plates, mosaics, etc., as early as 500 or 600 B.C.

In Japan these fishes are caught mainly by means of long lines or drift-nets, and in California the fishermen employ baited hooks. Another method of fishing is used in California, however, which is known locally as the " bonito method ". No bait is employed, and the fishermen line one side of their vessel with rods and lines. The fish make a dash for the shining hooks, and, by a dexterous movement, the fishermen lift them from the water and throw them backwards into the centre of the boat. If the fish are too large for one man to handle, two men connect their lines together, and fish with two rods and one hook. These heavier fish are spoken of as " Two-men Tuna ".

The Albacore gives pretty good sport to the anglers of California, who use bone, rag or feather " jigs " towed at a fair pace astern of the boat. The record fish was taken at Santa Catalina in 1912, and weighed 66 lb. 4 oz.

The name " Albacore " comes from a Portuguese word " Albacora ", said to be derived from two Arabic words, " al bacoro ", meaning " a little pig ". The scientific name, *Germo*, is from the French name for the fish, " Germon " ; *alalunga* is used in Sardinia, being derived from *ala*, wing, *longus*, long.

YELLOW-FINNED ALBACORES.

(Genus *Neothunnus*.) Fig. 50.

Related to the Tunnies and Albacores, and distinguished from them mainly by anatomical features. The full-grown fish may be easily recognized by the shape of the soft dorsal and anal fins, which form long, pointed, sickle-shaped lobes, and by the somewhat large size of the finlets. The pectoral fins are long, but only extend as far as or nearly as far as the level of the front of the anal fin, but not beyond it as in the Albacores. The coloration is essentially the same as that of the Tunnies and Albacores, but the soft dorsal and anal fins, as well as the finlets, are bright yellow, often with dark edges, the yellow hue being particularly brilliant in the young fish.

Grow to a length of 6 to 9 feet and a weight of at least 400 lb.

Two species which grow to a large size are recognized, one from the Atlantic and another from the Pacific, and there are probably one or two smaller species. The Atlantic Yellow-finned Tuna or Long-fin Albacore (*N. argentivittatus*) has been recorded from such widely-separated parts of the tropical and subtropical Atlantic as Portugal, Madeira, the Canaries, Angola, St. Helena, Bermuda, Florida and the West Indies. The Pacific species (*N. macropterus*) has been recorded from the Maldives, India, Ceylon, the East Indies, Japan, the Hawaiian Islands, Mexico, California and the Galapagos Islands. This is the " Yellow-fin Tuna " of Southern California, the " Ahi " of Hawaii, and in Japan is known as " kihata ", " kiwada ", " itoshibi " or " gesunaga ".

These are active fishes of the open seas, that approach the inshore waters only during the summer, although immature individuals may remain close to the land for most of the year. They are found chiefly near the surface, and are often to be seen leaping high above the water. The presence of small fishes from the middle depths in their stomachs suggests that the Yellow-finned Albacores sometimes descend to some depth. The food includes such diverse creatures as fishes of all kinds, squids, cuttlefishes, as well as several sorts of crustaceans. Dr. Beebe, who has made a special study of the food of these fishes in Bermuda and the West Indies, mentions a specimen, 6 feet in length, that had swallowed 58 fishes averaging barely 2 inches in length. " Also it would be difficult to choose a lot of fish," he adds, " less appetizing than these puffers, triggers, turbots and gurnards. They epitomize spininess in respect to skin, opercles and fin elements, and correlated with this supposedly protective armour the actual flesh and muscle necessary for swift movement are much less developed than in more ordinary fish. This choice must be deliberate, when we consider the amazing speed of these tunas, the ample size of their mouths and the abundance of smooth-skinned, thick-fleshed fishes of all sizes."

Practically nothing is known of the breeding habits of these fishes, and the eggs and larval stages have not yet been definitely recognized.

The flesh is firm, beautifully pinkish in colour, and of excellent flavour. In Japan and Hawaii it is mostly consumed fresh, in Ceylon it is employed in making the product known as " Maldive Fish ", and in California, although parts of the catches are sold in the markets, the bulk is used for canning. The fish are caught by means of nets of various kinds, as well as by hooks baited with live fish, squid or other dainties. A favourite method of capture is by trolling with feather or bone " jigs ".

In California anglers are said to find this an attractive sporting fish, and troll for it with " a flying-fish held aloft by a kite as bait ".

SPANISH MACKERELS OR KING-FISHES.

(Genus *Scomberomorus*.) Pl. III A.

The body is long and covered all over with rudimentary scales, but there is no distinct corselet in the "shoulder" region. The head is rather small and pointed in front. Both jaws are provided with strong, pointed, more or less flattened teeth, and there are some very small pointed teeth on the roof of the mouth. The dorsal fins are very close together, and the spinous dorsal, which has 12 to 15 spines, is low. The soft dorsal and the anal fin are short, with moderately high lobes in front, and each is followed by 7 to 10 finlets. The pectoral fins are rather short, and the pelvics are small. An air-bladder is present. The coloration is usually more or less silvery, with the back a metallic bluish-black; some species are uniformly coloured, but others have a number of round or oblong dark spots on the body, or a number of narrow vertical stripes. The spinous dorsal fin is generally black.

The larger species grow to a length of 5 or 6 feet and a weight of about 100 lb.

There are a number of species, of which the following are perhaps best known and all attain to a fair size: The Sierra or Pintado (*S. regalis*), found on the Atlantic coast of America from Cape Cod to Brazil; the King-fish, Cero or Cavalla (*S. cavalla*), found on both sides of the tropical Atlantic; the Seer or Commerson's King-fish (*S. commersoni*), from Indian and Pacific seas; the Spotted Spanish Mackerel (*S. guttatus*), with a similar distribution; and the Chinese King-fish or "Inusawara" (*S. chinensis*), from China and Japan.

These graceful and beautifully coloured fishes are generally to be found at or near the surface of the sea in shoals of large or moderate size. Full-grown and immature fishes are never found together. They are active, predaceous fishes, that feed mainly upon herrings, sardines and other sorts of small fishes.

Spanish Mackerels are of considerable economic importance, the flesh, except in very large fish, being firm, white and very palatable. They are caught by means of nets of all kinds, as well as on hooks. Some of the species give very good sport to the angler, and few fishes excel them in strength, swiftness

and fighting powers. In Florida, the Cavalla is caught by trolling, the favourite bait being a strip of white bacon rind cut to resemble a fish. A specimen weighing 73½ lb. was taken in the Bahamas in 1935. When hooked this fish is said frequently to leap clear of the water, sometimes to a height of 10 feet above the surface. Commerson's King-fish is popular with the rod fishermen of New South Wales, large numbers being captured in a successful season.

The scientific name, *Scomberomorus*, means "near *Scomber*", the term *Scomber* being the ancient name for the Common Mackerel.

PETO.

(Genus *Acanthocybium*.) Fig. 51.

In general appearance not unlike the Spanish Mackerels, but the jaws form a sort of pointed " beak ", and the maxillary bone of the upper jaw is completely hidden when the mouth is closed ; the teeth in the jaws are set close together, each being strong and knife-like, with fine saw-edges. The gills have a peculiar structure, the plates being connected to form a network. The spinous dorsal fin is long, and has about 25 spines. The scales are small and long. The coloration of the back is dark steel-blue, and is sharply differentiated from the pale bluish-grey of the sides and belly. Sometimes the whole fish is nearly black. There are several narrow cross-bands on the upper parts of the sides, which are most distinct in young individuals and tend to fade away in big specimens. The dorsal, pectoral and caudal fins are blackish, and the pelvic fins somewhat paler.

Grows to a length of 6 feet or more and a weight of at least 100 lb.

There is probably only a single species, the Peto, Wahoo, Guaha or Guarapucu (*A. solandri*), found in all tropical seas.

This is a large, fast-swimming, predaceous fish, found in the open sea, but rarely encountered in numbers. Little is known of its habits, but its food includes squids, cuttlefishes and other fishes. Like many other members of the family, its leaping powers are marked, and it has been seen to jump 10 or 12 feet above the surface on calm days.

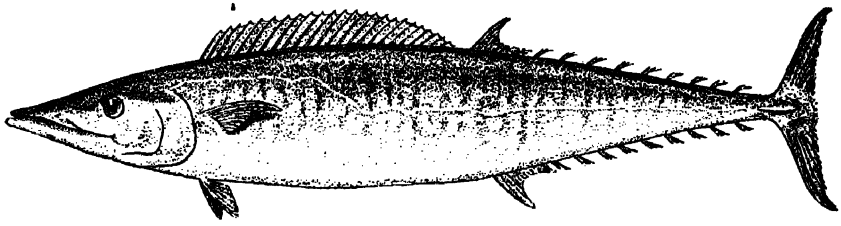


FIG. 51.—Peto or Wahoo (*Acanthocybium solandri*).

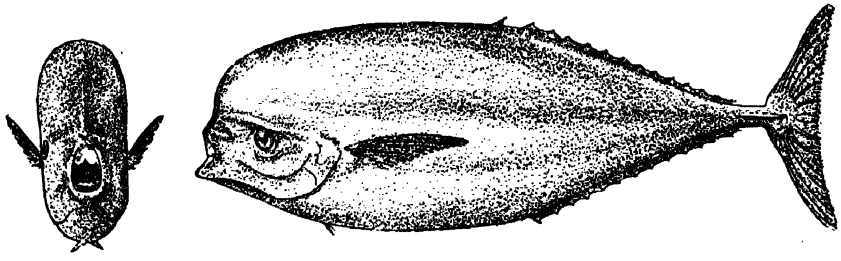


FIG. 52.—Louvar (*Luvarus imperialis*).

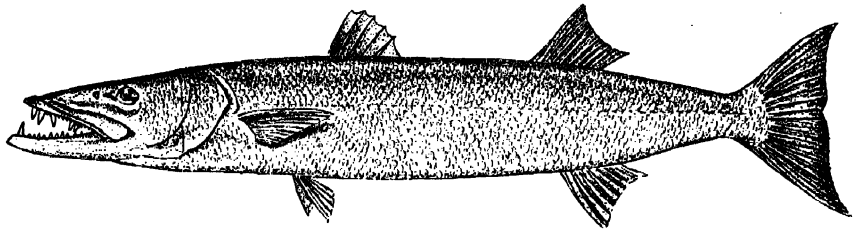


FIG. 53.—Black-finned Barracuda (*Sphyræna commersoni*).

The Peto is an excellent food-fish, and is captured by trolling. It is so greedy that it can be readily attracted by either natural or artificial baits. In Japan the lure sometimes consists of a model made of wood or canvas to imitate a flying-fish or mackerel. It is not well known as a sporting fish, but a fish weighing 124¾ lb. has been captured on rod and line.

This species is named after its discoverer, Solander, an early explorer.

GASTEROCHISMA.

Before leaving the family Scombridæ, mention may be made of a rare Bonito-like oceanic fish, *Gasterochisma melampus*, found in the more temperate waters of the Southern Hemisphere. It has been recorded from South Africa, Argentina, the Falkland Islands, Australia, Tasmania and New Zealand, but nothing is known of its habits and it has no commercial value. It grows to a length of 5 or 6 feet. This fish may be readily distinguished from the other members of the family dealt with in this chapter by the rather large, smooth scales, which cover the whole body and extend on to the head, and the slender peduncle of the tail, which has two keels on each side. The size and shape of the fins changes considerably as the fish grows, and individuals of different ages have been erroneously described as distinct species or even distinct genera.

LOUVAR.

(Genus *Luvarus*.) Fig. 52.

Another rare and remarkable oceanic fish, the Louvar (*Luvarus imperialis*), is also entitled to brief mention here. This fish, which grows to a length of 6 feet, is quite unlike any other Scombroid, and is placed in a distinct family (Luvaridæ). It has a plump body, blunt head, tiny and almost toothless mouth, and rough scales which form a kind of scurf on the smooth skin. The general coloration is pinkish-silvery and the fins are bright scarlet. It is widely distributed in tropical and temperate seas, and is a very occasional visitor to the southern coasts of the British Isles. Nothing is known of its

habits, but the food seems to consist of minute animals and oceanic plants.

SPEAR-FISHES AND SAIL-FISHES.

(Family ISTIOPHORIDÆ.)

Scombroids with a long, compressed body, covered with narrow scales which are more or less embedded in the skin. The snout and upper jaw are together prolonged to form a long, pointed rostrum, which is narrow, flattened on the edges, and more or less round in cross-section. Both jaws are provided with minute granular teeth, which are also present on the roof of the mouth. The gill-plates form a network. The dorsal fin is either single or double, but, if divided into two parts, the first is always much larger ; the first rays of the dorsal fin are stiff and spine-like. The anal fin is usually divided into two portions. The caudal fin is widely forked, and there are two fleshy crests or keels on each side of its base. The pectoral fins are placed rather low down on the sides of the body. The pelvic fins are narrow, and each consists of from 1 to 3 rays. There is a large air-bladder.

These are nearly all large fishes, and are found at or near the surface in most of the warm seas of the world, generally moving northwards during summer.

Fossil remains of Spear-fishes and Sail-fishes probably date back to the Eocene period.

SPEAR-FISHES OR MARLINS.

(Genus *Tetrapturus*.) Fig. 54.

The dorsal fin is low and appears to change considerably with age. In smaller individuals it forms a single continuous fin, with the middle portion nearly as high as the front, which scarcely forms a distinct lobe ; in full-grown individuals the front lobe is well developed, with the first few spines greatly thickened, and the remaining rays of this portion become progressively shorter towards the back, so that the whole dorsal fin is divided into two distinct parts. The anal fin is also divided into two portions. The pelvic fins are at first

longer than the pectorals, but seem to become much shorter with age. The coloration varies in the different species, but the back is usually bluish, black or dark brown, and the lower parts yellow, greyish-white, or silvery. Sometimes the whole body is nearly uniformly grey or black. In some species there is a row of narrow pale blue or silvery cross-bars along the upper part of each side.

The larger species grow to a length of 14 feet or more and a weight of at least 1000 lb.

A number of species have been described, but, as many of these are known only from single specimens, or in some cases only from parts of specimens or from photographs, it is impossible to decide whether some of them are really valid, especially in view of the fact that these fishes undergo considerable changes during growth. The following species, however, appear to be distinct and are all fairly well known: The Mediterranean Spear-fish, Peito, or Aguia (*T. belone*), perhaps occurring also in the adjacent parts of the Atlantic; the Short-nosed Spear-fish (*T. brevirostris*), of Indian seas; the Black Marlin (*T. mazara*) of the Pacific, which is abundant round Japan and the Hawaiian Islands, and appears to extend to the coast of California and to New Zealand; the Striped Marlin (*T. mitsukurii*), with a distribution similar to that of the Black Marlin; the White Marlin or Bill-fish (*T. albidus*), from the Atlantic coast of America, which is abundant in the West Indies; the Cape Marlin (*T. herscheli*), from South Africa; and the Indian Spear-fish or Joo-hoo (*T. indicus*), from the Indian Ocean and the Malay Peninsula and Archipelago.

Like the Tunnies and Albacores already described, and their near relatives the Sail-fishes and Sword-fishes, these fishes are tremendously powerful swimmers. Indeed, they are held by many experts to be among the swiftest of existing fishes, capable, not only of sudden rapid bursts of speed, during which they have been estimated to travel at 40 to 50 miles an hour, but of maintaining a high rate of progress for many hours on end. A torpedo fired from a battleship would soon be left behind by a large Spear-fish going "all-out"! The late Professor Owen, when called upon to testify in a court of law as to the power of one of these fishes, stated that "it strikes with the accumulated force of fifteen double-headed hammers;

its velocity is equal to that of a swivel-shot, and is as dangerous in its effects as an artillery projectile ". This tribute, coming from a man of science in the witness-box, carries conviction.

A glance at the body of a Spear-fish reveals that the greatest thickness lies about half-way between the tip of the rostrum and the root of the tail, and that the body tapers gradually backwards behind this point. Such a shape is well in accordance with the best principles of streamlining, and is just such a one as the engineer, with his curves and displacements, entering angles, runs and the like, might be expected to design were he called upon to produce an inanimate body capable of moving rapidly and efficiently through water. The pointed rostrum forms an effective cut-water, and the fins of the back and belly, which might hinder progress, are folded back and fit snugly into deep grooves in the body as the fish gets under way.

Rapid movement through the water places considerable strain on the bodily mechanism, and especially upon the supporting frame, the skeleton; in addition, the risk of a sudden shock when the fish strikes a large object or is obliged to " brake " suddenly is always present. It is of some interest, therefore, to find that the backbone of a Spear-fish is especially formed to obviate these dangers, its separate segments or vertebræ being comparatively few in number and provided with curious, flattened, interlocking processes, designed to give power and rigidity to the whole.

Stories of ships being struck by " Sword-fishes " are numerous, but in many cases it is evident that the fish involved was not a true Sword-fish, but either a Spear-fish or Sail-fish. It cannot be doubted that, when travelling at high speed, one of these fishes is powerful enough to plunge its " spear " into the bottom of a wooden vessel. As it is incapable of accomplishing the reversing movements necessary to withdraw the rostrum, it is compelled to break this off in order to get away, and the tip may remain as tangible evidence of the identity of the offender. In the Museum of the College of Surgeons in London is a section of the bows of a South Sea Whaler, which has been penetrated through 13½ inches of solid timber by a " spear " a foot in length and 5 inches in circumference. The British Museum possesses another piece of ship's timber

in which the transfixed " spear " has been thrust through no less than 22 inches. There is a case on record of the ship " Dreadnought ", which sprang a leak when voyaging from Ceylon to London, and on examination it was found that a hole about an inch in diameter had been neatly punched in the copper sheathing of the vessel. When a claim was duly made, the insurance company denied their liability, holding that the damage had been caused by some agent other than a fish, but when the case was taken to court the jury returned a verdict that the puncture had been brought about " by contact with some substance other than water " and added a rider to the effect that it was probably caused by a " Sword-fish ".

A number of other records of damage believed to have been caused by these fishes might be cited, and, after considering them, we are driven to conclude that some, at least, have been deliberate attacks, the fish presumably mistaking the ship for a whale. On the other hand, it seems more than likely that many of the occurrences are no more premeditated than, say, the head-on collision between two powerful motors at cross-roads, and may be due to like causes, not the least important of which is an inability to apply the brakes in time ! Some would explain all the damage done to ships along such lines, even suggesting that the " spear " is not an offensive weapon at all, but merely represents an extreme case of streamlining, and acts as a super cut-water.

The principal food of the Spear-fishes consists of other fishes, mackerels, sardines, flying-fishes and bonitoes being expecially favoured, but squids and cuttlefishes are also eaten in large numbers. They pursue the moving shoals of these fishes for days on end, and it is easy to believe that the appearance of one or two hungry Spear-fishes will cause something akin to panic among the prospective prey. Rising among a shoal of fishes, they have been described as striking viciously to right and left with the rostrum, afterwards feeding at leisure upon the dead and wounded victims.

The natural enemies of the Spear-fishes themselves seem to be large sharks, which have been observed chasing them in the open sea. On more than one occasion the remains of a Spear-fish have been taken from the stomach of a large Tiger

Shark or a " Man-eater ". It is said that the Spear-fish becomes " furious at the approach of sharks ".

Very little is known about the breeding habits of these fishes, which seem to spawn in late spring or early summer. The fact that the Spear-fishes have been observed in couples, male and female together, at this time, suggests that they may pair during the breeding season. The males are said to be generally smaller than the females.

All the Spear-fishes are of some commercial value, the flesh providing good food. Large specimens are common objects in the fish-markets of Honolulu, Japan and elsewhere. They are usually speared or harpooned, but are also captured on hooks. Their capture may be at times an exciting process, as the fish may make a dash for the boat—an attack which may result in drowning the fisherman or wounding him with the formidable rostrum. When hooked they are said to rise at once to the surface and there to make prodigious leaps and plunges in their efforts to free themselves. Eventually, however, they become exhausted, are dragged alongside the boat, and then beaten to death before being hauled on board.

As game fishes they have a very high reputation, and the larger Marlins undoubtedly provide exciting and strenuous sport. Huge fish have been taken by anglers in recent years, among which may be mentioned a Black Marlin of 618 lb. from Tahiti, a Striped Marlin of 1040 lb. from the same place, and another Black Marlin of 976 lb. from the Bay of Islands, New Zealand. The first two of these were taken by Mr. Zane Grey, the well-known author and big-game fisherman.

The scientific name, *Tetrapturus* (more properly *Tetrapterurus*), is derived from three Greek words and means literally " four-winged tail "—a reference to the wing-like keels at the base of the caudal fin. The popular name " Marlin " is simply an abbreviation of " marlin-spike ", and, like the name " Spear-fish ", refers to the rostrum.

SAIL-FISHES.

(Genus *Istiophorus*.) Fig. 55.

In general appearance very similar to the Spear-fishes, but distinguished from them by the single, high, sail-like dorsal

fin, supported by numerous rays. The coloration is usually a brilliant metallic blue or blue-black on the back, and a silvery-white on the sides and belly; sometimes there is a series of pale blue cross-bands, or a number of pale blue spots arranged in transverse series. The dorsal fin is generally blue, and is nearly always ornamented with numerous small, round black spots; the caudal and pelvic fins are dark brown or black.

Grow to a length of 12 feet or more and a weight of several hundred pounds.

As in the case of the Spear-fishes, a number of species have been described, but it is doubtful whether more than a quarter of these are really valid. It seems possible that there are only two existing species: the American Sail-fish, Voladora, Bicuda, Boohoo or Bécasse de Mer (*I. americanus*), found all over the tropical part of the Atlantic; and the Indian Sail-fish, Kansegan or Banana Sail-fish (*I. gladius*), found in the Indian Ocean and extending right-across the Pacific to the Hawaiian Islands, and the coasts of Mexico, California and Panama.

Like the Spear-fishes, the Sail-fishes are inhabitants of warm seas, but during the summer months they follow the shoals of smaller fishes northwards. In the Atlantic they may extend as far as Cape Cod on the American side. Until recently Sail-fishes have never been seen in the neighbourhood of the British Isles, although a young one had been caught somewhere between France and South Africa. In August, 1928, however, a large individual was captured in a dying condition in the estuary of the Yealm River in South Devon.

The Sail-fishes are regarded as being among the swiftest of fishes, rivalling the Spear-fishes in this respect. When travelling at high speed the huge dorsal fin is folded away into a deep groove in the back, the pelvic and anal fins are likewise stowed away, and the pectorals are pressed close against the sides of the body. It has been suggested that these fishes are able to travel at 60 miles an hour, but accurate information on this point is not forthcoming.

On calm days Sail-fishes have been described as basking in the sun at the surface of the sea, with the brilliantly coloured dorsal fin fully erect and projecting from the water. Some

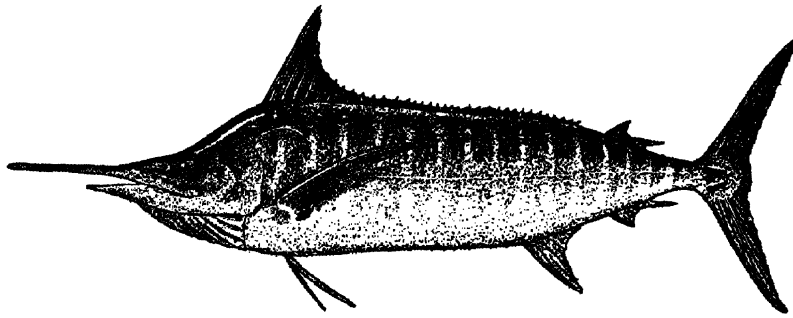


FIG. 54.—Striped Marlin (*Tetrapturus mitsukurii*).

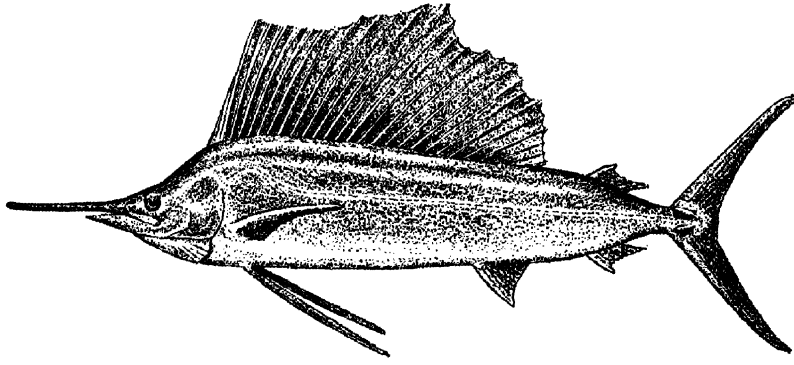


FIG. 55.—American Sail-fish (*Istiophorus americanus*).

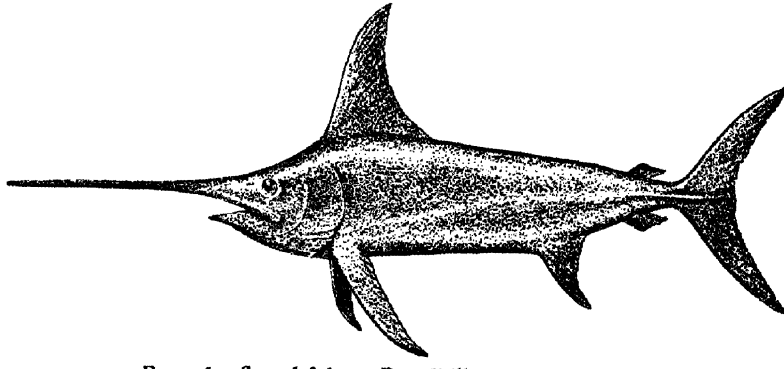


FIG. 56.—Sword-fish or Broadbill (*Xiphias gladius*).

authorities are of the opinion that they sometimes make use of this fin as a sail to catch the wind, and in this connection the following passage from the life of Sir Stamford Raffles is of interest: " The only amusing discovery we have recently made is that of a sailing fish, called by the natives *Ikan layer*, of about 10 or 12 feet long, which hoists a mainsail, and often sails in the manner of a native boat, and with considerable swiftness. . . . When a school of these are under sail together they are frequently mistaken for a fleet of native boats ".

The food and the methods of feeding are essentially the same as those of the Spear-fishes, and the breeding habits are also believed to be similar.

Certain of the young stages of a species of Sail-fish (or perhaps of a Spear-fish) have been described and figured by the late Dr. Günther, and are of considerable interest. In the first stage, a little fish only 9 mm. long, both jaws are equally produced and provided with pointed teeth; the edge of the head above the eye has a series of short bristles; and long spines project backwards from each side of the head above and below. The dorsal fin has the form of a long low fringe, the pectoral fins are large and square-cut, and the pelvic fins are represented by a pair of short buds. At the next stage, 14 mm. in length, the dorsal fin has grown enormously, the pelvic fins are long filaments, and the shape of the pectorals has changed. The spines on the head are still prominent, but the bristles above the eye have disappeared; the upper jaw is now a little longer than the lower. At the third stage, 60 mm. in length, the dorsal fin has a front portion of great size, and a smaller hinder part; the upper jaw projects considerably beyond the lower and the teeth have all but disappeared; the spines on the head are relatively smaller; and the pelvic fins are considerably reduced in size.

The flesh of the Sail-fishes provides excellent food. As sporting fishes they have a high and well-deserved reputation, and are regarded by many as the greatest of all the game-fishes. A frantic Sail-fish leaping " across forty feet of water on a loose line " must be a truly inspiring sight!

The scientific name, *Istiophorus*, is derived from two Greek words, and means " sail-bearer ".

SWORD-FISH OR BROADBILL.

(Family XIPHIIDÆ ; Genus *Xiphias*.) Fig. 56.

In general appearance similar to the Spear-fishes. There are no scales, except in young individuals. The rostrum forms a pointed " sword " instead of a " spear ", being horizontally flattened and oval in cross-section. There are no teeth in the adult fish. In the young the dorsal fin is continuous and rather high, but later becomes divided into two, and in the adult fish consists of a high front lobe, widely separated from the small second portion, which is placed well back on the tail and opposite to the second part of the anal fin. There is a single fleshy keel on the middle of each side of the peduncle of the caudal fin. There are no pelvic fins. The coloration in life is a rich dark purple-blue on the back and upper parts of the sides, with a beautiful metallic sheen, grading into a silvery-grey on the belly. The " sword " is nearly black on its upper surface, but paler underneath, and the fins are all dark with a silvery sheen.

Fossil remains of Sword-fishes probably date back to the Eocene period.

Grows to a length of nearly 20 feet and a weight of over 1000 lb.

There is only one species, the Sword-fish, Broadbill or " Espada " (*X. gladius*), which ranges through all the tropical and temperate seas of the world. It is a not uncommon visitor to the British Isles in summer and autumn months, especially on the southern and south-western coasts.

This a veritable giant of the open sea, and, apart from certain Sharks and the ribbon-like Oar-fish, it is probably the largest of the oceanic fishes living to-day. The average size is between 6 and 10 feet long, however, with a weight of about 100 lb. Sword-fishes have been described as solitary hunters, and this is mainly true. Many individuals may be present in a given part of the sea at the same time, but they never seem to swim together in shoals, but keep at least 30 or 40 feet apart. As a rule they swim near the surface of the sea, and the traveller has his attention drawn to their presence by

the appearance of two fin-tips projecting from the water—the tip of the dorsal fin and that of the upper lobe of the caudal fin.

Like the Spear-fishes and Sail-fishes, they prey mainly upon smaller fishes of all kinds, and attack these in much the same manner. Some observers credit them with splitting bonitoes and albacores with a single stroke, but it seems likely that their preference is for the smaller fishes, whose massed formation makes them an easy object of attack.

Much has been written concerning the alleged ferocity of the Sword-fish, that " terrible giant of the sea ", as one writer describes it, but so many of the accounts are so obviously unreliable or based upon what is clearly faulty observation that it is wellnigh impossible to get at the truth. Further, in the vast majority of " Sword-fish yarns " no effort is made to indicate the type of fish concerned, and Spear-fishes, Sail-fishes, as well as the true Sword-fish or Broadbill, are lumped together indiscriminately as " Sword-fishes ". Books of ocean travel, especially the older ones, abound with eye-witness accounts of terrific combats between huge whales and sword-fishes, sometimes assisted by threshers, but closer investigation generally reveals that the story has been copied (and frequently embellished) from some previously existing report, or that the fight has been observed " from a considerable distance ".

A certain Captain Crow has the following story: " One morning during a calm, when near the Hebrides, all hands were called up at 3 a.m. to witness a battle between several of the fish termed thrashers or fox sharks and some swordfish, on the one side, and an enormous whale on the other. As soon as the whale's back appeared above the water the thrashers, springing several yards into the air, descended with great violence upon the object of their rancour, and inflicted upon him the most severe blows with their long tails, the sounds of which resembled that of muskets fired at a distance. The swordfish in turn attacked the distressed whale, stabbing from below; and, thus beset on all sides and wounded, the water around him was dyed with blood." Another account describes the Sword-fish as attacking from below, goading his mighty adversary to the surface with his sharp beak, while the thresher belabours him with strokes of his long, lithe tail!

Experts are frankly sceptical of many of these " yarns ". They are loath to admit the possibility of such an aggressive partnership between creatures so diverse as the Sword-fish and the Thresher Shark, and they find it difficult to understand why the former should make an unprovoked attack upon one of the larger whales. Many hold the view that the attackers were not Sword-fishes or Threshers at all, but Killer Whales, and this seems a likely explanation. In this connection we may note that the Killer Whale itself is sometimes known by the popular name of " Swordfish ", probably on account of the shape of its dorsal fin (see p. 290). Others, while inclined to reject many of the stories of alleged attacks, do credit the Sword-fish with the habit of " going berserk " on occasions, and of venting its spleen on the nearest object, whether it be a whale, ship or rock ! It is certainly true that a number of authentic records of attacks upon small fishing vessels do exist.

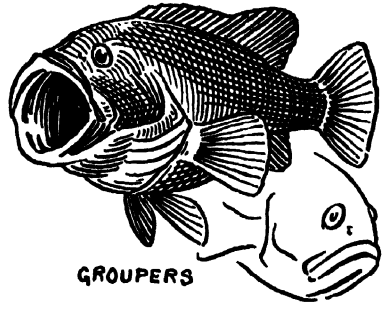
Some of the older books contain stories of attacks upon man himself, and in Daniel's ' Rural Sports ' we read that in the Severn, near Worcester, a man was " struck, and absolutely received his death wound through a swordfish ".

The breeding habits of the Sword-fish are as yet somewhat imperfectly known, but it has been conjectured that they pair during the spawning time, which, at least in the Mediterranean, takes place in late spring or early summer. The eggs are small and buoyant, and the larval fish hatches out after about 2½ days. The newly-hatched larva shows no trace of the rostrum. A little later the young Sword-fishes are still curious looking creatures, and so unlike their parents that they were originally mistaken for an entirely different species. They have both the jaws nearly equal in length, and armed with long, pointed teeth, but as they grow up the lower jaw becomes gradually shorter and the teeth disappear. There is a single high dorsal fin along the whole length of the back, and along either side of the slender body are four rows of spiny plates. The caudal fin is at first scarcely forked, and the fleshy keel on the peduncle is wanting. An interesting feature of the young fish is its resemblance to a fossil Sword-fish (*Blochius*) found in the Eocene formations of Monte Bolca in Italy.

The flesh is firm, greyish-white in colour, and richly flavoured, and in America " Sword-fish steak " is looked upon by some as a prime delicacy. Young Sword-fishes are very abundant off the coast of Sicily and they are much esteemed as food. In the Mediterranean and on both sides of the Atlantic there are important fisheries, these being conducted rather after the manner of whaling ; that is to say, individual fish are singled out and harpooned. Every summer large numbers of Sword-fish make their appearance off the Atlantic coast of the United States, and more than 5,000,000 pounds of fish are caught annually in America alone. It has recently been discovered that the oil obtained from the liver has a high medicinal value, being even richer than the better-known cod-liver oil.

As a sporting fish the Sword-fish is very popular, but it is not taken to the same extent as the Spear-fishes and Sail-fishes. It is described as the " hardest to manage of all that take the angler's hook ", and its tremendous strength and activity undoubtedly provide the angler with exciting and at times even dangerous sport. In 1934 a fish weighing 837½ lb. was taken on rod and line in Chile, and Mr. Zane Grey has one of 578 lb. from the Atlantic to his credit.

The Spanish name for the Sword-fish is " Espadon emperador ", meaning " the emperor's broadsword ", and the French refer to it as " Espadon ", " Empereur ", or " Épée de Mer ". The scientific name is a combination of Greek and Latin, the terms *Xiphias* and *gladius* both meaning a sword.



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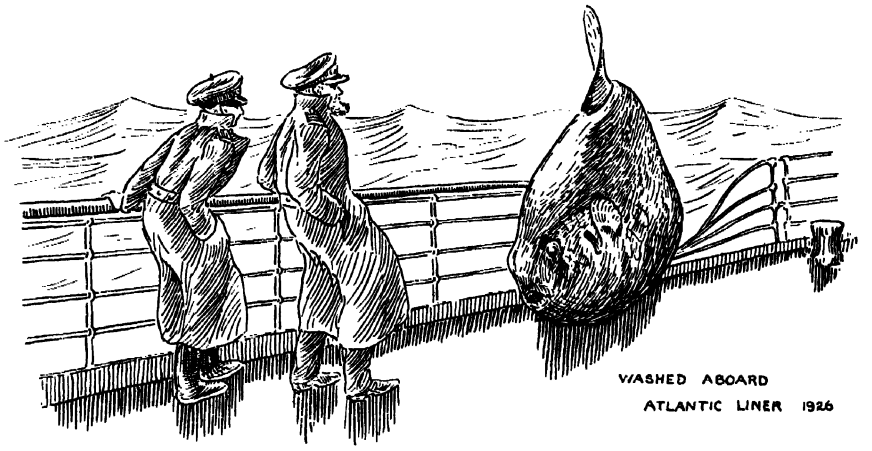


CHAPTER VII: BARRACUDAS, REMORAS AND OTHERS.

Barracudas. Remoras or Sucking-fishes. Flatfishes. Halibuts. Sun-fishes or Head-fishes.

BARRACUDAS.

(Family SPHYRÆNIDÆ; Genus *Sphyræna*.) Fig. 53.

WITH the Barracudas we complete our survey of the great Order of Perch-like fishes (Percomorphi). The Barracudas, with the smaller Grey Mullets and Sand Smelts or Atherines, form yet another suborder, the Mugiloids. The members of this group are distinguished from the Percoids by the backward position of the pelvic fins, which are situated well behind the pectorals. The Barracudas may be described as follows:

The body is long, moderately compressed, and covered with small, smooth scales. The head is very large, pointed and pike-like in appearance. The mouth is large, with powerful jaws, and the lower jaw projects beyond the upper. The teeth are strong, fang-like, unequal in size, and set in sockets in the jaws and on the roof of the mouth; there is usually a very large, sharp canine tooth near the front of the lower jaw. The gill-covers are without spines, and are covered

with small scales. The spinous dorsal fin, which is placed above the pelvics, has 5 rays and can be folded back into a groove in the back; it is widely separated from the soft dorsal, which equals the anal fin in size and is situated more or less above it. The caudal fin is forked or concave on its hinder edge, and is set at the end of a stout peduncle. The pectoral fins are placed rather low down on the sides. A lateral line is present and runs straight from head to tail. There is a large air-bladder. The coloration varies somewhat, but is usually dark green or grey above and chalky-white below; there is sometimes a row of darker cross-bars or black spots on each side. The fins may be yellowish or dusky.

Fossil remains of these fishes have been found in rocks of the Eocene period.

The larger species grow to a length of 8 feet or more and a weight of about 100 lb.

About twenty species are known, but only the following attain to a large size. The European Barracuda, Barracouta or Spet (*S. sphyræna*), found in the Mediterranean and eastern Atlantic; the Great Barracuda, Picuda or Becuna (*S. picuda*), ranging on the Atlantic coast of tropical America from Florida to Brazil and reaching the Bermudas; the California Barracuda (*S. argentea*), extending from Puget Sound southwards to Cape San Lucas; the Indian Barracuda (*S. jello*) and the Black-finned or Commerson's Barracuda (*S. commersoni*), both from the seas of India and the Malay Peninsula and Archipelago.

The Barracudas are active and voracious pike-like fishes, and among the most formidable of the Bony Fishes of the sea. The larger individuals appear to be more or less solitary in their habits, but young and half-grown fish frequently congregate in shoals. Their food consists almost entirely of fishes of all kinds, and large Barracudas are said to have the interesting, if somewhat unpleasant habit, when gorged, of herding a shoal of fishes in shallow water and of keeping guard over them until ready for another meal.

In some parts of the world, and more especially in Florida, large Barracudas are more feared by the natives than sharks, and there is no doubt that at times they may be dangerous to man. Not only are they highly inquisitive and quite fearless, but they are ferocious to a degree. They will not

hesitate to attack bathers, and cannot be scared off by splashing the water as is generally the case with sharks. Moreover, the extraordinary ease and rapidity with which their lithe bodies slip through the water makes it almost impossible to detect their approach.

The Sieur de Rochefort, writing in his 'Natural History of the Antilles', published in 1665, says: "Among the monsters greedy and desirous of human flesh, which are found on the coasts of the islands, the Becune is one of the most formidable. It is a fish which has the figure of the pike, and which grows to 6 or 8 feet in length and has a girth in proportion. When it has perceived its prey, it launches itself in fury, like a blood-thirsty dog, at the men whom it has perceived in the water. Furthermore, it is able to carry away a part of that which it has been able to catch, and its teeth have so much venom that its smallest bite becomes mortal if one does not have resource at that very instant to some powerful remedy in order to abate and turn aside the force of the poison." Writing in 1707, Sir Hans Sloane observes that "it is very voracious, and feeds on Blacks, Dogs, and Horses, rather than on White Men, when it can come at them in the water". Père Labat, in 1742, confirms this curious prejudice of the Barracuda against the flesh of the white man, and adds another surprising fact: "But a thing rather surprising," he writes, "yet one which is however of public notoriety, is that these same fish more often attack an Englishman than a Frenchman, when they find them both together in the water." He goes on to explain that the hearty, meat-eating habits of the Englishman as compared to the dainter feeding of the Frenchman produce a stronger exhalation in the water to attract the nostrils of the Barracuda—an explanation which savours more of national prejudice than of scientific accuracy!

Attacks of Barracudas on human beings have been summarized by two American scientists in a paper submitted to the American Medical Association, and this makes grim reading. After discussing the general fear of these fishes among the natives of the Carribbean region, the nature of the wounds made by their jaws, and the fact that they tend to hunt by sight rather than by smell, they add the somewhat more comforting statement that "while the barracuda, attracted

by a flashing object in the water, may hesitate in his attack and come again, he has never been known to strike more than once. If the object is not to his taste, he lets go and passes on ".

Practically nothing is known of the breeding habits of these fishes, but it is believed that spawning takes place in the open sea.

All the Barracudas are regarded as good food-fishes, but there is a certain prejudice against eating the flesh, which has a long-standing reputation of being poisonous, at least at certain seasons. The eating of the fish at these times is said to be accompanied by violent gastric upset and paralysis, followed in extreme cases by coma and death, and a whole family has been recorded as having been " wiped out " following a meal of Barracuda. These symptoms, however, are indistinguishable from those caused by ptomaines, due to the action of bacteria in the decomposing tissues of the fish, and it seems likely that many, if not nearly all, the cases of " Barracuda poisoning " in the tropics are due to eating fish that has begun to go bad.

An example of the futility of prohibiting as food any fishes suspected of possessing poisonous properties is provided by the action which was taken by the Government of Cuba in drawing up an official list of forbidden species. As more and more cases of poisoning occurred, new names were constantly added to the roll, which finally included all the best food-fishes of the West Indies!

Barracudas are caught by means of nets of various kinds, as well as by trolling with lines baited with fish or other delicacies. So inquisitive are these fishes, however, and so insatiable their appetites, that they will readily bite at artificial lures made up of feathers, pieces of coloured rag and so on. Trolling for Barracuda is a favourite sport on the coast of Florida, where they are also caught on rod and line from stationary boats. A large fish hooked on light tackle may be guaranteed to give the sportsman his measure of excitement before it is brought to the gaff. The record fish was captured at Miami in 1924, and weighed 64½ lb.

There is some doubt as to the origin of the name " Barracuda " (also spelt barracouta, barracuta, parricoota, paracuta,

etc.), but this is perhaps a native Indian word. The scientific name, *Sphyræna*, meaning " hammer ", is also obscure, but Dr. Gudger has pointed out that the Barracuda is the " *Pick-hammer* fish ", the name referring to the pick end of the tool and in allusion to the shape of the head and snout.

REMORAS OR SUCKING-FISHES.

(Family ECHENEIDIDÆ.) Fig. 57.

With the Remoras or Sucking-fishes we leave the Perch-like fishes (Percomorphi) and pass on to another Order of Bony Fishes, the Discocephali (" disc heads "), a group which has clearly been derived from Perch-like ancestors. Indeed, apart from the transformation of the spinous dorsal fin into an adhesive disc, these fishes might well be regarded as Percoids. The Remoras may be described as follows :

The body is long, or of moderate length, and is covered with minute smooth scales. The mouth is wide, with the lower jaw projecting beyond the upper. There are bands of small, pointed teeth in the jaws, on the roof of the mouth, and usually on the tongue. The spinous dorsal fin is transformed into a large, oval sucking disc, which is placed well forward on the flat upper surface of the head, and is provided with a series of transverse plates, with free hinder edges, and surrounded by a membrane. The soft dorsal and anal fins are rather long, and are placed opposite to each other. The caudal fin is rounded, square-cut or a little concave on its hinder edge. The pectoral fins are placed high up on the sides of the body, and the pelvic fins are placed just below them. There is no air-bladder. The coloration is black, grey, brown or dark green, and the belly is usually as dark or nearly as dark as the back. In some species the young and half-grown individuals have a broad, dark stripe, edged with white, running lengthwise from the tip of the snout through the eye to the tail on each side, and the edges of the dorsal and anal fins, as well as the corners of the caudal fin, are tipped with pure white.

The largest species grows to a length of 3 or 4 feet.

There are four genera of Remoras, and about ten species. The two most familiar types are the Shark-sucker, Pega, Pegador

or Sucking-fish (*Echeneis naucrates*), and the Common Remora (*Remora remora*). Both these fishes have an almost cosmopolitan distribution in warm seas, and the latter is an occasional visitor to the British Isles.

These remarkable fishes can scarcely be said to merit the description of giants, and their inclusion in this book must be justified by the fact that they are so universally associated with the larger oceanic fishes, and are so often seen by ocean voyagers.

Their most interesting structural peculiarity is, of course, the adhesive disc on the head. By means of this apparatus a Remora is able to attach itself to any flat surface, a slight raising of the transverse plates, or laminæ, creating a series of vacuum chambers. The adhesion is very strong, and to dislodge a fish from any object to which it is clinging it is necessary to pull it forwards, thus lowering the plates; a backward pull only serves to raise the plates, and the harder the pull the firmer becomes the attachment. The interest of the sucking disc to the scientific man lies in the remarkable fact that it is in reality nothing more or less than the very much modified spinous dorsal fin, the spines of which have become divided into halves, bent outwards in opposite directions, and transformed into the transverse plates. It is of some interest to note that a fossil Remora, remains of which have been found in rocks of the Eocene period, had a much narrower sucking disc, which was placed behind the head, and both in form and position this was more like a normal dorsal fin than that of its descendants living to-day.

Dr. Regan has pointed out that the broader gill-covers and the forked tail of this extinct fish indicate that it was a stronger swimmer than the existing Remoras, and it seems likely that it swam more and held on less than they do. "In form it was not unlike a pilot-fish," he writes, "and it is evident that the sucker-fishes must have been derived from fishes which had, as the pilot-fish has to-day, the habit of associating with sharks. The spinous dorsal fin of the pilot-fish and of other oceanic fishes of the same type, with the spines folded back within a groove, might possibly have some power of adhesion if the edges of the groove were applied to another object and the spines were then slightly raised."

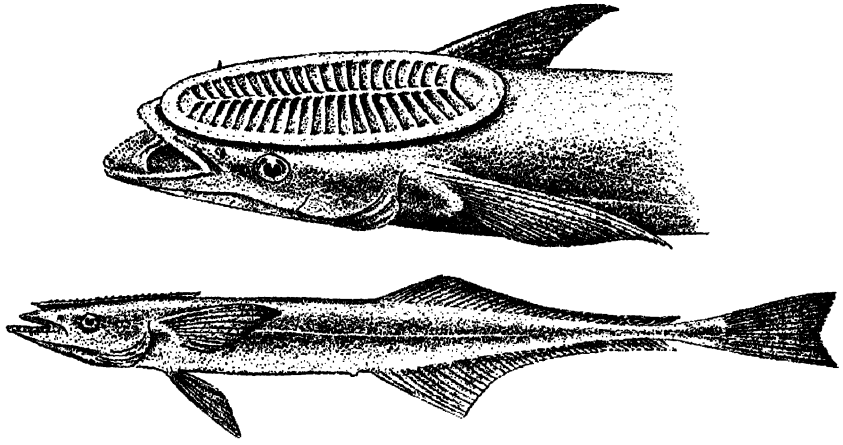


FIG. 57.—Shark-sucker (*Echeneis naucrates*).

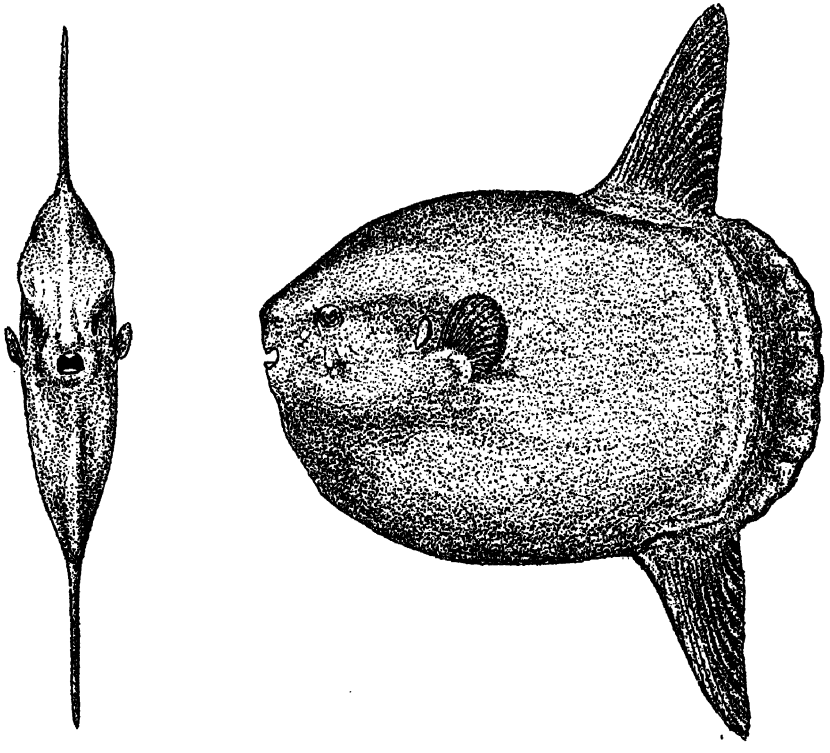


FIG. 58.—Common Sun-fish (*Mola mola*).

The Remoras are in the habit of attaching themselves to sharks and other large oceanic fishes, turtles, or even to the bottoms of ships or to other floating objects. It is rare indeed to catch a large shark without finding 2, 3 or more of these fishes attached, but the Remoras invariably drop off when the shark is hauled out of the water. It has been stated by one naturalist that, when attached to its " host ", a Remora seems to become quite insensitive, and shows no signs of life however roughly it is treated. They do not attach themselves solely to the external surface of the body of the " host ", but are often found inside the mouth or even beneath the gill-covers of " Sword-fishes ", Tunnies, Sun-fishes, etc., and have even been known to shelter well inside the mouth of the gigantic Devil-fishes.

The purpose of the association between the Remora and its " host " seems to be twofold : in the first place, it obtains a measure of protection from its enemies, and probably also a share of its companion's meal ; in the second place, it obtains a free ride, and is carried without effort on its own part to fresh feeding-grounds. The normal food of the Remoras consists of other fishes, and once among a shoal of suitable prey they detach themselves and swim about in active pursuit. Hunger being appeased, they will look about for other large fishes, to which they will promptly adhere, digesting the meal in comfort and seclusion. The sharks, curiously enough, seem to tolerate these messmates, and so far no remains of Remoras have ever been found in their stomachs.

It has been said that a Remora when attached to a shark or other object has its normal coloration more or less reversed : that is to say, it tends to be paler on the back than on the belly. It is certainly true that in practically all the species the lower parts of the body are quite as dark, if not darker, than the upper. As the fish is attached by the *upper* surface of its head it is the belly that is exposed to the light, and it has been suggested that the development of dark pigment is due to the action of the light. Another example of reversed coloration is known among fishes, namely an African fresh-water Cat-fish (*Synodontis*), known to the Arabs as " Batensoda " (Black Belly), in which the lower parts are dark brown or black and the back pale silvery grey. This

fish, which is common in the Nile and in other parts of tropical Africa, has the remarkable habit of habitually swimming *upside down*—a fact that must have been familiar to the ancient Egyptians, who have frequently depicted the fish in this position.

There is a very ancient belief, often encountered in classical and medieval literature, that the Remoras are able to impede the progress of sailing vessels or even to stop them altogether. Mr. Radcliffe, in his book, ' Fishing from the Earliest Times ', tells us that the Roman author, Pliny, " solemnly asserts that the death of the Emperor Caligula was presaged by a *Remora* stopping his great galley, alone out of all the accompanying fleet, on his voyage to Antium. Not only did the *Remora* stop a ship, but according to Pliny, it could, from its power of checking the natural actions of the body under excitement, hasten or stay an *accouchement* as well as a law suit : hence plaintiffs seldom ventured into the fish-markets, because the mere sight of a *Remora* at such a juncture was most inauspicious ! " The scientific name *Echeneis*, from two Greek words meaning " to hold back " and " ship ", and *Remora*, an ancient Latin name meaning " holding back ", both refer to this alleged power of impeding vessels, a power which is, of course, purely mythical.

The flesh of the Remora does not seem to be much valued as food, but the natives of various countries make use of the living fish to catch turtles, fishes, dugongs, etc. A ring is fastened round the tail of a living Remora, and to this is attached a long cord ; the fish is kept in a bucket of water until required, and is released when a turtle or other creature is observed at the surface. The fish fastens on to the turtle and the two are pulled in together. Some skill is required in carrying out this manœuvre, as the ring may be pulled off the fish if undue strain is put on the line.

FLATFISHES.

(Order HETEROSOMATA.)

The Flatfishes represent another order of Bony Fishes, the Heterosomata, the members of which have been derived from Perch-like ancestors. They are unique among fishes in

having both their eyes on the same side of the head—the right side or the left side. In the minds of many, the members of this order (Halibut, Plaice, Dab, Turbot, Sole and so on) are lumped together with the Skates and Rays as " Flat Fishes ", but the resemblance between these two types is purely superficial. Both have become adapted for a life spent mainly upon the sea floor, and both have acquired a flattened shape, but, whereas the body of a Ray is *depressed* (*i. e.* flattened from above downwards), that of the true Flatfish is *compressed* (*i. e.* flattened from side to side). Thus, the " upper " or coloured side of the Flatfish, as it lies on the bottom, is really its right or left side, and not the true dorsal or upper side as in the Ray. The two sides of the Flatfish are usually referred to as the " eyed side " and the " blind side " respectively.

One point of special interest may be mentioned here. As a general rule, a particular species of Flatfish is either right-sided or left-sided, and not, as might perhaps be supposed, sometimes right- and sometimes left-sided. Thus, to mention the better-known British species, the Halibut, Plaice, Dab, Flounder, Lemon Sole, Witch and Sole are all right-sided species; the Turbot, Brill, Megrim and Topknot are left-sided species. In the case of the Flounder, however, as well as in certain other species, reversed examples are fairly common, but such individuals are abnormal, and the structure of the fish leaves no doubt as to the side on which the eyes should be.

This is a very large Order of fishes, and includes some of the most important and valuable food-fishes in various parts of the world. Only one type of Flatfish grows to a size sufficient to warrant its description as a giant, namely, the Halibut, and this may now be considered in some detail.

HALIBUTS.

(Family PLEURONECTIDÆ; Genus *Hippoglossus*.) Pl. V c.

Flatfishes with a rather long body, which is somewhat rounded on the eyed side and flat on the blind side, and is covered with small, more or less smooth scales. The eyes are on the right side of the head, and are separated from one another by a fairly wide, flat space. The mouth is large, and

the jaws and strong, pointed teeth are equally developed on both sides of the head. The dorsal fin forms a fringe along the edge of the head and body, extending from above the eyes nearly to the tail, and is supported by about 100 flexible rays. The anal fin is similar, but starts farther back and has only 70 to 85 rays. The caudal fin is well developed, and is placed at the end of a stout peduncle. The pectoral fins are unequal in size, that of the eyed side being the larger. The pelvic fins are small, about equal, and are placed below the hinder part of the head. There is a distinct lateral line on each side of the body, which is arched above the pectoral fin and from thence runs straight to the tail, where it extends on to the caudal fin. There is no air-bladder. The coloration of the eyed side is nearly uniformly olive-brown, dark brown or black, and that of the blind side is pearl-white; young individuals are usually marbled with paler and darker shades.

Grow to a length of about 10 or 12 feet and a weight of at least 500 lb.

Only two species are known: the Common Halibut (*H. hippoglossus*), widely distributed in the North Atlantic; and the Pacific Halibut (*H. stenolepis*), from the North Pacific.

The Halibut has a longer and generally plumper body than the majority of Flatfishes, and its large mouth is armed with rows of strong, pointed teeth. In these respects it presents a very different appearance to, say, the Plaice, which has a shorter, deeper and thinner body, and a smaller mouth, which is twisted over towards the blind side of the head, so that both the jaws and the teeth are much better developed on that side. These differences in structure are related to differences in the habits of the two fishes. The Halibut sometimes lies in wait for its prey, lying flat on the sea bottom, but, as its form suggests, it is a powerful swimmer, and quite often goes in active pursuit of other fishes, sometimes chasing them right up to the surface. The Plaice, on the other hand, like the great majority of Flatfishes, is much less active, spends practically all its time on the bottom, and feeds on shellfish, crustaceans, worms, and other ground-living creatures. When the Halibut is chasing its prey it gets along mainly by the aid of its strong muscular body and powerful tail, but the Plaice relies more upon wave-like movements of the body and of the fringing fins to glide

slowly over the sea-floor. It may be emphasized here that when a Flatfish leaves the bottom it swims *on its side*, with the eyed or coloured side uppermost.

The Halibuts are voracious fishes, found at all depths from quite close inshore in the case of the small fish to 200 fathoms or more in the case of large individuals. Their preference is for offshore banks of moderate depth, or for deep and rocky situations. They are often to be found in numbers on grounds frequented by cod—a fish with a similar diet. Their food consists largely of fishes of various kinds, but crabs and shell-fish are also eaten. Dr. Goode has stated that " they often kill their prey by blows of the tail, a fact which is quite novel and interesting ".

The same author describes how the Halibuts catch fish which " they waylay lying upon the bottom, invisible by means of their flat bodies, coloured to correspond to the general colour of the sand or mud upon which they rest ". As in other Flatfishes, the coloration of the eyed side of a Halibut bears a close resemblance to that of the ground upon which it lies, and furthermore, it has the power of changing its coloration in harmony with its surroundings developed to a remarkable degree. A fish lying on a patch of mud will be almost black, but if it should happen to move to a sandy ground, the prevailing hues will at once become pale. It has been proved that in order to change its colours the fish must be able to see the ground on which it lies, and if we look at a Flatfish living in an aquarium, with its eyes standing out from its head and moving round independently in almost every direction, rather like miniature gun-turrets, we can see how this may be accomplished. A fish that has been blinded will remain quite dark even if transferred to a white background. Further, experiments have shown that if a Flatfish be placed with its head on a white ground and its body on a black ground, the whole fish will become pale.

As is well known, the coloration is due mainly to the presence in the skin of numerous pigment-containing cells known as chromatophores. Each of these has the form of a minute bag with thin and highly elastic walls, supplied with fine muscles, which are in turn associated with delicate nerve-endings. The colour change is brought about roughly in the

following manner: The fish surveys the ground and receives a sensory stimulus through the eyes, which is transmitted to the brain; from there another impulse is sent out to the muscles controlling the chromatophores, and by the contraction of, say, the red and orange cells here, and the expansion of the brown and black there, the appropriate shade or pattern is acquired. It cannot be said that the fish consciously imitates the surroundings, the whole process partaking of the nature of a series of reflex actions and being accomplished in less than a second.

Breeding takes place from May to July, at least in the eastern Atlantic. The roes of a ripe female Halibut are of relatively enormous size, those of a fish of 350 lb. each being about 2 feet in length and together weighing more than 40 lb. Each ovary may contain upwards of 2,000,000 eggs, each of which when ripe is only about $\frac{1}{8}$ inch in diameter, and about 32,000 eggs make up a quart. They are of the buoyant type, and are shed and fertilized in the open sea.

As in all Flatfishes, the larval fish undergoes a metamorphosis, which is not only very remarkable in itself, but throws considerable light on the evolutionary history of the group. The eggs hatch after a few days, and the larvæ are at first quite symmetrical, and have one eye on either side of the head just as in any other fish. They swim about at the surface of the sea, and, in the case of the Halibut, seem to be carried by the currents towards the inshore waters. After a time one of the eyes (the eye belonging to the future blind side of the fish) moves round over the edge of the head, until it finally comes to lie close to its fellow of the opposite side; at the same time the dorsal fin, which at first begins behind the head, is prolonged forward, and as soon as the eye has moved round to its final position the fin grows along the edge of the head above it. While these important changes are taking place the little fish sinks to the bottom of the sea, and thenceforward lies with the eyed side uppermost; at once pigment-cells commence to develop on this side of the head and body. After this stage growth appears to be rather slow, and it has been estimated that a Halibut 4 feet long is about twelve years old.

It is a well-established fact that in many animals the various

phases of the development of the individual repeat to a greater or lesser extent the history of the race, and the Flatfishes provide an excellent example of this phenomenon of recapitulation, as it is called. Without going into details, it may be pointed out that all the available evidence suggests that the ancestral Flatfishes originated from symmetrical fishes not unlike the Sea Perches. Some of these Perches have the habit of lying upon their sides when at rest, and the earliest Flatfishes probably lengthened these resting periods, remaining on their sides when awaiting their prey, and then darting off in pursuit. There is one very primitive type of Flatfish still living to-day in tropical seas which has habits of this sort, and this interesting fish bears a marked resemblance to some of the Sea Perches. The eye of the blind side remains on the top of the head, instead of moving over in the direction of its fellow, and the dorsal fin commences behind the head instead of above the eyes. Further, the front part of the dorsal fin consists of slender spine-like rays and the hinder part of soft flexible rays; and each pelvic fin consists of a spine and 5 soft-rays.

The flesh of the Halibut is both wholesome and nutritious, but lacks the delicate flavour of that of the Turbot or Sole. At one time it was so little esteemed in Britain that it was referred to in parts of the country as " workhouse turbot ". Nowadays, however, it is gradually growing in popularity, and small Halibuts, known to the fishermen as " chicken halibut ", are much esteemed. The liver provides a valuable medicinal oil, which threatens to rival the better-known cod-liver oil.

Halibuts are caught mainly by hook and line, although a certain proportion are taken in the trawl. The British supply comes mainly from the rich fishing-grounds near Iceland and the Faroe Islands, and the chief ports of landing are Grimsby and Hull, especially the former.

The scientific name, *Hippoglossus*, is the ancient name for the Halibut, and is derived from two Greek words meaning " horse " and " tongue "—a reference to the general shape of the fish.

A

B

C

D

A. Hammer-head Shark (*Sphyrna zygæna*). B. Tailed Sun-fish (*Mola lanceolata*). C. Halibut (*Hippoglossus hippoglossus*). D. Tope (*Eugaleus galeus*).

SUN-FISHES OR HEAD-FISHES.

(Family MOLIDÆ; Genus *Mola*.) Pl. V B; Fig. 58.

The Sun-fishes, with which we conclude our survey of the giant Bony fishes, belong to another Order, the Plectognathi, the members of which have been evolved from Perch-like ancestors. This is a large and varied group of fishes, and includes such diverse types as the File-fishes, Leather-jackets, Trigger-fishes, Trunk-fishes, Puffers, Globe-fishes, Porcupine-fishes and Sun-fishes. Only the last-named grow to any size, and may be defined as follows:

The body is deep, oval in shape, and covered with a thick, rough, leathery skin. The snout projects a little above the small mouth, in which the teeth are fused together to form a single, bony, sharp-edged plate or "beak" in each jaw. The dorsal and anal fins are very large and high, and are placed opposite to each other; behind them the body ends abruptly without any decrease in depth, and is margined by a low tail-fin, which may be evenly rounded, wavy in outline, or drawn out into a point in the middle. The pectoral fins are short and rounded, and are placed just behind the small gill-openings. There are no pelvic fins. There is no air-bladder. The coloration is uniformly grey, olive-brown, or nearly black, with silvery reflections on the sides; young individuals are dark above, with some more or less conspicuous round dark spots on the hinder part of the body, and white beneath; very young individuals are silvery on the belly.

Grow to a length of 8 to 10 feet and a weight of more than a ton.

Two species are recognized, and some authorities place these in separate genera. Both have a world-wide distribution in tropical and temperate seas. The Common, Round-tailed, Short or Ocean Sun-fish (*M. mola*) has the hinder part of the body rounded or wavy in outline; the Tailed or Pointed-tailed Sun-fish (*M. lanceolata*) has the hind end of the body more or less pointed in the middle. The latter is a very rare

fish, and almost nothing is known of its manner of life, so that the following remarks refer exclusively to the Common or Round-tailed Sun-fish. There is yet another Sun-fish, the Oblong or Truncated Sun-fish (*Ranzania truncata*), with a similar cosmopolitan distribution, but this fish rarely exceeds a length of 2 feet. The Common Sun-fish is quite well known round the British Isles, making its appearance about June and generally departing as winter approaches.

The name " Head-fishes " sometimes given to these grotesque creatures is singularly appropriate, for a Sun-fish certainly has the appearance of being composed of an enormous head to which small fins are attached. Indeed, it looks for all the world as if the hinder part of its body had been cut off just behind the high dorsal and anal fins. It has been suggested that its curious shape is in some way associated with its habit of diving from the surface to deep water, but this explanation has been questioned by many experts.

Sun-fishes live in the open sea, and, although they are often to be seen singly or in pairs, they seem to become gregarious at certain seasons, when they band together in small schools consisting of upwards of a dozen individuals. As their name implies, they are fond of basking in the sun at the surface of the sea during calm weather, and are often to be observed lying more or less on their sides with the dorsal fin out of the water. When swimming, they are said to progress with a waving motion from side to side, " like a man sculling a boat ", and with the dorsal fin projecting from the water like that of a shark. " They swim," writes Mr. Whitley, " by turning both the dorsal and anal fins to one side at the same time. These fins are opposite one another, and twist slightly as they are moved from side to side, the result being rather like the action of a ship's propeller. The side fins, or pectorals, flap continually, somewhat like the ears of an elephant, and the stumpy tail acts as a rudder. As an ' auxiliary engine ', either gill-opening can squirt a powerful jet of water at will, and the sun-fish can also shoot water from its beak-like mouth."

Living mainly at or near to the surface, at least during calm weather, Sun-fishes drift more or less passively with the great ocean currents, and feed mainly upon the rich

supplies of surface food—small fishes, jellyfishes, crustaceans and the like—borne by these currents. They are also known to be very partial to the leaf-like larvæ of the Common Eel. A large Sun-fish captured in the trawl off the south of Ireland was found to have in its stomach the remains of a Silver Ling. Now this fish lives on the sea bottom in depths of at least 100 fathoms—a fact that suggests that at times the Sun-fishes descend to considerable depths.

Many are the stories told to illustrate the extreme stupidity of these sluggish giants, and there is little doubt that they will allow a boat to come right up to them without making any effort to escape. Their strength, however, is considerable, and it is no easy matter to get a large Sun-fish aboard. The following extract from the ' Voyage of the " Scotia " ' provides an interesting account of the capture of a Sun-fish off Montevideo : " The catch consisted of a large sunfish, weighing about three-quarters of a ton. Some half-dozen of these huge fish were seen during the day basking at the surface, the largest being about the size of a small haystack. The one we captured was really quite tiny, but it was all we could do to haul it on board. Its stupidity was amazing ; unable to swim faster than a boat could row, all it had to do to escape us was to sink—and this they can do quite well—but, although struck by a harpoon a dozen times before one held, it made no attempt to escape. Davidson, an expert harpooner, managed to insert a harpoon into the gill-cleft ; then the beast allowed itself to be towed to the ship, apparently dying of disgust."

The same writer goes on to describe how this fish, when dissected, was found to have a layer of hard gristly material, 2 or 3 inches in thickness, just under the skin, providing an explanation of the inability of the harpoon to penetrate. It seems likely that this armour is intended to compensate for the absence of locomotive power, and to protect the fish from potential enemies. Mr. Whitley mentions a large Sun-fish caught in Botany Bay, New South Wales, whose tough hide rendered it impervious to bullets fired from Winchester rifles !

When captured, Sun-fishes have been described as uttering sounds which are comparable to sighs or to " the grunting of

swine ". Dr. Day mentions a 6-foot specimen that became entangled in the fishermen's nets on the Chesil Beach in Dorsetshire. This was dragged ashore, and dashed about on the pebbles with great vigour, and finally expired in about 3 hours after uttering " hideous groans ".

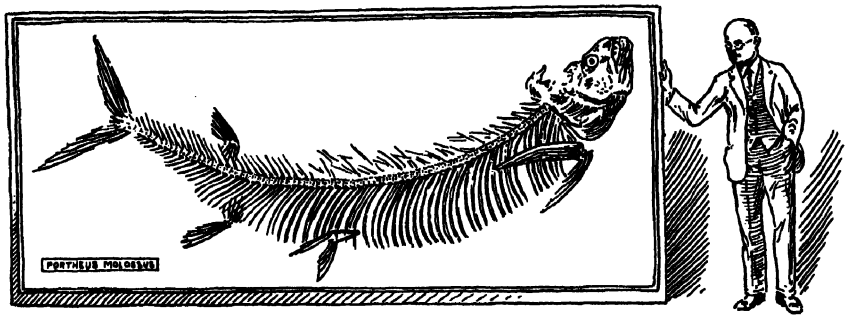
Practically nothing is known of the breeding habits of these fishes, but they seem to be highly prolific. The ovary of a female Sun-fish has been found to contain no less than 300,000,000 small, unripe eggs. As far as is known, the eggs are shed and fertilized in the open sea, and, as is the case in all fishes that produce huge numbers of eggs, the almost helpless, newly-hatched larvæ are left to the mercy of the elements, and a very small proportion of them survive to reach maturity. The eggs are believed to be about $\frac{1}{20}$ inch in diameter, and the newly-hatched larvæ are extraordinarily minute, when compared with the colossal bulk of their parents. As Dr. Gudger puts it, " the larval Sun-fish is to its mother as a 150-lb. rowboat is to sixty ' Queen Marys ' ".

The larva when first hatched is about $\frac{1}{10}$ inch in length, and is quite ordinary, with a paddle-shaped caudal fin like any other young Bony Fish. It soon loses this caudal fin, however, and acquires a regular armour of spines projecting in every direction from the surface of the body. Five of these spines later grow out into long " horns ", one of which projects from the middle of the back, one from the snout, one from the chest, and one from each side of the body. When rather less than half an inch in length, the little fish undergoes a marked change in shape, the body becoming deeper than long, and at the same time the spines shorten and a new tail-fin develops, which connects the abbreviated dorsal and anal fins.

The flesh of the Sun-fish is generally regarded as worthless, and, as this fish is a relative of the Globe-fishes or Puffers, which have the reputation of being highly poisonous to man, it is rarely eaten. It seems to be harmless, however, but tough and quite tasteless. Dr. Day mentions a portion of Sun-fish that was sent as a present to a gentleman, whose cook made it into a soup that was described as " the best turtle soup he had tasted for a long time ".

The name " Sun-fish " refers, of course, to the habit of

basking at the surface, and it may be noted that the inhabitants of the Island of Aran use the same name for the Basking Shark, which has a similar habit. Unfortunately, the popular name of " Sun-fishes " is also given to a group of small Perch-like fishes found in the rivers and streams of North America. The scientific name, *Mola*, is a Latin word meaning " millstone ", and refers to the general shape of the fish.



RELICS OF THE PAST — A FOSSIL TARPON

CHAPTER VIII: KEY TO THE PRINCIPAL FISHES DESCRIBED IN THIS BOOK.

THE following key deals with nearly all the different kinds of fishes described in detail in these pages, and is intended to be used in conjunction with the descriptions and illustrations for the identification of any large fish that the reader is able to examine. The arrangement is, naturally, somewhat artificial, and the species brought together in a certain section of the key are not necessarily in any way closely related.

Some difficulty may be experienced at first in using a key of this nature, but with a little practice the reader should be able to " run down " most of the fishes he is likely to encounter. The key is so arranged that alternative characters are contrasted, one character or set of characters being placed under a letter (A), the other under a corresponding double letter (AA). If, on consulting the key, the characters given under a particular letter do not fit the specimen at hand, try those given under the corresponding double letter. If these fit, then continue to read on in this section as far as they continue to fit; when they do not fit, skip to the alternative double letter where they do. Thus, proceed as far as possible and the name of the fish under consideration will be found.

Suppose, for example, that we have a specimen of the Greenland or Sleeper Shark before us, and, being ignorant of its identity, wish to find its name by using the key. Under the first letter in the section devoted to Selachians (A) we have to consider whether the external gill-openings are on the sides

of the head, or, as in AA, whether they are on its lower surface. As they are in the former position, we continue with B. There

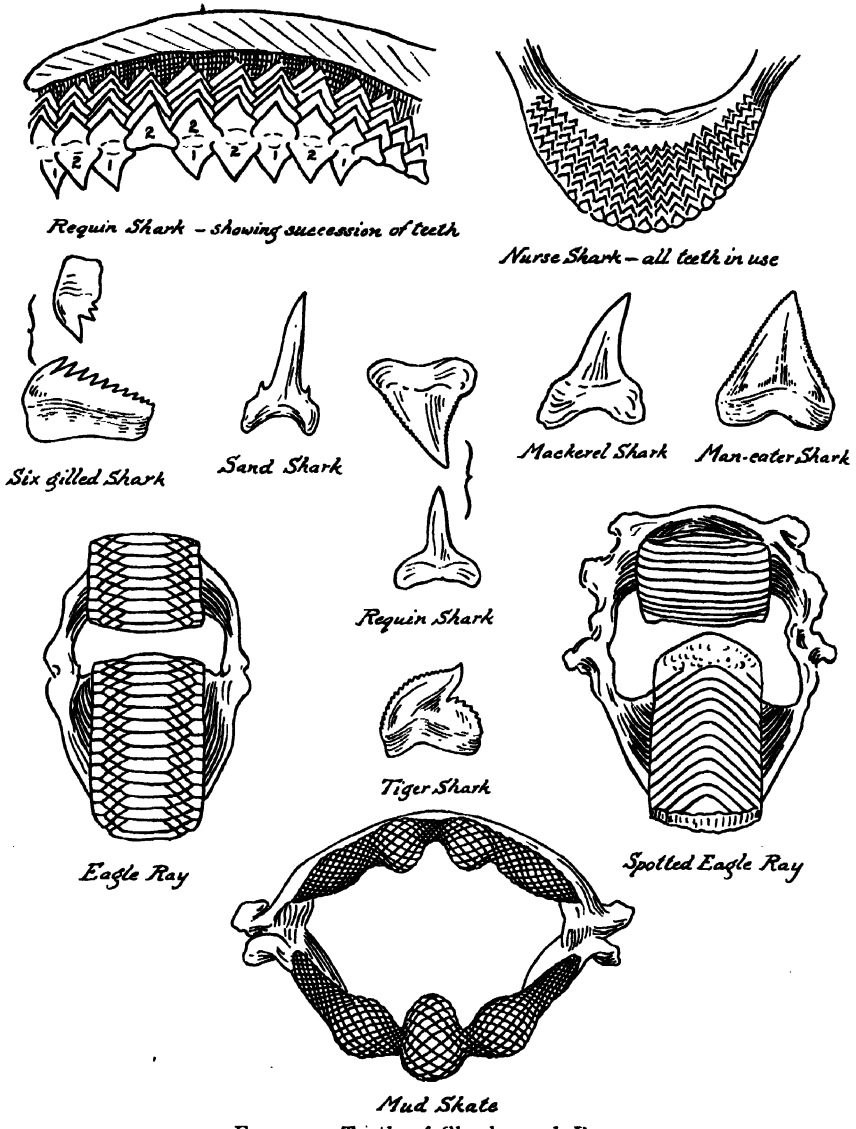


FIG. 59.—Teeth of Sharks and Rays.

are two dorsal fins in our shark, so we skip to BB, and then pass on to D. The character given under D will not fit our shark, so that we have to skip again to DD, and then read on with R. The body is not broad or depressed, and the pectoral

fins are normally shaped, so that we pass straight on to s. Our shark fits all the characters given under s, so that we then know that we are dealing with a Greenland or Sleeper Shark.

I. There are 5 to 7 external gill-openings on each side (**Selachians**).

A. The external gill-openings are on the sides of the head, the last being in front of or above the base of the pectoral fin; the front edge of the pectoral fin is free (**Sharks**).

B. There is 1 dorsal fin; there are 6 or 7 external gill-openings on each side.

C. There are 6 external gill-openings on each side
SIX-GILLED SHARK or GRISET (p. 5).

CC. There are 7 external gill-openings on each side
SEVEN-GILLED SHARK or PERLON (p. 5).

BB. There are 2 dorsal fins; there are only 5 external gill-openings on each side.

D. An anal fin in present.

E. The eye has no third eyelid or nictitating membrane.

F. There are no grooves connecting the mouth with the nostrils; all the gill-openings are placed in front of the pectoral fin or the last is just above its root.

G. The upper lobe of the caudal fin is less than one-third of the total length of the shark.

H. The tail has no keel; the caudal fin is not symmetrical; the second dorsal fin is nearly as large as the first.

I. The lower lobe of the caudal fin is distinct; the snout is short; the 2 dorsals, the anal, and the pelvic fins are all nearly equal in size
SAND SHARKS or SLENDER-TOOTHED SHARKS (p. 7).

II. The lower lobe of the caudal fin is not very prominent; the snout is long; the dorsal fins are smaller than the anal or pelvics
ELFIN or GOBLIN SHARK (p. 9).

HH. There is a marked keel on each side of the tail; the caudal fin appears more or less symmetrical; the second dorsal fin is much smaller than the first.

J. The external gill-openings are of moderate size; the teeth are large.

K. The teeth are slender and awl-shaped, with smooth edges
PORBEAGLES and MAKO SHARKS (p. 12).

KK. The teeth are triangular, flat, and with fine saw-like edges
GREAT WHITE SHARK or MAN-EATER (p. 14).

JJ. The external gill-openings are very large, and extend nearly right round the "neck"; the teeth are very numerous, small and conical in shape
BASKING SHARK (p. 20).

GG. The upper lobe of the caudal fin is more than one-half of the total length of the shark
THRESHER or FOX SHARK (p. 24).

FF. Grooves are present connecting the mouth with the nostrils; the last 2 to 4 gill-openings are placed above the base of the pectoral fin.

L. The caudal fin is long and very asymmetrical; the external gill-openings are of moderate size; there are no gill-rakers.

M. The spiracles are small; the anal fin is quite free from the caudal fin
NURSE SHARKS (p. 28).

MM. The spiracles are large or of moderate size; the anal fin is either joined to the caudal fin or ends directly in front of it.

N. The body is thick-set, with the head and trunk broad and depressed; the sides of the head are provided with tassels of skin; the eyes have folds below them; there are no ridges along the body
WOBBEGONGS or CARPET SHARKS (p. 33).

NN. The body is long, and the head and trunk are not very broad or depressed; there are no tassels of skin on the sides of the head; the eyes have no folds below them; there are keels or ridges along the back and sides
ZEBRA SHARK (p. 34).

LL. The caudal fin appears nearly symmetrical; the external gill-openings are large; gill-rakers are present WHALE SHARK (p. 29).

EE. The eye has a third eyelid or nictitating membrane; there are no grooves connecting the mouth with the nostrils; the last 1 or 2 gill-openings are placed above the base of the pectoral fin.

*

O. The head is normally formed.
P. There is a pit at the root of the caudal fin.
Q. There are no spiracles; the teeth each have a single strong, sharp point, which may be smooth or with fine saw-like edges . BLUE SHARKS (p. 36).
QQ. Small spiracles are present; the teeth are large, flat, roughly sickle-shaped, with a fluted edge, and with a triangular point which is turned obliquely outwards . . . TIGER SHARK (p. 42).
PP. There is no pit at the root of the caudal fin; the teeth are set obliquely in the jaws, are notched, and have fine saw-like edges TOPES (p. 45).
OO. The sides of the head are more or less drawn out into fleshy lobes, with the eyes at their extremities, the head being kidney- or hammer-shaped HAMMER-HEAD SHARKS (p. 46).
DD. There is no anal fin.
R. The body is not broad and depressed; the pectoral fins are normally shaped; the first dorsal fin is placed above or in front of the pelvic fins.
S. The first dorsal fin is placed well in front of the pelvic fins; the spiracles are of moderate size; the skin is uniformly covered with tiny denticles GREENLAND or SLEEPER SHARK (p. 48).
SS. The first dorsal fin is placed above the pelvic fins; the spiracles are minute; the skin has a number of scattered, round, flat, button-like denticles, some of them with tufts of small prickles BRAMBLE or SPINOUS SHARK (p. 51).
RR. The body is broad and depressed; each pectoral fin is prolonged forward to form a free angular "shoulder"; the first dorsal fin is placed well behind the pelvic fins ANGEL-FISHES or MONK-FISHES (p. 53).
AA. The external gill-openings are on the under side of the head, and are all below the base of the pectoral fin, which extends forward above them; the front edge of each pectoral fin is joined to the side of the body or head (**Rays**).
T. The pectoral fins are expanded, but are not completely united with the head and trunk to form a flattened disc; there is a strong, muscular tail, with two dorsals and a caudal fin.

u. The snout is not drawn out to form a toothed "saw". . . . GUITAR-FISHES (p. 58).

uu. The snout is drawn out to form a flat, blade-like rostrum or "saw", with a row of strong "teeth" on either edge . . . SAW-FISHES (p. 60).

rr. The head, trunk and the greatly expanded pectoral fins are all united to form a flattened circular, rhomboid or lozenge-shaped disc, from which projects the comparatively feeble tail.

v. The disc is normally more or less circular; the tail is short and stout, with a broad caudal fin; there are paired electrical organs between the pectoral fins and the head; the skin is soft and flabby ELECTRIC RAYS or TORPEDOES (p. 64).

vv. The disc is usually more or less rhomboid or lozenge-shaped, rarely circular; the tail is more slender; the caudal fin, if this is present, is small; there are no electrical organs between the pectoral fins and the head.

w. The tail is rather stout, with two small dorsal fins near its extremity; there is no saw-edged spine on the tail; the pelvic fins each have a conspicuous notch in their hinder border SKATES and RAYS (p. 67).

ww. The tail is narrow, usually more or less whip-like, and with never more than 1 dorsal fin; there is often a saw-edged spine on the back of the tail (sometimes 2 or 3); the hinder borders of the pelvic fins are not notched.

x. The front parts of the pectoral fins do not form horn-like appendages at the sides of the mouth.

y. There is no dorsal fin in front of the saw-edged spine; the pectoral fins extend evenly to the extremity of the snout; there are several rows of small teeth in each jaw WHIP-TAILED STING RAYS (p. 72).

yy. There is a single dorsal fin in front of the saw-edged spine; the front edges of the pectoral fins are much indented, so that they have the appearance of being missing at the sides of the head; the teeth in both jaws are large, flat, and form a tessellated pavement .

z. There are several rows of teeth in each jaw; the coloration of the upper side of the adult is more or less uniform.

a. The fleshy pad at the front of the head forms a single, bluntly pointed or rounded lobe .. EAGLE RAYS (p. 76).

aa. The fleshy pad at the front of the head is divided into four lobes COW-NOSED RAYS or WHIPPAREES (p. 79).

zz. There is a single row of long, bar-like teeth in each jaw; the upper surface has numerous round, pale spots SPOTTED EAGLE RAY (p. 78).

xx. The front parts of the pectoral fins are separated off to form projecting horn-like cephalic fins placed on either side of the mouth; there is a single small dorsal fin at the base of the short, whip-like tail; the teeth in the jaws are very small and numerous.

b. The mouth is wide and is placed at the end of the head; teeth are present only in the lower jaw . . MANTA or GREATER DEVIL-FISH (p. 81).

bb. The mouth is less wide and is placed on the under side of the head; teeth are present in both jaws or only in the lower jaw SMALL or LESSER DEVIL-FISH (p. 84).

II. There is only 1 external gill-opening on each side, or the gills are entirely protected by a bony gill-cover (**Bony Fishes**).

A. Pelvic fins are normally present.

B. The pelvic fins are never placed farther forward than the level of the middle of the pectoral fins (when the latter are lying flat against the body).

C. There is only 1 dorsal fin, composed entirely of soft-rays.

D. The body is without normal scales, but has 5 rows of large bony scutes; the mouth is small, round, funnel-like, and placed on the under side of the head; there is a transverse row of 4 barbels or feelers in front of the mouth STURGEONS (p. 88).

DD. The body is covered with thin, overlapping scales, but there are no rows of large scutes; the mouth is never round or funnel-like, and is placed at the end of the head; there is no row of barbels in front of the mouth.

E. The dorsal fin is placed near the middle of the back, and in front of the anal fin ; its last ray is drawn out into a long filament
TARPON (p. 93).

EE. The dorsal fin is placed on the hinder part of the back, and more or less opposite to the anal fin ; its last ray is not prolonged.

F. Both jaws are drawn out to form a long "beak", which is armed with small pointed teeth mixed with larger needle-like teeth ; the pectoral fins are of moderate size ; the scales are small
GAR-FISHES or NEEDLE-FISHES (p. 102).

FF. The jaws are short and do not form a "beak" ; the teeth are all small and feeble ; the pectoral fins are very large ; the scales are of moderate size
FLYING-FISHES (p. 104).

CC. There are 2 dorsal fins, the first being composed of stiff spines ; the pelvic fins are placed below the hinder parts of the pectoral fins ; the scales are small . . . . BARRACUDAS (p. 169).

BB. The pelvic fins are placed farther forward, being just behind, below, or in front of the bases of the pectoral fins.

G. The snout and jaws are not drawn out to form a pointed "spear".

H. The eyes are normal, one being on each side of the head.

I. The spinous dorsal fin, if this is present, is not transformed into an adhesive disc.

J. Each pelvic fin has from 15 to 17 rays ; the body is deep and nearly oval in shape
OPAH or MOONFISH (p. 107).

JJ. Each pelvic fin has from 1 to 9 rays (generally 6) ; the body is never very deep or oval in shape.

K. No detached finlets behind the dorsal and anal fins.

L. The body is compressed and more or less band-like, usually rather long ; the skin is either naked or with some scattered spines or tubercles ; there is a long dorsal fin, running for nearly the whole length of the back.

M. There is no anal fin ; the mouth is small, and is toothless or provided with feeble teeth.

N. The body is of moderate length; each pelvic fin has from 5 to 9 rays; the caudal fin is well-developed and is set at an angle to the axis of the body
DEAL-FISHES (p. 110).

NN. The body is very long and ribbon-like; each pelvic fin is composed of a single long ray; the caudal fin is a mere rudiment or is absent altogether OAR-FISH (p. 112).

MM. An anal fin is present, and is composed of numerous short spines; the mouth is large, and is provided with strong, sharp teeth.

O. No dagger-like spine behind the vent; eye of moderate size; colour silvery
SCABBARD-FISH (p. 138).

OO. A dagger-like spine behind the vent; eye large; colour dark-brown or black
BLACK SCABBARD-FISH (p. 140)

LL. The body is never greatly compressed or very long; the skin is usually provided with thin, overlapping scales.

P. Dorsal fin consisting of a spinous and a soft portion; the head is normally shaped.

Q. Teeth are nearly always present on the roof of the mouth.

R. The spinous part of the dorsal fin is longer than the soft, and is composed of stout spines; none of the anal spines is detached; the hinder edge of the caudal fin is rounded, square-cut, or rather concave.

S. The inner teeth in the jaws are not hinged or depressible inwards; there are no larger canine teeth at the front of the jaws.

T. The head has some rough spiny ridges or crests; there is a patch of teeth on the tongue; the pelvic fins are placed below the roots of the pectorals
STONE BASS or WRECK-FISHES (p. 115).

TT. The head has no rough, spiny ridges; the tongue is quite smooth; the pelvic fins are placed just in front of the roots of the pectorals JEW-FISHES (p. 117).

SS. The inner teeth in the jaws are hinged at their bases and are depressible inwards; usually there are some larger canine teeth at the front of the jaws
GROUPERS or ROCK-FISHES (p. 119).

RR. The spinous part of the dorsal fin is shorter than the soft, with the spines either slender or quite short; the front 2 spines of the anal fin are detached from the rest of the fin (but sometimes hidden under the skin); the caudal fin is forked.

U. The soft dorsal fin is longer than the anal.

V. The spinous dorsal fin has 7 spines, which are connected with one another by membrane
AMBER-FISHES or YELLOW-TAILS (p. 122).

VV. The spinous dorsal fin has 4 or 5 weak spines which are not connected by membrane PILOT-FISHES (p. 124).

UU. The soft dorsal and the anal fins are nearly equal in size; the spinous dorsal fin has 7 small spines, which are not connected by membrane
LEER-FISH (p. 127).

qq. There are no teeth on the roof of the mouth; the spinous part of the dorsal fin is shorter than the soft, and is composed of rather weak spines
CROAKERS or RONCADORS (p. 129).

pp. There is a single, undivided dorsal fin, extending from the head to the tail, without any true spines; the head is high, with a nearly vertical cutting edge in front DOLPHINS (p. 127).

kk. There are always 2 or more detached finlets behind the dorsal and anal fins.

w. The caudal fin is moderately forked, the lobes not being acutely pointed; the peduncle of the tail is not very slender and is without keels.

x. The skin is covered with sharp, forked prickles; the belly is keeled; the spinous dorsal fin has from 13 to 15 spines; the soft dorsal and anal fins are followed by 2 finlets
ESCOLARS or OIL-FISHES (p. 135).

xx. The skin is without prickles; the belly is not keeled; the spinous dorsal fin has 20 spines; the soft dorsal and anal fins are followed by 6 finlets . . SNOEK (p. 136).

ww. The caudal fin is widely forked, the lobes being acutely pointed; the peduncle of the tail is slender and is keeled on each side.

y. The spinous dorsal fin has from 10 to 16 spines; the teeth have smooth edges.

z. The body is oblong and robust; the scales in the "shoulder" region form a corselet; the teeth are not or scarcely flattened.

a. The soft dorsal and anal fins form pointed lobes of moderate height.

b. The pectoral fins are of moderate length, and do not extend as far as the beginning of the anal fin
TUNNIES (p. 142).

bb. The pectoral fins are long, and extend beyond the level of the beginning of the anal fin
ALBACORES (p. 148).

aa. The soft dorsal and anal fins form high, pointed, sickle-shaped lobes (at least in the adult); the pectoral fins extend to or nearly to the level of the beginning of the anal fin
YELLOW-FINNED ALBACORES (p. 151).

ZZ. The body is long and not very robust; there is no distinct corselet in the "shoulder" region; the teeth are more or less flattened
SPANISH MACKERELS or KING-FISHES (p. 153).

YY. The spinous dorsal fin has about 25 spines; the teeth have fine, saw-like edges . . PETO (p. 154).

II. The spinous dorsal fin is transformed into an adhesive disc, and is placed on the flat upper surface of the head . REMORAS or SUCKING-FISHES (p. 173).

HH. Both eyes are placed together on the same side of the head; the body is flattened from side to side; the eyed side is coloured and the blind side is white . . . HALIBUTS (p. 178).

GG. The snout and jaws are drawn out to form a pointed "spear".

c. The dorsal fin is rather low, and in adults consists of a distinct lobe in front, which is well separated from the hinder portion
SPEAR-FISHES or MARLINS (p. 157).

cc. The dorsal fin is high, undivided and sail-like
SAIL-FISHES (p. 161).

AA. There are no pelvic fins.

d. The snout and upper jaw are drawn out to form a long, flat, pointed "sword"
SWORD-FISH or BROADBILL (p. 165).

dd. The snout is not drawn out to form a "sword".

e. The body is long and eel-shaped; the mouth is wide; the dorsal and anal fins are very long and low.

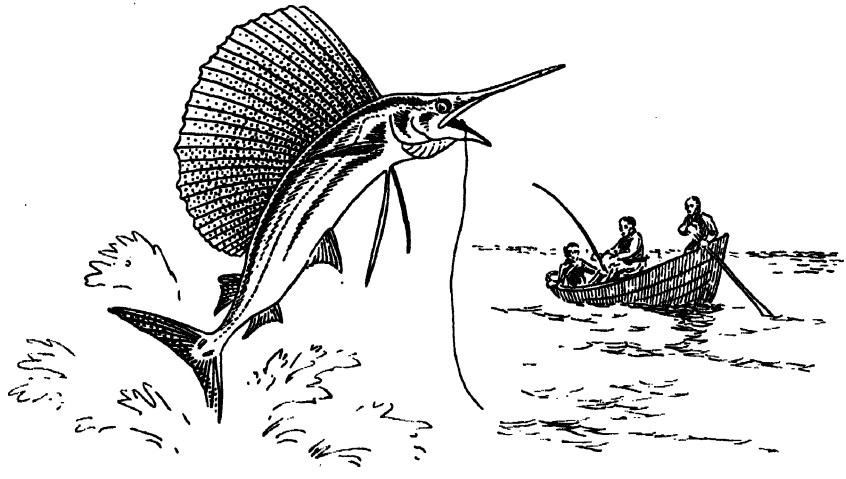
f. The pectoral fins are present; the gill-openings are rather large . . . CONGER EELS (p. 97),

ff. There are no pectoral fins; the gill-openings are small and rounded

MORAYS or PAINTED EELS (p. 100).

ee. The body is deep, plump, and oval in shape; the mouth is small; the dorsal and anal fins are short and high, and are joined at the hinder end of the body by an abbreviated tail-fin

SUN-FISHES or HEAD-FISHES (p. 183).



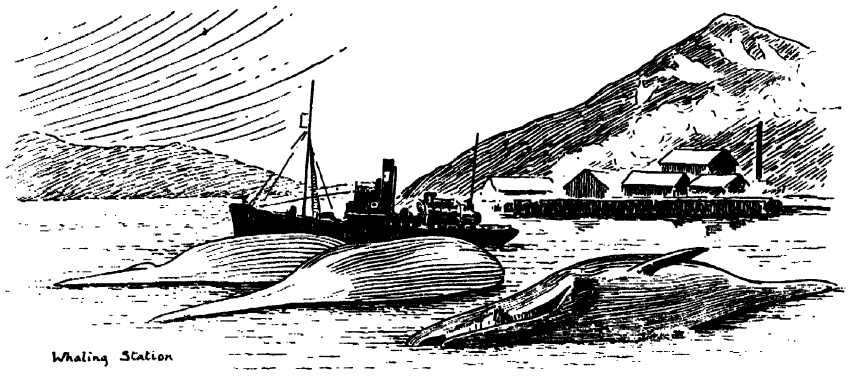
SAIL-FISHING

Part II

WHALES AND DOLPHINS

BY

F. C. Fraser, B.Sc., F.Z.S.



CHAPTER IX: RIGHT WHALES.

Whalebone Whales. Greenland Right Whale. Black Right Whales. Pigmy Right Whale.

THE features distinguishing whales from other aquatic mammals and from fishes have been discussed in the Introduction to this book, so that we can begin here with a description of the first of the two great divisions of the Order Cetacea. The separation into two sub-orders is really a very simple one, the one group of whales having whalebone or baleen in their mouths—the Mystacoceti—and the other group without whalebone but having teeth instead—the Odontoceti. It is true that in the course of development vestiges of teeth are found in the gums of the whalebone whales, but they are merely relics which never function nor indeed appear through the gums.

The first group, the Whalebone Whales, is characterized as we have just said by the presence of whalebone in the mouth. This is not bone in the accepted sense of the word, but a horny substance, glossy in appearance, hard to the touch and of varying flexibility in the different species encountered. The arrangement of whalebone in the mouth is admirably fitted for the straining function it performs. A series of plates of whalebone, placed one behind the other, is suspended

from either side of the palate and hangs down into the cavity of the mouth. Upwards of 300 plates usually make up one " side ". The plates are inserted in the palate at right angles to the long axis of the head, and a space of about a quarter of an inch separates one plate from the next. The plate itself is normally about a third of an inch thick and is roughly triangular in outline. Of the three margins much the shortest is that attached to the palate, and of the remaining two one is smooth and the other, that on the inner side, is frayed out, so that with the adjoining plates it combines to make an efficient sieve for straining water containing food organisms.

Apart from the possession of baleen, their enormous size is a feature which distinguishes the Whalebone Whales from other Cetacea: only the Sperm among the Toothed Whales can compare with them in this respect. Another distinctive feature is the paired blowhole, formed by the nostrils opening to the exterior by two distinct longitudinal slits. The group includes the great Blue Whale, which may grow to a length of nearly 100 feet, and even *Neobalaena*, the pigmy of this sub-order, may be up to 20 feet in length. All the remaining species are at least 30 feet long when fully grown.

RIGHT WHALES.

Family Balænidæ.

The Right Whales receive their popular name from the fact that at the time when they were hunted to the exclusion of all other kinds they were the " right " whales to be pursued. They are distinguished from the next family by the absence of grooving or furrows externally on the throat, by the absence of a dorsal fin (except in the little *Neobalaena*), by the presence of very long, narrow, flexible whalebone blades, by the great development of the lower lips, which project upwards on either side and have the strongly arched narrowed upper jaws lying between them when the mouth is closed. A variety of internal characteristics also distinguishes this family, but the only one that needs to be mentioned here is that the 7 neck vertebræ are fused into a single unit.

Genus *Balæna.*

THE GREENLAND RIGHT WHALE (*Balæna mysticetus*).

Fig. 60.

The most valuable and accurate description of the Greenland Right Whale is that contained in William Scoresby's 'Account of the Arctic Regions', published in 1820. We are indebted to this authority more than to any other for the knowledge we have of this now very rare whale. The description which follows is derived almost entirely from Scoresby's work.

The body has its greatest circumference just behind the fins, from whence it gradually tapers in a conical form towards the tail. "It is cylindrical to within 10 feet of the tail, beyond which it becomes quadrangular, the greatest ridge being upwards or on the back and running backwards nearly across the middle of the tail." "The head is somewhat triangular in shape; the under part, the arched outline of which is given by the jaw bone, is flat, and measures 16 to 20 feet in length and 10 to 12 feet in breadth. The lips extend 15 or 20 feet in length and 5 or 6 feet in height, and form the cavity of the mouth, are attached to the under jaw and rise from the jaw bone at an angle of about 80°, having the appearance, when viewed in front, of the letter U". The greatly narrowed upper jaw is bent down at its free end to fit into the space between the lower lips. The flippers are large and broad, and differ markedly from the tapering form found in the Rorquals. The tail flukes, according to Scoresby, measure 18 to 24 or 26 feet from tip to tip, and are 5 to 6 feet in length. The blowhole, situated on the most elevated part of the head, is about 16 feet behind the anterior extremity of the jaw. It consists of two longitudinal apertures 6 to 8 inches in length. The whalebone in this species has an average length of 10 to 11 feet, and each "side" of whalebone consists of more than 300 plates. The whalebone is longest nearest the middle of the "side" and diminishes in size towards either end. The greatest width of the whalebone, which is at the gum, is 10 or 12 inches. Scoresby mentions blades 15 feet long, but says that even 13 feet is "a magnitude seldom met with".

He states in his description that a slight beard, consisting of a few short scattered white hairs, surmounts the anterior extremity of both jaws.

The colours of the Greenland Right Whale are velvet black, grey and white, with a tinge of yellow. Black is the predominating colour, but a white area which covers the chin and front portion of the lower jaw is characteristic of the species. "Sometimes," says Scoresby, "a little of the upper jaw at the extremity and a portion of the baleen are white. The eyelids, the junction of the tail with the body, a portion of the axillæ of the fins (*i. e.* the flippers), etc., are grey. I have seen whales that were all over piebald. The older animals contain the most grey and white, under-sized whales are altogether of a bluish black and "suckers" of a pale bluish or bluish grey colour."

It is greatly to Scoresby's credit that, unlike so many who have described these great marine mammals, he does not endeavour to magnify the size of the whales he describes. He discounts records of Greenland Right Whales 100 feet in length, and states that of 322 individuals in the capture of which he was personally concerned, none exceeded 60 feet in length, and the largest he ever measured was 58 feet from one extremity to the other. He mentions one caught near Spitzbergen which measured as much as 70 feet, but 60 feet may be regarded as the general limit of size in this species. It is interesting to note that of this great length the head alone accounts for about one-third.

The Greenland Right Whale is, as its name implies, a northern form, of which the distribution is, or perhaps more correctly was—for it is scarce to the point of extinction in these days—entirely restricted to the more polar parts of the Arctic Ocean. It has been pursued commonly in the past in the neighbourhood of Spitzbergen, Jan Meyen, the east and west coast of Greenland, Davis Strait, Baffin Bay and in the Bering Sea.

This whale, in common with all those that bear whalebone, is dependent for its food supply on the small organisms, chiefly shrimp-like animals, that abound in the open sea. In feeding, the whale takes into its mouth the sea water containing the food organisms, drains the water through the matted

inner surface of the baleen blades back to the sea again and leaves a deposit of food within the mouth. It can be imagined that many millions of "shrimps" are consumed by a single whale, but such is the prodigality of the provision that great numbers of the largest existing animals are sustained by feeding in this way. The whales of the family we are now dealing with are the most specialized for feeding on "plankton"—the name given to the small current-born animals just mentioned. In the Right Whale the head is very large in comparison with the rest of the body, the cavity of the mouth is enormous, and the area of the sieve formed by the baleen much greater than in the related Rorquals. The lower jaws, too, are well adapted; U-shaped in front and raised high on either side, they form an efficient scoop for gathering large quantities of food into the mouth.

Although it is probable that the Greenland Right Whale may undertake small changes of location, it never migrates, either for feeding or breeding, far from the ice-covered regions of the Arctic.

Scoresby states that pairing in this species is often observed about the latter end of the summer, and females with "suckers" or calves along with them are most commonly met with in the spring of the year. "The time of their bringing forth, it is presumed, is in February or March, and their period of gestation is nine or ten months." The usual number of young at a birth is one, but occasionally two calves have been seen along with the parent animal. The maternal affection of this whale is commented on by Scoresby, but while he points out that it would do honour to the superior intelligence of human beings, he does not allow this parental regard to influence him to the extent of abandoning the pursuit of the animals: "The object of the adventure, the value of the prize, the joy of the capture, cannot be sacrificed to feelings of compassion."

The phase of commercial whaling involving the pursuit of the Greenland Right Whale originated from an extension northwards of the search for the Biscayan Right Whale. This latter, about which we shall have more to say later, had been known and hunted for hundreds of years with a gradual widening of the field of operation of the whaling fleets, until about the beginning of the seventeenth century the whaling

ships, pushing far northwards into the Arctic seas, found an abundance of the more valuable Greenland Right Whale in the bays of Spitzbergen.

It should be emphasized that prior to the middle of the nineteenth century the operation of the whale fishery was quite unlike that carried on at the present time. Nowadays highly-powered steam vessels, upwards of 120 feet in length, equipped with harpoon guns and capable of a speed of 12 to 15 knots, can pursue the greatest whales with the minumum of risk to the chaser's crew either from the elements or from the animal they are hunting. Whether the whale floats or sinks when slain is not important to the modern whaler; the carcase of the harpooned animal is heaved alongside the whale-catcher by means of a powerful winch, a hollow tube is forced into the body-cavity and air is pumped in to give the carcase sufficient buoyancy to float.

In the old days whaling was a much more primitive and adventurous undertaking. The animals had to be hunted in small rowing-boats; hand harpoons and lances were used, so that the harpooners had to get close up to the whales in order to use their weapons effectively. Thus the speed of the animal when alive and the buoyancy of its carcase when it was killed were factors which limited the whale fishers in their choice of quarry until the introduction of modern inventions.

The Greenland Right Whale was admirable for this earlier type of hunting. Scoresby says of it that " being less active, slower in its motion and more timid than any other of the kind of similar or nearly similar magnitude, it is more easily captured ". It shares, with the other species of *Balæna*, the property of being slightly lighter than the water in which it swims. In addition, however, to the favourable qualities just mentioned, the Greenland Right Whale was sought out because of its exceeding richness. Sir Sidney Harmer in his ' History of Whaling ' says that at one time whalebone sold for as much as £2250 a ton, and that a large individual might produce a ton and a half of this material; thus, together with the oil, of which 30 tons might be obtained from one animal, it was possible for the total expenses of an expedition's ship to be defrayed out of the proceeds of a single whale. Scoresby's maximum figure for whalebone was £700 a ton, and he

calculated that at least £100,000 a year was paid to the Dutch for whalebone between 1715 and 1721, when the price was £400. One of the principal uses of whalebone seems to have been in the construction of ladies' corsets, but it was also used in the manufacture of umbrellas and parasols, in the construction of chairs and sofas, in the making of portmanteaux and travelling trunks, and of such particles as ramrods, fishing rods, springs for carriages and similar articles where it was necessary to have strength combined with a considerable degree of elasticity.

The oil extracted from the whale was used in a variety of ways. In Scoresby's time, for instance, it was largely used in lighting streets and dwelling houses, and was employed in the manufacture of soft soap, in the preparation of leather and in the construction of coarse woollen cloth. Other uses were in connection with the mixing of paint, as a lubricant and in the manufacture of rope. Just when Scoresby was writing his 'Account of the Arctic Regions', the consumption of whale oil was being considerably diminished by the introduction of coal gas as an illuminant. He devotes several pages of his work to the advocacy of oil gas, meaning of course whale oil, as opposed to coal gas. "Whale oil of the most inferior qualities is found to afford a gas which in point of brilliancy, freeness from smell, ease of manufacture, etc., is found to be greatly superior to that produced from coal." Whether by improvement in the quality of coal gas or because of the inadequacy of the supply of whale oil to meet an ever-increasing demand for the newer method of lighting, Scoresby's plea for the use of oil in this way was not fruitful, and although at the present time new methods of exploiting the supply have been evolved, its utilization as an illuminant is not one of them.

In his 'History of Whaling' Sir Sidney Harmer divides the Greenland Whale fishery into three phases, separated from one another both as regards time and area of operation. The first of these, commencing about 1611, involved Spitzbergen, Jan Meyen and the east coast of Greenland; the next, from 1719, was in Baffin's Bay and neighbouring waters; and the last, from 1843, in the Bering Strait and Okhotsk Sea.

When the whalers first visited Spitzbergen the Greenland Whale was found in immense numbers throughout the whole extent of the coast. The animals frequented the many bays and inlets and, being unused to human intrusion of any sort, were at first unafraid and were caught in large numbers with comparative ease. The whaling ships remained at anchor throughout the period of the whaling season. The blubber was not boiled on the whaling ships themselves, but plant was erected on shore for the purpose. This favourable state of affairs did not last long, however, and the retreat of the whales from the bays began. According to Scoresby, the whales seem to have become scarce in the bays about the years 1630 to 1640, but they could still occasionally be found in plenty in particular places along the coast. As long as the whales were taken conveniently close to the bays where the factories had been erected, the carcases were towed to them and cut up on shore, but in time this, too, became impracticable, the ships had to go to where the whales were being found, and either had to extract the oil at sea, or else to carry back the blubber in casks to the home port at the end of the whaling voyage. The progress of the whales away from Spitzbergen continued, and they were followed by the whalers to the ice-edge, where they had gone for shelter. Ships were specially strengthened for operating in the ice, and a modified technique evolved for the capture of the whales to cope with the new conditions encountered. The whales finally disappeared from Spitzbergen about 1720.

In the year 1719 the Davis Strait fishery was first attempted by the Dutch. The area in which it was pursued was in that region bounded on the east by the west coast of Greenland and on the west by the east coast of Canada. The ships penetrated northward into Baffin Bay, and Lancaster Sound and Smith Sound were visited. For some time the fishery was carried on with great success, but, as in Spitzbergen, here also it began to decline. It became unimportant about the middle of the nineteenth century, and faded out altogether in the second decade of the present one. The final reports make sad reading; Harmer says: "Only one ship left Dundee in 1912 and 1913 and . . . the total catch in each of those years was returned as O." So ended a fishery which at

one time used to send two to three hundred ships a year northwards from British ports alone.

The Bering Strait and Okhotsk Sea phase of the fishery had commenced before the middle of the nineteenth century. It was essentially an American enterprise and the whales, although known to their pursuers as Bowheads, are not regarded as being in any way specifically different from the Greenland Right Whale. The story of this fishery is similar to that of the other two just described. It commenced with the discovery of the fishing ground; it was carried on for some time with great profit to the whalers; this was followed by a period during which whales were caught in greatly diminished numbers, and finally the fishery became completely unprofitable and had to be abandoned. The beginning of the present century saw the extermination of the Bowhead in this last retreat to be discovered.

In Scoresby's time the Greenland Whale was so common that it was referred to simply as " The Whale " or " The Common Whale ", but between that time and the present it has been so harried in every part of the Arctic it frequented that now it must be classed as one of the rarest of whales that exist in the sea.

THE BLACK RIGHT WHALES (*Balæna glacialis*, *Balæna australis*, etc.) Fig. 61.

The inclusive name of Black Right Whale is used here for the sake of convenience to group together a number of forms of Right Whale whose chief claim to differentiation into species appears to be that they occur in different geographical areas. Thus in the past there have been identified *B. glacialis* or *biscayensis* from the North Atlantic, *B. australis* from the South Atlantic, *B. antipodarum* from the South Pacific, *B. japonica* from the North Pacific and many others besides. It is preferable for our present purpose at all events to regard these, not as so many distinct species, but rather as local races of one species which is widely distributed.

In the north the Black Right Whale is commonly referred to as the Biscayan or North Atlantic Right Whale by British people, and as the Nordkaper by the Dutch; the old French

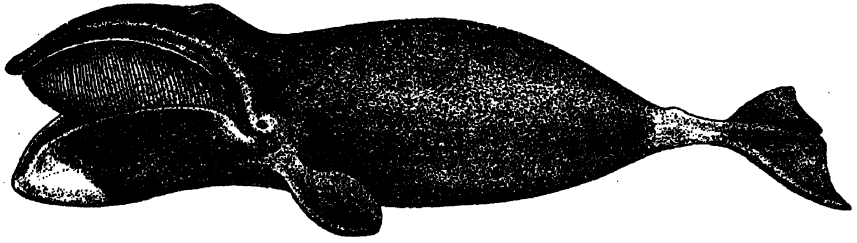


FIG. 60.—Greenland Right Whale (*Balæna mysticetus*). To 60 feet.

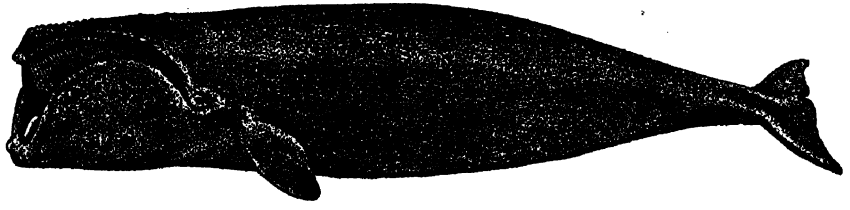


FIG. 61.—Black Right Whale (*Balæna glacialis*). To 60 feet.

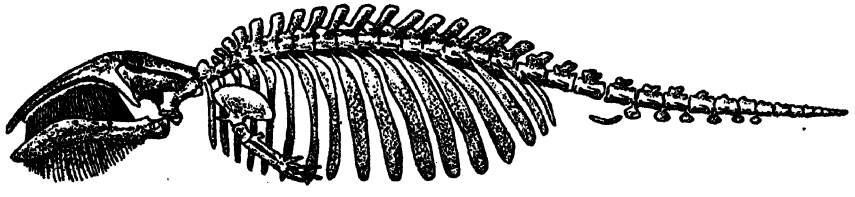


FIG. 62.—Skeleton of Pigmy Right Whale (*Neobalæna marginata*). To 20 feet.

whalers called it the Sarde, and in Icelandic the Sletbag was the name given to it.

The features distinguishing the Black Right Whale from the Greenland Right are not very conspicuous ones. The general external appearance is the same in both species, and it is only in detail that any difference can be detected. The colour, of course, is usually indicative, and the absence of a white patch on the anterior end of the lower jaw means that the animal is other than a Greenland Right Whale. But although the other species is generally black all over, patches of white may occasionally be distributed quite irregularly on the under surface of the body. White spots, too, are sometimes found, due to the alteration of the skin produced by parasites.

The head of the Black Right Whale is shorter than that of the Greenland Right, being only about one-quarter of the body-length as compared with one-third in the latter species. The arching of the upper jaw, or crown, is not so pronounced as in the Greenland Whale, so that when viewed laterally the outline of the head passes evenly backwards into that of the body. The outline of the lower jaw is somewhat different from that of the Greenland Whale. The whalebone, although still much longer than in any of the Rorquals, is on the average a foot or two shorter in the Black Right Whale than in the Greenland Right.

There is commonly developed on the front portion of the upper jaw a horny excrescence known as "the bonnet". It is irregular in shape and infested by parasitic worms and crustaceans; its length is about 11 inches and its width 8 inches. The function of this protuberance, which has been compared to the horn of the rhinoceros, is unknown. Beddard, in his 'Book of Whales', says that it "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 to get rid of the barnacles which are apt to infest it". The presence of parasitic barnacles is in itself almost a diagnostic feature of the species, for they are never known to occur in the Greenland Right Whale.

In the absence of dorsal fin and of grooving on the throat

the two species of *Balæna* agree with each other, and there is also a close similarity in the appearance of the flippers and tail flukes.

Whales of the species we are now describing may reach a length of nearly 60 feet. The largest of 67 Atlantic Right Whales landed at the Scottish whaling stations between 1908 and 1914 was recorded as 59 feet long.

The different varieties are, as already mentioned, very widely distributed throughout the oceans, both in the north and south, but apparently never in tropical seas. Thus, the Biscayan Right Whale has been recorded, in addition to the locality which gives it its name, from places as far distant from each other as Newfoundland and Norway, the northern limit of its occurrence being roughly the southern limit of the distribution of the Greenland Right Whale in Arctic seas. The southern form frequented the coasts of South Africa, Australia, New Zealand, South Georgia, and was also very abundant at one period in the Indian Ocean. In the Pacific many Southern Right Whales were captured off Chile, and a few stragglers off the coast of California. In the north of the Pacific the Right Whale had an area of distribution extending, on the west coast of America from Vancouver Island to the Aleutian Islands, and on the west side of the Pacific it was plentiful off Kamchatka and in the Okhotsk Sea.

It will be noted that, in the foregoing description of distribution, the past rather than the present tense predominates; this is because although at one time the whales were abundant in the areas mentioned, it is not so now. In the history of the Black Right Whale fishery the sequence of events described for the Greenland Whale fishery is repeated again and again; it is a story of abundance at first followed by decimation and disappearance of the stock later, with the result that the fishery was no longer profitable.

The fisher folk inhabiting the shores of the Bay of Biscay were the first to practise the pursuit of the great whales in a systematic manner. From the earliest times the Biscayan Right Whale frequented the coast of the Basque provinces and, according to Sir Clements Markham, who has written of this fishery, in the twelfth century the trade was well established. Six towns along the coast have the whale

included in their coats of arms, and old documents and place-names testify to the importance of whaling to these people. Some of the names used in connection with whaling, even at the present time, can be traced back to this Basque fishery, and the commonest one of all, "harpoon", we are told, is derived from the Basque "arpoi", of which the root is "ar", meaning to take quickly.

When compared with the scale of modern whaling the Basque fishery was a small and insignificant one. Sir Sidney Harmer has calculated from Markham's records that the total catch of twenty villages for the hundred years commencing 1517 was somewhere in the neighbourhood of 700 to 1000—a contrast to the annual slaughter of about 30,000 Blue and Fin Whales at the present time. Yet even the modest proportions of the Basque fishery were harmful to the stock. The whales, which habitually visited inshore waters in that region in the winter and early spring months, ceased to do so, and, about the middle of the seventeenth century, they became so scarce that long voyages had to be undertaken in their pursuit. Even in the sixteenth century the Basque whaling ships had reached Newfoundland and, in the first English voyage to Spitzbergen early in the seventeenth century, it is interesting to note that Basque whaling men were employed; for at that time, according to Sir Clements Markham, they had monopolized all the experience and skill which then existed in connection with the craft and mystery of whale fishing.

Other foci of the North Atlantic Right Whale fishery were on the New England coast, off Iceland and to the north of Norway. Each had a more or less prolonged period of abundance, and each in turn had to be abandoned because of the ultimate insufficiency of the catch, until at last there came a time when it was believed that the North Atlantic Right Whale was extinct. It began to appear, however, it is true in very small numbers, in the second half of the nineteenth century, and small catches were made from some of those areas where it had once been so plentiful.

In the southern hemisphere the southern variety of Black Right Whale was very abundant 150 years ago. The whalers in search of Sperm Whales, seeing this other species, recognized that here was a fruitful source of supply of oil. Soon every

region where the whale was to be found was ruthlessly exploited and a terrible destruction occurred, particularly, it is said, of females and their calves that were in the habit of frequenting inshore waters. Here again both in the South Atlantic and in the Pacific the pursuit was too vigorous for the maintenance of the stock, and the industry, so far as Southern Right Whales were concerned, became so unproductive that it could no longer continue. At the present time the Southern Right Whale does not appear at all in the catches of modern whaling expeditions to the south. During the 1934–35 whaling season, of 39,254 whales caught throughout the world four only were Right Whales, two of which were taken in Alaska and two on the coast of Natal.

In the North Pacific the variety of Black Right Whale known as *B. sieboldii* was hunted by the American whalers from the coast of Oregon to the Aleutian Islands and, according to Bolau, 300 to 400 whaling ships engaged in the pursuit of this animal were to be found on the Kodiac Ground, extending from Vancouver Island to the Aleutian Islands, from April to December in 1846–1851. But here again the area was over-fished, and the capture just mentioned of only two Pacific Right Whales from this region during the last whaling year for which data are available gives adequate evidence of the manner in which the hunting of this species has declined.

No specimens of North Atlantic Right Whales have appeared in the records, instituted by the British Museum (Natural History) twenty-five years ago, of whales and dolphins stranded on the British coast, although, as already mentioned, this species was represented in the catches of the Scottish and Irish whaling stations operating during the earlier part of this period. There are a few early records, however, of stranded specimens, some questionably belonging to this species, but one at least, concerning which an additional description was produced a year or two ago, leaves no doubt that it was a North Atlantic Right Whale. In the zoological notes from the voyage of Peter Mundy (1655–56) the author in his diary gives a description of this whale, stranded at Greenwich on June 3rd, 1658. John Evelyn, in his diary, also mentions the same animal. Mundy gives a full and very accurate account of the whale, illustrated by drawings of its external form and of the way it feeds.

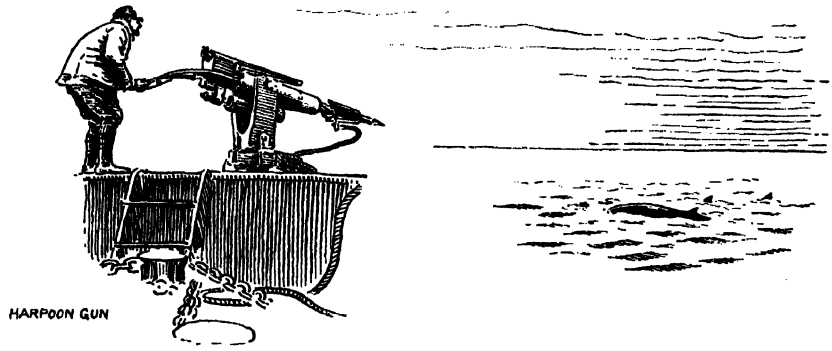
Genus *Neobalæna*.

THE PIGMY RIGHT WHALE (*Neobalæna marginata*).

Fig. 62.

Neobalæna is in many ways nearly connected with the larger Right Whales, with which it agrees in the fusion of the 7 neck vertebræ, in the absence of pleats or grooving on the throat, and in the possession of long, slender, flexible whalebone. As its name implies, however, it is characterized by its diminutive size compared with its closest relatives. When fully grown it attains a length of only about 20 feet, and further differs from the other Right Whales in the possession of a small recurved fin on the back. Little is known concerning its external appearance, but the colour of a female specimen from Stewart Island, New Zealand, was described as "black with a light stripe on the belly". The colour of the baleen of this specimen was yellowish-white with a dark margin, and 230 plates of this whalebone composed a "side". Lydekker, in his description of the whalebone of this species, says that it is more flexible, more elastic and tougher than that of any other; and that if it could be obtained in any quantity it would fetch a higher price in the market than that of the Greenland Whale. The flipper of *Neobalæna* is small and narrow, and has only 4 digits developed within it. The head is about one-quarter of the total length of the animal. It is not within the scope of this book to deal exhaustively with internal body structure, but the peculiar ribs of the Pigmy Right Whale are certainly worthy of notice. It has a greater number than any other whale, and they extend tailwards further than in any related species, so that only two vertebræ intervene between those that bear ribs and those composing the tail. The individual ribs become increasingly broadened and flattened towards the tail, so that in the living animal they must provide an almost continuous protection for the underlying viscera.

The distribution of the Pigmy Right Whale is confined to southern seas; it is known from New Zealand, Australia and South America. It is by no means a commonly-occurring species, and little or nothing is known of its habits. It has no economic importance.



HARPOON GUN

CHAPTER X: RORQUALS OR FIN WHALES.

Characters of Rorquals. Blue Whale or Sibbald's Rorqual. Finner Whale or Common Rorqual. Sei Whale or Rudolphi's Rorqual. Piked Whale or Lesser Rorqual. Bryde's Whale. The Rorqual Fishery.

Family BALÆNOPTERIDÆ.

THE group of whales known as Rorquals or Fin Whales is an interesting one, not only because of its commercial importance at the present time, but also on account of the colossal size attained by certain of the species. The most obvious distinction between the Rorquals and the Right Whales discussed in the previous chapter is that the former have a triangular fin on the back towards the tail, and are furnished with a series of parallel grooves running longitudinally on the under surface of the throat and chest region. The name Rorqual, it is said, means "the whale having folds or pleats". Many other characters separate the two groups, of which the most noteworthy are (1) the much shorter, coarser and less flexible whalebone in the Rorquals, (2) the more flattened and shortened head, and (3) the possession of flippers which are long and tapering, not bluntly rounded as in the Right Whales. An internal feature which distinguishes the Rorquals is the unfused condition of the 7 neck vertebræ; it will be remembered that in *Balæna* these were welded together into a single compact unit.

There are four well-established species of Rorqual: the Blue

Whale or Sibbald's Rorqual; the Finner Whale, Razorback or Common Rorqual; the Sei Whale or Rudolphi's Rorqual; and the Lesser Rorqual or Little Piked Whale. A fifth species, closely allied to the Sei Whale, Bryde's Whale, should perhaps be added to the list. Quite a number of other Rorquals have been recognized at one time or another, some on the slenderest of evidence. A single bone, a difference of locality, a difference in colour due to the presence of a film of microscopic unicellular plants, called diatoms, on the skin, have all been made sufficient reason for the creation of separate species, but with the exception of Bryde's Whale, restricted to the South African coast, all the species of the group are world-wide in their range. It is fairly safe to say that there is no specific difference between the Blue Whale found in the North Atlantic and that frequenting the African coast or the seas surrounding the Antarctic, and the same applies to the other members of the group.

Genus *Balænoptera*.

THE BLUE WHALE OR SIBBALD'S RORQUAL (*Balænoptera musculus*). Plate VI A.

The Blue Whale is the largest of all living animals, although in its natural element it does not give one the impression of ungainly bulk or superfluous size. It is only when it is dead and hauled on to dry land that any proper conception of its immensity can be obtained. The general proportions of this species and, indeed, of all the Rorquals are much finer than those of the Right Whales. The girth is much smaller compared with the total length, and the whole outward appearance of the animal suggests a greater capacity for speed of swimming. The head is less than a quarter of the total body-length, and while still of considerable magnitude, its bulk is a much lesser proportion of the whole body than it is in the Right Whales. The foremost part of the head is not narrowed and arched, but forms a more or less flattened beak-like extension of the skull with nearly parallel sides to within a short distance of the tip, where the lateral margins bend round to meet each other. When the mouth is closed this rostrum or beak fits in between the two lower jaws; the great

fleshy development of the lower lips found in *Balæna*, and associated in that whale with the much longer baleen plates and arched fore part of the skull, are not found in the Blue Whale. The baleen in the Blue Whale is jet black, and the hairy fringes are the same colour.

Hairs are to be found on the tip of the lower jaw, along the side of each jaw and on the surface of the rostrum, but this typical mammalian covering is here reduced as in other whales, almost to disappearing point. The "beard" consists of 20 to 40 hairs, the number on jaws and rostrum being anything between 2 and 20 on each side.

The colour of this species is conveyed by its name; it is a dark slate blue over the whole of the body with the exception of the tip and under surface of the flippers, where pigmentation is absent. The actual shade of blue may vary quite considerably in different individuals, and may be modified by a pale mottling which is sometimes diffused and sometimes concentrated in coalesced patches in different regions of the body.

The dorsal fin is particularly low and small and placed far back on the body; the flippers are long and tapering, measuring about one-seventh of the total body-length, and have a convex lower border. The ventral grooves on the throat and chest region vary in number, but 80 to 100 are generally present.

The fully-grown Blue Whale may reach a length of 100 feet, and records of specimens over 90 feet long are quite common. At birth this animal is over 24 feet in length—an astonishing size when we consider that only about a year is required for this growth and development to be accomplished. Two Blue Whales weighed piece by piece at a South Georgia whaling station gave the following results: the one, 89 feet long, weighed over 119 tons; the other, 66 feet long, 51 tons. These figures approximate very roughly to the weight estimations of Blue and Fin Whales made by the whalers, allowing a ton for each foot of length.

It has already been stated that the distribution of the Blue Whale is world wide; it has been the object of commercial pursuit almost since the inception of modern whaling in the middle of last century. In the last period for which figures are available, the southern summer season, 1934-35, and the

northern summer of 1935, this species has been taken by whaling enterprises in the Faroe Islands, Iceland, Alaska, Kamchatka, 'Japan, Mexico, Chile, California and South Africa; but during that time nearly 94 per cent. of a total world catch of nearly 17,000 came from the Antarctic alone.

The Blue Whale feeds almost exclusively on shrimp-like animals called Euphausians or, by the whalers, Krill. One kind of Krill is found in northern waters and another, a southern form, in the Antarctic. Southern Krill occurs in immense shoals in the seas surrounding the Antarctic continent, and it is no uncommon sight to see whales and large perch-like fish devouring the Krill from below the surface of the water, and hosts of sea-birds—Giant Petrels, Cape Pigeons and Whale-birds—swooping down from above. This shrimp is a key organism in the economy of Antarctic life, for not only does it provide food for whales, fishes and the birds mentioned, but certain species of penguin and at least one species of seal are entirely dependent on its abundance.

The device for straining the food-charged water is the same in the Blue as in the Right Whale, but whereas the lower jaws of the latter animal are used as a kind of scoop to collect plankton, in the Blue Whale and other Rorquals the external grooving of the throat probably allows distension of that region so that water flows into the mouth and into the cavity formed by the distension. Subsequent contraction of the muscles expels the water through the whalebone plates, leaving the food deposited on the matted fringes.

The Blue Whale migrates annually in a general northerly and southerly direction, but these movements tend at times to be obscured by subsidiary migrations resulting from variations in local conditions. Nevertheless, as Mackintosh and Wheeler say in their 'Southern Blue and Fin Whales', "it may be mentioned here that there is a general movement northwards into warmer waters for breeding during the southern winter and southwards for feeding during the southern summer". Subtropical waters contain very little whale food, but, as we have already mentioned, Krill is abundant in the Antarctic seas, and thither the whales go to consume it. Most of the whales taken in low latitudes are thin and ill-fed, whereas those that have been in the Antarctic for some time

are fat and well-nourished, with stomachs usually filled with Krill.

The breeding season is a protracted one, but pairing is commonest in these southern whales in the months of June and July, during the southern winter when the animals are in the warm water. The period of gestation is about a year, and the calf is suckled for 6 or 7 months after birth. Growth is very rapid, and sexual maturity is usually reached in 2 years, when the animals are from 74 to 77 feet in length. Only one calf is normally produced at a birth; twins are infrequent, but not unknown. Not less than 2 years elapse between successive pregnancies—that is to say, pairing does not take place during the suckling period. The almost equal proportion of males and females in recorded catches indicates that the Blue Whale is monogamous. The slow rate of propagation is important economically; the protracted breeding season and rapid growth to maturity help greatly in the replacement of the stock, but are counterbalanced by this other factor.

Female animals are, on the average, a foot or two more in length than males of the same age, but otherwise there is no essential difference in general body form in the two sexes. It is believed that the Blue Whale is physically mature and fully grown when it is 12 to 14 years old, and although no accurate knowledge is available of the age to which they live, it is considered probable that a Blue Whale over 50 years old has exceeded the normal span of life for this species.

External parasites are rare, and those found are believed to be collected when the animals are in warm water. A species of barnacle and another parasitic crustacean called *Penella* are the most common, and the whales seem able to throw them off when they migrate into colder water again. The film of diatoms sometimes found on the skin of Blue Whales is an exception to the more general warm-water infestation, for it is those whales which have been long in cold water which get covered with the microscopic unicellular organisms. This film is sometimes so extensive that the normal colouring is overlaid by that of the diatoms, and it was their yellow colour that gave rise to the name "Sulphur-bottom", and to the belief that this was a separate species.

A mysterious pitting of the skin occurs on the flanks and

tail of all Blue and Fin Whales. The pits are about 3 inches long, 2 inches wide, and an inch or so deep and are sunk in the blubber; they commonly appear as open sores in whales taken in warm water, whereas in those caught in cold water only the healed scars can be detected. The exact origin of the wounds is not certainly known; lamprey-like fish, the parasitic crustacea already mentioned, and micro-organisms have been suggested as the cause, but as a source of the damage none of these seems to be entirely convincing.

The Blue Whale, for all its great size, is not by any means an aggressive animal; indeed, if anything, it is of a timid disposition. Bennett, describing the hunting of this species in 'Whaling in the Antarctic', says: "It has always to be remembered that quite small noises scare them. A man shouting while the whale is on the surface with its nostrils open is enough to cause it to bolt. When this happens it is seldom worth while to give chase, for no boat has the slightest chance of overtaking a thoroughly scared whale, which can move at such a pace that it is out of sight in a few minutes."

The economic importance of this species will be dealt with, along with that of the other Rorquals, later in this chapter.

THE FINNER WHALE OR COMMON RORQUAL (*Balænoptera physalus*). Fig. 63.

The Common Rorqual has been referred to as the greyhound of the ocean because of its slender build and great speed of swimming. It is smaller than the Blue Whale, and while it retains, of course, the external features common to all Rorquals, it is distinguished by several well-defined characters. The fore part of the head, when viewed from above, is wedge-shaped, not having the sides nearly parallel. Towards the tail the back is distinctly and acutely ridged, and for this reason the name "Razorback" has aptly been applied. The dorsal fin is quite high and triangular, usually with a concave posterior border, and the flippers are small, measuring about one-ninth of the total length.

The body colour, especially its asymmetry in the head region, immediately separates this species from the other Rorquals. The general colour is light grey above and pure

white below, but in the fore part of the body there has been, as it were, a shifting of the pigmentation to the left side, so that externally the right lower jaw is without colour, while the left is pigmented. This asymmetry of colour, which distinguishes the species, extends on to the head and shoulders. Inside the mouth the right jaw is pigmented while the left is without colour, and on the tongue also pigment predominates on the right. The inner sides of the flippers are white and the lower side of the flukes also, the latter character especially distinguishing this species from the Sei Whale. For the most part pigment is absent on the under surface of the body from chin to tail flukes, and the whiteness of the skin is such that an author describing it said that it made the sea-foam look grey as it washed to and fro across the body of the whale.

The whalebone reflects the asymmetry in the colouring of the head, for the blades on the right side are white for more than a third of the distance from the tip of the snout, the remainder on that side and all on the left being coloured a dull blue-grey with streaks of white and yellow. The frayed edges of the baleen, both of the white and of the pigmented blades, are a uniform yellowish-white.

Mackintosh and Wheeler state that the largest Common Rorqual measured by them, a female, was 80 feet 5 inches in length, and they suggest that 82 feet is probably about the limit of size attained by this species. As in the Blue Whale, females are a foot or two longer than males of the same age, and those found in the Antarctic are, on the average, larger than those in the northern hemisphere.

The distribution of the Common Rorqual is world-wide, but it does not appear to be such an ice-loving species as the Blue Whale. In the Atlantic it is much more abundant than the latter species; for instance, in the last year for which statistics are available, while 385 Finners were taken by the whaling companies in the Faroes, Iceland, Norway, coast of West Greenland and Newfoundland, only 10 Blue Whales were caught during the same period. On the coast of Natal at the present time the numbers captured are second only to those of Sperm Whales, and in Kamchatka, Japan and Korea it is also one of the major constituents of the commercial catch.

The method of feeding restricts the Finner to the smaller

animals found in the sea, but in the North Atlantic at any rate its food varies more than that of its bigger relative. At one period of the year it feeds on herring or one sort of krill, at another on fishes called Capelin, and again on a smaller sort of krill. In the Antarctic the Finner, like the Blue Whale, feeds only on the one kind of krill already described, but it is interesting to note that even when referring to this one species of shrimp the whalers recognize Blue Whale krill and Fin Whale krill, which are respectively its young and adult forms.

At birth the Finner Whale is about 22 feet in length, and grows with such speed that it is capable of reproducing at the beginning of the third year of its life, when the males are generally about 64 feet long and the females 66 feet. The pairing season may extend over 7 to 8 months, but as regards Antarctic Finners, May to August is the period of maximum frequency. Mackintosh and Wheeler state that there is no justification for the assumption that pairing can take place at any time of the year. The period of gestation is about 360 days, and the calves are suckled for the same length of time as in the Blue Whale. Referring to the proportions in which males and females are found, they say that it seems difficult to avoid the conclusion that males are in a slight majority; of all the Fin Whales examined by them 45% were female and 55% male.

Data obtained from a vast number of whales led Wheeler to conclude in a later work that cessation of the reproductive function does not occur in whales up to 20 years of age, and that there appears to be a sexual prime at 10 years. The Finner is fully grown when 6 to 8 years old.

This species is more gregarious in its habits than the Blue Whale, which does not commonly gather in large schools, but is more often seen singly or in pairs. Solitary Finners are sometimes encountered, but more often they are congregated in schools, which may range from a few individuals—a "stim"—to two or three hundred in number. Millais, in 'Mammals of Great Britain and Ireland', reports that a whaling captain observed nearly 200 Finbacks in sight at once from the masthead; they were scattered over an area of some 5 square miles, singly or by twos and threes. Bennett says of them: "One would readily believe that they (the Fin Whales) had a fixed

destination so straight is the course they steer, and it is possible that they have. 'Fins,' as they are commonly called for short, on the occasions when they are met with singly or only a few together are usually feeding, and they are then hunted in much the same way as the Blue Whale. But when a 'school' is encountered, the procedure differs. A whaler with high speed is necessary to capture the fast-moving Fins for they have literally to be run down. The excitement of chasing this animal is much greater than any provided by the humdrum creep after Blues."

It is difficult for the unskilled to distinguish the different species of Rorquals by their "blow", the variations appreciated by the whalers being generally of degree rather than of essential difference in form. In all Rorquals the "blow" is vertically upwards and, in its early stages, shaped like an attenuated inverted cone. Atmospheric conditions, of course, alter the permanence of the effect; it is most clearly seen in cold weather, and soonest dissipated when it is windy. It should not be thought that the whale blows or spouts water through the blowhole. Moisture-charged breath is vigorously ejected under pressure from the lungs and expands as it reaches the air. This expansion causes a fall of temperature, which brings about a condensation of the water vapour in the expired breath in the form of a visible cloud.

The progression of the whale through the water is punctuated by the necessity to come up for fresh air at intervals. Usually a series of shallow dives are succeeded by a deeper one of longer duration, when the animal is said to "sound". The shallow dives are in more or less rapid succession and vary in number; in a recorded instance the whale dived four times at 15-second intervals. During the "blows" between shallow dives the air in the lungs is thoroughly refreshed, and then the animal, arching its body and taking a final inspiration, swims steeply downwards. It remains underneath for a time which may be anything from about 4 to 15 minutes; the maximum time of remaining under water is not known, but it is probably about half an hour. When the whale dives its body is rounded into an arc, so that the observer sees in succession head and shoulders, back and dorsal fin, then tail appear and disappear, but in the Fin Whale the tail flukes

are not normally exposed at any stage of the dive. It is not usual either for the Finner to leap clear of the water, but occasional instances have been recorded of what must be a most impressive spectacle, and one gets some idea of the tremendous strength of these animals by considering the force that must be required to project their massive bulk and great weight clear of their natural element.

Stranded Blue Whales are not very common on the British coast, but the Finner is found all round it, and is not concentrated in any particular area. Systematic records of stranding have been instituted for over twenty years. There has been a marked diminution in the number of Finners reported in the last decade, and it may be that cessation of whaling in British waters has reduced the chance of wounded animals becoming stranded. It is not improbable, however, that the lesser number is associated with a real diminution of the stock of Finners in these northern waters.

The economic importance of the Common Rorqual will be discussed along with that of the Sei and Blue Whales.

THE SEI WHALE OR RUDOLPHI'S RORQUAL

(*Balænoptera borealis*). Fig. 64.

The Norwegian name of Sei Whale (Sejhval) applied to *Balænoptera borealis* is associated with its appearance off the Finmark coast at the same time of year as the Seje or Coalfish. This rorqual is intermediate in size between the Common Rorqual and the Little Piked Whale, and, according to R. Chapman Andrews, who has written an exhaustive monograph on this species, " it is neither as slender as the Finback nor as 'chunky' as the Little Piked Whale, and although it resembles the Blue Whale in some particulars is much more graceful in its general proportions. The body is deepest about opposite the middle of the pectoral fin and, as in other members of the genus, the peduncle is strongly compressed, forming a thin dorsal and ventral ridge and joining the flukes abruptly". The rostrum or beak is sharply pointed as in the Finner and viewed laterally it is slightly curved, recalling the arcuate form of head of *Balæna*, but of course in a very much less degree.

The dorsal fin, which has a deeply concave hinder margin, is relatively larger and more conspicuous than in either the Blue or the Finner Whale, and the flippers are unusually small, measuring about one-eleventh of the total length. The ventral grooving is distinctive in this whale, for whereas in the other two species just mentioned the grooves extend beyond the navel, in the Sei Whale they are much shorter, and terminate about halfway between the tip of the flipper (when it is placed along the body) and the navel. There is great variation in the number of grooves present. Andrews gives a range of 32 to 60, and says that the variation has no relation either to size or to sex.

The whalebone is very characteristic in the Sei Whale. The blades are mainly black, but a few may be partly white. The frayed inner edges, white in colour, are of a softness, silkiness and fineness of texture not found in any other Rorqual, and the inner aspect of the "side" has been said almost to resemble the fleece of a sheep.

Hairs are present in small numbers on the upper and lower jaws and on the rostrum.

The colour of the body is, for the most part, bluish-black. A white area is always present, which stretches backwards from the chin along the under surface, narrows in the region of the insertion of the flippers and then widens out again. This area is subject to very considerable individual variation, but never extends backwards to the tail as it does in the Finner Whale. The under surface of the flukes is never white; this feature and the pigmentation of the under surface of the flippers help to distinguish the Sei from the Finner Whale, in which these areas are unpigmented. Between the blue-black of the back and the unpigmented under surface the sides are greyish in colour.

The maximum length attained by this Rorqual is about 60 feet, and males and females appear to occur in roughly equal numbers. Andrews says that "observations seem to demonstrate that in the Atlantic, *Balænoptera borealis* as a rule breeds early in the spring, but that mating may take place among some individuals at any time of the year". He quotes Millais, who states that "the females probably bring forth their young about November, after a period of gestation

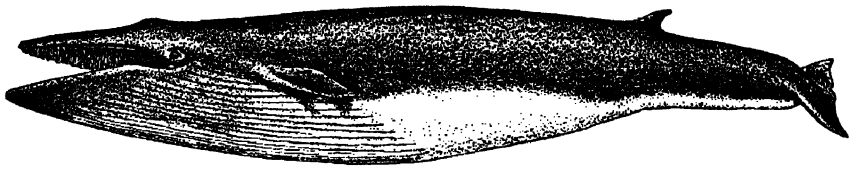


FIG. 63.—Finner Whale or Common Rorqual (*Balænoptera physalus*). To 80 feet.

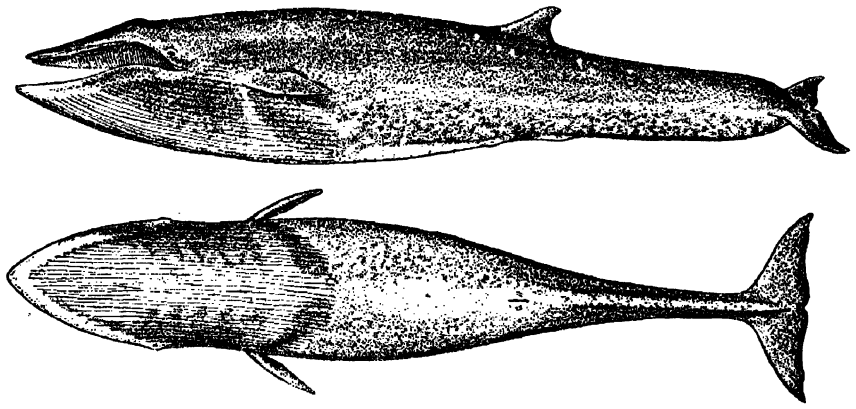


FIG. 64.—Sei Whale or Rudolphi's Rorqual (*Balænoptera borealis*). To 60 feet. (After Andrews.)

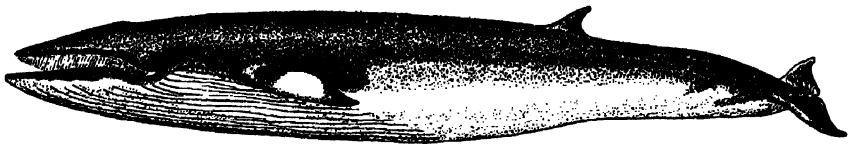


FIG. 65.—Piked Whale or Lesser Rorqual (*Balænoptera acutorostrata*). To 30 feet.

of ten or eleven months". It is usual for a single calf to be born at one time, but twins have been recorded.

The Sei Whale is widely distributed throughout the oceans of the world, and features in the commercial catch in places as widely apart as the Antarctic ice-edge in the south and Japan and Korea in the north. It is the most abundantly taken of any species on the Norwegian coast at the present time, and when whaling was carried on in British waters its prevalence, as indicated by captured specimens, was only exceeded by that of the Common Rorqual.

In the North Pacific this whale undertakes more or less regular migrations and is found most commonly on the northern parts of the Japanese coast in June and July. In the north Atlantic on the Norwegian coast Sei Whales, according to Collett, come in June and disappear in August. Andrews mentions the great invasions of the North Atlantic by these whales in 1885, 1898, and again in 1906, when they came in thousands. In the Antarctic the Sei Whale is a visitor to high latitudes only for a very few months of the year, in the latter half of the southern summer. That it is not recorded more frequently in early and midsummer is, to some extent, due no doubt to the prevalence of Blue and Fin Whales during these times, and no whaler would hunt for Sei Whale when these other two much more valuable species were to be found. The figures given by Sir Sidney Harmer in 'Southern Whaling' indicate that the occurrence of the Sei Whale is restricted in Antarctic waters. Of the total number of Sei Whales taken at South Georgia over a period of sixteen successive seasons, 50·4% were captured in March, 27·7% in April and 15% in February, leaving only 6·9% for the rest of the year. A similar seasonal distribution to that at South Georgia is indicated by the returns of the pelagic whaling companies operating at the Antarctic ice-edge. It would seem that both in the northern and southern hemispheres the Sei Whale migrates into higher colder latitudes late in the summer, when the water in those regions is no doubt warmer than at other times of the year, but whether the reaction of the whales is a direct one or whether they seek out the greatest abundance of food is not easy to say.

Of the many Sei Whales examined by Andrews on the

Japanese coast, only five had a quantity of sardines in their stomachs, although the Japanese name for the Sei means " Sardine Whale " ; the remainder had been eating only the small crustacean *Euphausia* (krill). In the North Atlantic this whale, in addition to eating krill, feeds very largely on a little crustacean which, in spite of its importance as a food supply, is without a popular name, and is known only by the Latin one of *Calanus finmarchicus*. About one-quarter of the size of krill, *Calanus* occurs in immense quantities in the cold northern waters, and besides being the food of the Sei Whale, whose silky close-knit baleen fringes seem admirably adapted to deal with it, it forms an important part of the diet of the ordinary herring. Millais, describing the Sei Whale feeding, says, " They go through the water very slowly, rolling in the usual fashion, without turning on the side ", and Andrews also observes, " Captain H. G. Melsom tells me that he has never seen one turn upon its side, as do Humpbacks and Finbacks ".

The " blow " of the Sei Whale resembles that of the Finner, but, correlated no doubt with the smaller size of this species, it is neither as dense nor as high. When the whale sounds it does not arch its body into a curve, as do the Blue and Finner Whales, but keeps more or less rigid and shows comparatively little of itself above the surface of the water. It very rarely jumps completely out of the water, but in the water " for short bursts of speed ", says Andrews, " no other whale can approach *Balænoptera borealis*. As soon as the harpoon strikes its body, if the iron does not penetrate a vital place the animal dashes off at a tremendous pace for perhaps a third of a mile or less, but soon tires and swims slowly thereafter. During the initial rush I believe the Sei Whale can attain a speed of 30 miles per hour ".

PIKED WHALE OR LESSER RORQUAL

(*Balænoptera acutorostrata*). Fig. 65.

The smallest of all the Rorquals, the Piked Whale or Lesser Rorqual most nearly resembles the Finner in general appearance, but it is of a somewhat stouter build. The snout is shorter for its width compared with other Rorquals, and it is

triangular in shape when viewed from above. The flipper measures an eighth of the body length and the dorsal fin is prominent and high, with a recurved posterior border. About 50 ventral grooves are found in the throat region in this species and, as in the Sei, extend only to about halfway between the end of the flipper (laid along the body) and the navel. Upwards of 300 blades make up a " side " of baleen, and all the blades, as well as their fringes, are entirely yellowish-white in colour; the maximum length of the baleen is a little less than a foot. The colour of the baleen serves at once to distinguish the Lesser Rorqual from all the others. Another and unfailing characteristic of the Lesser Rorqual is the white patch on the outer surface of the flipper and, unlike so many points used to distinguish various species of Cetacea, it is one which can be noted in the living animal without any difficulty.

The general body colour is blue-grey on the back, but underneath, from the chin to the tail flukes, the body is pure white. The under surface of the flukes is also white.

This species when adult is about 30 feet long, the largest stranded British specimen recorded being 33 feet. Little is known of its breeding habits, but it is believed that the period of gestation is about ten months as in other Rorquals, and that the calves at birth measure 9 feet and are born in November, December or January.

The food of this species includes the smaller plankton animals and fish. A Lesser Rorqual stranded on the Dutch coast had bones of herrings in its throat, and Allen in ' Whalebone Whales of New England ' states that it undoubtedly feeds largely on this fish. Cod, Capelin and even Dogfish constitute part of its diet.

Not much is known about the migrations of Lesser Rorquals, but as they occur more abundantly at certain times of the year than at others, it is presumed that such movements do take place. On the Norwegian coast, says Allen, " it is called the Summer Whale since it appears more frequently at that season". Round the British coast, on which it often gets stranded, the Lesser Rorqual is far commoner in the second half of the year, chiefly in August and September. Its range is wide, including as it does all the great oceans of the world. It occurs abundantly along the Norwegian coast, and in the

summer goes as far north as Spitzbergen. In the south it penetrates into Antarctic waters, and has frequently been observed haunting the narrow channels between the islands of the South Shetlands and the Palmer Archipelago. Allen mentions its preference for inshore waters, saying, " So far as observations show, it is distinctively a shore-frequenting whale, and seems to avoid the high seas."

Scammon describes how the Lesser Rorqual often gambols about vessels under-way, darting from one side to the other beneath their keels. When this whale blows, the spout is very faint, in comparison with that of the Blue or Finner Whale. The animal rises to the surface of the water 5 to 8 times in succession, and when diving again the tail flukes do not break surface. Allen mentions an instance of a Lesser Rorqual "breeching": " Five times it shot above the surface, belly uppermost, clearing the water beautifully, and with body arched slightly backward, fell on its back with a great splash."

Scammon in ' The Marine Mammals of the North-Western Coast of North America ', and Captain Scott, in the diary of his last expedition, both describe the peculiar behaviour of this Rorqual when in the neighbourhood of ice-floes. If there is not sufficient room to come up to breathe in the normal manner, " they frequently emerge through the narrow fissures bolt upright, with their heads above the broken ice to blow". Scott says: " Several times one rested its head upon a floe . . . with its nostrils just on the water line ; raising itself a few inches it would blow and then subside again for a few minutes to its original position, with its snout resting on the floe." Shackleton describes a Finner and Scammon the Californian Grey Whale behaving in the same manner. It is perhaps not strange that an action which in these whales is considered to be purely for the purpose of respiration should, in the Killer Whale, be given a secondary and more sinister significance because of the evil reputation of the latter animal. Thus, we have frequent reports of Killers rearing their bodies half out of water to scan the ice floe for possible victims.

Lesser Rorquals have no commercial value, but they are sometimes killed by the Eskimos for food, and the excellence of the meat has been commented on by more than one author.

BRYDE'S WHALE (*Balænoptera brydei*).

Bryde's Whale was not acknowledged as a distinct species until 1912. Even at the present time it is probable that it is often mistaken for the Sei Whale, which it most nearly resembles, but there is not much doubt of the validity of giving this whale specific recognition. A paper "On the External Characters and Biology of Bryde's Whale, a New Rorqual from the Coast of South Africa", by O. Olsen, was published in the 'Proceedings of the Zoological Society' for 1913, from which most of the present description is taken. The body of Bryde's Whale is remarkably elongated, and of far less powerful build than that of either the Sei Whale or the Lesser Rorqual. The dorsal fin is very moderate in size, smaller than that of the Finner and different from both the Sei Whale and Lesser Rorqual. The hinder margin is concave, often with a slight cut in it near the base. The ventral grooving on the throat extends to the navel, while in the Sei Whale it extends only about halfway between the tip of the flipper (laid along the body) and the navel. The flippers are slender and pointed, and measure about one-tenth to one-twelfth of the total length.

The back is bluish-black in colour, and on the under surface in the region of the throat there is a dark bluish-grey area which may extend laterally backwards to the region of the flippers. The rest of the under surface is white, or more or less yellowish, often with a grey band across the belly in front of the navel. The flippers are dark bluish-grey on both surfaces.

Bryde's Whale is a comparatively small Rorqual and the average length is about 42 feet, the maximum length recorded being just over 49 feet. Females reach a size slightly larger than males.

The baleen is distinctive of the species; in shape, size and texture it differs from that of all the other Rorquals. The blades are comparatively broad and have a concave inner margin; they are small for the size of the animal, the longest being about 19 inches, whereas in a Sei Whale of the same length they are about 27 inches long. The bristles are longer than in the Sei Whale and thick and stiff, being on the whole of very strong construction. The colour of the baleen in the

anterior part of the jaws and extending backwards about 27 inches is generally white, but frequently has grey stripes; the remainder of the baleen is greyish-black. Sometimes there is asymmetry of coloration similar to that found in the Common Rorqual.

The difference in texture between the baleen of Bryde's Whale and that of the Sei Whale was the reason for a lawsuit several years ago. The baleen of the former species had unwittingly been sent as that of the Sei Whale to a purchaser, who returned it on the grounds that it was not from the species of whale demanded. The suppliers had consigned it in all good faith as Sei Whale baleen, but the result of the litigation which ensued was that the authorities who examined the baleen gave judgment in favour of the buyers. It will be seen from this that even amongst experienced whaling folk there is considerable difficulty in distinguishing between the Sei and Bryde's Whale.

The food of Bryde's Whale is chiefly fish, usually a variety of herring, but sometimes a species of mackerel a foot or so in length. Olsen comments on this whale's voraciousness, which he claims to be greater than that of any other species of Rorqual, and he describes how it has been seen hunting among large crowds of small sharks, specimens of which more than 2 feet in length have been found in the whale's stomach. But perhaps most astonishing of all is the record of 15 large penguins having been discovered in the stomach of a Bryde's Whale. Olsen suggests that the birds, the moment the whale reached the surface of the water, had probably dived down into its open mouth, endeavouring to catch fish in that most abundant hunting-ground, and had thus themselves been involuntarily captured by the whale.

Information about breeding habits and development is very scanty. Males and females are taken in about equal numbers, and the widely different size of unborn young ones found at approximately the same time of year suggests that in this, as in other Rorquals, pairing may take place at any time over an extended period.

Bryde's Whale is commonest on the coast of Cape Colony, occurs also off Natal and Angola, and has been reported at Granada in the West Indies.

THE RORQUAL FISHERY.

The history of the whaling industry up to the present time would in itself fill a volume, so that only some of its salient features can be mentioned here. Undoubtedly the chief factor leading to the inception of modern whaling was the perfecting of the harpoon gun by the Norwegian, Svend Foyn, in 1865. He was not the originator of the idea of using a gun of some sort to slaughter whales, because more than a century before a portable harpoon gun had been tried; William Scoresby also took a harpoon gun with him on his whaling voyages at the beginning of the nineteenth century. But it was Svend Foyn's gun, used from the bows of a small steam vessel, which made pursuit of the whales belonging to the Rorqual family a practicable undertaking. Their size, speed and lack of buoyancy when killed had caused the Rorquals to be neglected by the earlier whalers using hand harpoons and hunting from small boats; also the poor quality of their baleen compared with that of the Right Whales made them less attractive prizes when whalebone was a valuable commodity and prices for it were high. The modern harpoon gun is an exceedingly effective weapon for the destruction of the great Cetaceans. It has a bore of $3\frac{1}{2}$ inches, and takes a 6-foot long iron harpoon with pointed and barbed tip which projects from the muzzle. The harpoon weighs upwards of a hundredweight, and the cast-iron point is charged with gunpowder, which is timed to explode a few seconds after the harpoon is fired, so that the iron fragments, flying in all directions within the animal's body, add greatly to the lethal effectiveness. The barbs are hinged and splay out to a wide angle after the harpoon pierces the body, so that the weapon is firmly secured and will not draw out when strain is put on the harpoon line. The line consists of two sections, a thinner shorter "foregoer" of Italian hemp, which is coiled on a platform immediately below the gun, the one end of it attached to the harpoon and the other to the second, much thicker, longer rope, of which there may be as much as half a mile coiled in bins below deck. The foregoer runs out when the harpoon is fired, and the strain of the whale's struggles and of the pitching ship is taken on the thicker rope which, before going outboard,

passes several times round the drum of a winch and through a system of blocks attached to springs, thus lessening the chances of the line parting and the whale getting away.

The Rorqual Fishery was started on the Finmark coast of Norway in the 'sixties of last century, and since then the practical operation of the industry has been so extensively in the hands of the Norwegians that even at the present time the position is comparable to that existing in the beginning of the seventeenth century when, although Dutch, French and English were concerned in the Greenland fishery, the experience and skill was a monopoly of the Basque whaling men. The Finmark fishery was the first of many to be started in the northern hemisphere. Before the end of the nineteenth century whaling stations had been built in Iceland, the Faroe Islands, Scotland, Western Ireland, Labrador, British Columbia, Japan and Korea. Blue, Sei and Finner Whales were pursued, and in addition the Humpback, an inshore frequenting species, was often the first to be commercially exploited. The same sequence of events, noted in connection with the Greenland and Atlantic Right Whale fishery, occurred in the new Rorqual fishery. Abundance in the beginning was succeeded as a result of over-fishing by a reduction of the stock of whales, so that it became unprofitable to hunt them and the whalers had to go further afield to new areas, eventually finding their way into the southern hemisphere.

In 1892 a whaling expedition from Dundee, carrying the Scottish Antarctic explorer, Bruce, sailed to the Weddell Sea in search of Right Whales. In this it was unsuccessful, but when Bruce returned he tried to interest business men in Edinburgh in the possibility of developing an Antarctic Rorqual fishery. He failed to get any support for his intended project, but the Norwegian, Captain C. A. Larsen, who had visited the South Shetlands in 1893–94, and again in 1901, was more fortunate, for on his return from the south to Buenos Aires he founded the first company to operate in Antarctic waters—the Compania Argentina de Pesca, with its whaling station at Grytviken, South Georgia.

South Georgia has much to recommend it as a base for whaling operations. There are many long fjords on the north-east coast which make good natural harbours, and it is ice-free

throughout the year. When Larsen commenced operations, in addition to Rorquals, Humpback Whales abounded close inshore, and he noticed too that in the waters round the island, krill, the food of whales, was present in conspicuous abundance. Still another factor favouring South Georgia is that for whaling within the cold waters of the Antarctic it is the place closest to northern ports; for here the circumpolar currents bend northward, so that although it is roughly in the same latitude as the Falkland Islands and the southern end of South America it has an entirely different climate, and the waters surrounding it abound in the whale food which is scarce in warmer regions.

The shore stations of five whaling companies were soon built on South Georgia, and every year 1500 to 2000 men, chiefly Norwegians, were employed, hunting whales and extracting oil from the carcases in this previously uninhabited little dependency of the Falkland Islands. In the meantime a modification of this shore station fishery had made its appearance, and floating factories, chiefly old cargo vessels adapted for the purpose of dealing with whales, commenced to operate, with their attendant catchers, from harbours in the South Shetlands and South Orkneys. Essential features in the working of these floating factories were that they remained in their chosen harbour throughout the season, they were dependent on a supply of water from the shore, and were subject to the regulations under which licences were granted by the Government. By these regulations the number of companies and catchers was limited; the companies operating had to make the fullest use of the carcases so as to avoid waste, and they were forbidden to take whale calves or parent animals accompanied by calves. At first the whalers at South Georgia and in the other dependencies of the Falkland Islands concentrated on Humpbacks, but in time, partly on account of the modification of their vessels to take Finner and Blue Whales, and partly because of the reduction in the number of Humpbacks, the larger Rorquals became the main constituents of the catch.

In the season 1925–26 Antarctic whaling was responsible for over 60% of the total world production of whale oil, and the number of whales slaughtered, consisting of Finner, Blue, Humpback, Sperm and Sei, in this order of importance, was

nearly 14,000—an enormous number when compared with the scale on which the old Right Whale fishery was pursued. Although the figures given here are mainly taken from shore station and floating factory records, another element, presently to become the dominating one, played a part in the catch secured. In 1923 the same Captain C. A. Larsen who had started whaling in the south sailed into the Ross Sea with a factory ship, the "Sir James Clark Ross", accompanied by five whale catchers, and, working on the high seas at the edge of the ice, brought back a cargo of 17,000 barrels of oil. This method of fishing was continued with increasing success in the years that followed. This venture of Larsen's led to a general adoption of pelagic whaling, as the method of using factory ships in the open sea is called. New ships were built, and old ones converted, and these vessels, having slipways to take the whales on board for flensing and being independent of a harbour for shelter and for supplies of water, could go where whales were most abundant. They went to the whaling grounds at the beginning of the season and remained at sea till its close. Fuel was transferred to them and whale-oil from them by transport vessels, and as work was carried out in high latitudes, where during part of the time, at any rate, there is no darkness, it continued throughout the twenty-four hours of the day. The whalers were not restricted at first by regulations comparable to those under which licences had formerly been granted to shore stations, and by the end of the southern summer of 1930–31, 3,420,410 barrels of oil had been produced in the one season from 37,465 whales. Factory ships with their attendant catchers, extending round three-quarters of the Antarctic continent, had effected a slaughter of the great whalebone whales quite unprecedented in the history of whaling. A drop in the price of oil resulted. In the following season the Norwegian-owned companies did not send their factories south and the world production was reduced to a figure of less than a million barrels, comparable with that of about eight years earlier.

The seasons 1932–33 and 1933–34 saw Norwegian and some British companies working under a quota agreement which was to limit the number of whales to be slaughtered. Even then the catches for the two seasons were over 24,000 and

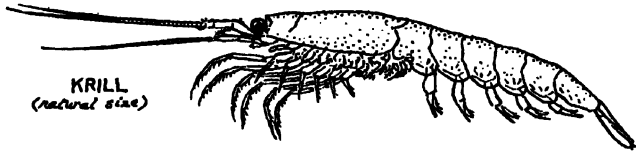
26,000 whales respectively, and for the last season for which figures are available, 1934–35, the number had exceeded 30,000. The world production of oil for 1934–35 and the summer of 1935—it is necessary to express the annual figures in this way as the Antarctic season is partly in two calendar years—was 2,691,283 barrels, of which 2,453,999, or 91% of the total, was from the Antarctic.

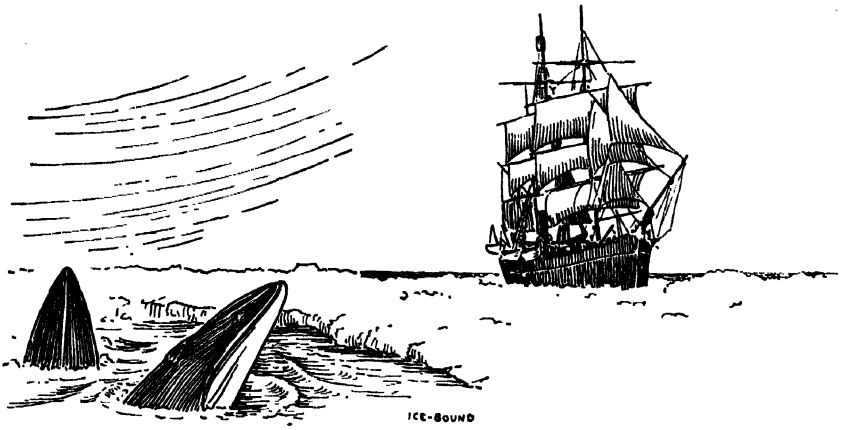
A glance at the statistical table in the ' Norwegian Whaling Gazette ' for August, 1936, gives an idea of the composition of the Antarctic catch. There were taken 16,500 Blue Whales, 12,500 Finners, 1965 Humpbacks, 266 Sei, and 577 Sperm Whales.

In addition, however, to the whaling carried on in the Antarctic there are at the present time other whaling stations throughout the world, on the coast of Africa, North-Western Europe, the western coasts of North and South America, and in Kamchatka, Japan and Korea, but the insignificance of all these compared with the immensity of the Antarctic industry is indicated by the production figures just quoted.

It is difficult to say how long the Antarctic will continue to be so abundantly productive, but judging by what has happened in other whaling grounds and to other species of whales we should anticipate a very limited duration of profitable fishing. It is true that the area of supply is immensely greater than, for instance, that from which the Greenland Right Whales were derived, but if the area is greater the methods of hunting are vastly more efficient now than in the days of the Greenland fishery. Whaling interests admit the necessity for control, and certain restrictions have already been imposed. In the last two seasons the fishing period was shortened, and regulations have been drafted prohibiting the taking of immature animals, and encouraging the careful utilization of every whale carcase. The problem is whether the stock of whales is being replaced at a rate commensurate with its depletion. The Antarctic is the last important haunt of these animals which can be exploited, and whether we consider the question economically or zoologically, the possibility of the stock being reduced below the point where replenishment can take place should encourage every person interested in whales or in whaling to strive for a control of the industry and the formulation of policy far-sighted

enough to look beyond the immediate needs of commercial demand. Should such a control not be imposed, it is likely that the present generation will be held responsible for permitting the extinction of the largest animals the world has ever known. " To the naturalist," says Sir Sidney Harmer in his ' History of Whaling ', " the extermination of a species must appear a crime unless it is definitely warranted by the necessity of removing it in the interests of humanity. There is no such motive in the case of the large whales."





CHAPTER XI: HUMPBACK WHALE; CALIFORNIAN GREY WHALE.

THE two kinds of whale to be described in this chapter are not considered together because they are closely related, but rather because they are the two genera of whalebone whales which do not come within the category either of Right Whales or of typical Rorquals. The Humpback is, however, included in the family—the Balænopteridæ—of which the Rorqual genus is the only other representative; but both its appearance and its behaviour justifies the separation of the Humpback from the other division of the family. The California Grey Whale is even more isolated, differing so widely from all other whalebone whales that it constitutes a family—the Rhachianectidæ—of which it is the sole living representative.

Genus *Megaptera*.

THE HUMPBACK WHALE (*Megaptera nodosa*).
Plate VI B.

The name *Megaptera* indicates the feature which serves best to distinguish the Humpback Whale, namely the extraordinarily long flippers, which may be nearly one-third of the total length of the animal; *nodosa* refers to the irregular knobs

and protuberances on the head and flippers. The common name of Humpback has been explained by some as applying to the small fin situated on the back towards the tail, and by others to the rounded appearance of the animal when it dives. The Norwegian "Knølhval", the French "Baleine à bosse" and the Danish "Stubhval" are all names which draw attention to the tubercles on head and flippers.

The body form is relatively shorter and stouter than that of the Finner Whale. "Its shape", says Scammon, "compared with the symmetrical form of the Finback, California Grey and Sulphur-bottom is decidedly ugly," and there is no doubt that the Humpback's thickset build coupled with its excessively long flippers contrast rather unfavourably with the lines of the more finely proportioned Rorquals.

The beak is short and broad, and the region between the dorsal fin and tail—the "small" of the old American whalers—is greatly reduced in size. The dorsal fin is not unlike that of the Common Rorqual, although usually without the very pronounced concave posterior margin. The tubercles, already referred to, on the surface of the head and jaws vary greatly in number but are arranged in well-defined areas. Thus, there is usually a series extending forwards from the front ends of the blowhole slits to the tip of the snout, and two more, one on either side of the middle set, on the margins of the upper jaws. A cluster of them is found on the chin, and they also extend along the outer surface of the lower jaws. Their distribution corresponds to that of the hair in the Rorquals, and in the present species 1 or 2 short bristles are usually associated with each tubercle.

The pleating on the throat, extending from below the chin to the navel, is much coarser than that of the Rorquals. The width between grooves is from 5 to 8 inches, whereas in the Blue and Finner Whales it is only 2 or 3 inches. As in these species, nevertheless, individual grooves may split up into two or fuse with others, the total number being from 14 to upwards of 20, far fewer than are ever encountered in the Rorquals.

The great length of the thin narrow flipper has already been mentioned as the outstanding characteristic of this species. A cast of one 14 feet long from a Humpback measuring 49 feet

6 inches is exhibited in the British Museum (Natural History), and, as pointed out by Sir Sidney Harmer, its length is slightly greater than the flipper from a Blue Whale of 90 feet, which length is almost double that of the Humpback. The lower margin of the flipper has several large prominences, marking the positions externally of the joints between the bones of the fingers and of the wrist. The hinder margins of the broad tail flukes are scalloped so that the edges have a serrated appearance.

The colour of the back is black, whilst on the ventral surface a very variable amount of white may be present. It has been suggested that the white on the under surface increases with the age of the animal, and that immature specimens are more often black below. The flippers are always white underneath, and this absence of pigmentation may extend round the anterior border on to the upper surface, where the amount of black is rather variable. The flukes are usually white underneath and black or parti-coloured above.

The whalebone is grey-black with bristles of the same colour, but sometimes white blades may be found. About 400 blades make up a "side", and the longest scarcely exceeds 24 inches.

The fully-grown Humpback is about 50 feet long, but, as already mentioned, its bulk is disproportionately great. A comparison of the oil yield from one Blue Whale with the yields from other whales gives some idea of this: 1 Blue Whale is equivalent in oil production to 2 Fin Whales, to $2\frac{1}{2}$ Humpbacks, and to 6 Sei Whales. It will be remembered that the Sei Whale exceeds the Humpback by 10 feet in length, and the Finner exceeds the Humpback by 30 feet.

The Humpback, like the Rorquals, is a widely distributed species, occurring as it does in all the great oceans of the world. It is coast-loving in its habits, frequenting bays and inlets, and it may be for this very reason that so few get into difficulties in shoal water. Allen in 'The Whalebone Whales of New England' says, "Although the Humpback sometimes comes very close inshore it is very rarely indeed that one becomes stranded", and Harmer also in his 'Stranded Whales Report, No. 10', remarks on their absence from these records, although a certain number had been taken by British whaling companies operating during the period covered by his report.

The converse happens in the case of the False Killer Whale, a typical oceanic species, hundreds of the animals sometimes getting into difficulties in shallow water. A noteworthy stranding on the British coast, at an earlier date, was the Tay Whale, a Humpback which haunted the Firth of Tay for about six weeks in 1866 before it was harpooned. It was the subject of a detailed anatomical description by Sir John Struthers. Allen, referring to the Humpback's coast-frequenting habits, says that it will enter harbours and even go a little way up the mouths of large rivers, but perhaps those which visited Nantucket and Newport—harbours famous in the history of American whaling—may be credited with greater courage than the rest of their fellows, described as " neither very timorous nor very fierce ".

The food of the Humpback consists chiefly of the same kinds of krill as are eaten by the Rorquals, but in addition it consumes capelin and probably other small fishes as well. Allen states that there is no evidence of herring being included in its diet, and mentions as exceptional a report of a Humpback having a great quantity of codfish in its stomach. Another instance, of a Humpback which had swallowed six cormorants and had a seventh in its throat, can probably be explained in the same way as the penguins associated with Bryde's Whale.

In both northern and southern hemispheres winter is the time of calving and pairing, and for these purposes the animals migrate into warmer waters. In the north the principal pairing period is in April, and in the south September. Scammon, in ' The Marine Mammals of the North-Western Coast of North America ', describes the behaviour of Humpbacks at this time: " In the mating season the Humpbacks are noted for their 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 swordfish and thresher attacking whales. When lying by the 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 also rub each other with these same huge and flexible arms, rolling occasionally from side to side and indulging in other gambols which can easier be imagined than described." The calves

are carried for a little less than a year; the exact period is not known. The largest fœtuses recorded measured 16 feet 5 inches and 16 feet 9 inches, and Scammon calculates the length at birth to be about a quarter of the length of the parent animal. He describes also how the calf suckles, " by holding the teat between the extremity of the jaws or lips while the mother reclines a little on one side, raising the posterior portion of her form nearly out of water and lying in a relaxed condition. This peculiar manner of suckling the young appears to be common to all the whalebone whales". It is believed by one authority that the Humpback females become pregnant every year, and that pairing takes place again about a month after parturition. If this is so the Humpback differs from the other whalebone whales whose cycle has been studied, for in the latter it is not usual for calves to be produced more often than once in two years.

Perhaps because the Humpback frequents inshore waters more than do the large Rorquals its migrations are more certainly known, but in addition it is so regular in its occurrence that, to quote the whaling authority, Risting, " If the whalers have found a station from which it can be hunted on its course it is easier to shoot down and exterminate than any other species". The migrations are for a definite purpose, and like the Blue and Finner Whales, the animals go into warmer water for breeding and into more Polar regions for feeding. Off the north coast of Norway the Humpbacks are known to move westwards in February and March, and at this time the females are carrying large fœtuses. In April and May they are found along the west coast of North Africa, the females being followed by newly born young. On their passage northwards again their route takes them by the Hebrides and Faroes and they are back again on the Finmark coast from June to August. Later, towards the winter, they move further eastwards.

Scammon, in his description of the distribution of the Humpback on the western coasts of North and South America, tells of large numbers resorting to the Gulf of Guayaquil to calve, and of the whaling season being at its height during July and August—presumably these were whales from the south. In the north, in the Bay of Monterey, Upper California,

the best season was October and November, but some whales were taken from April to December. " A great body of these whales, however," he says, " are observed working their way northward until September, when they begin to return southward; and the bay being open to the north many of the returning band follow along its shores or visit the southern extremity in search of food."

On the South African coast Humpbacks arrive during May, but the majority reach the breeding-places about the middle of July; whereas in the Antarctic, as indicated by South Georgia whaling statistics, the maximum number is caught in November.

In the " Terra Nova " report on Cetacea, Lillie, referring to the Australasian region, states that the Humpbacks migrate from the Antarctic at the beginning of the southern winter and pass New Zealand on their way northward between mid-April and the end of August, but chiefly during May and early June. About mid-September in the same locality they are moving south, and during October the migration to higher latitudes is at its height, while by mid-December they are all to the south of New Zealand.

The behaviour of this creature in the water has many characteristic features. Its blow is a very short broad jet of vapour, distinguishable from the higher, thinner spout of the Rorquals. The number of shallow dives between the deeper or sounding submergences is very variable; sometimes it is only 1 or 2, and at others 10, 12 or even as many as 18 or 20. The time between these shallow dives is a matter of seconds, but when the animal sounds it may remain below the surface for as long as 15 or 20 minutes. The tail flukes do not appear above the surface of the water except just prior to the sounding dive, then as described by Allen, " the whale goes down in a nearly perpendicular course, more of the posterior part of the body appears above the surface with the greater effort and the flukes of the tail finally rise clear of the water, and following the forward rolling of the body, dip in nearly vertically, looking like the spread wings of a great bird as they disappear". The whale moves through the water in a leisurely way and, according to Scammon, seldom keeps in a straight course for any considerable distance. At times it lies perfectly motionless

on the surface or, again, swims just below with its back exposed, or rolls over and over with the great flippers waving in the air. Most spectacular of all is when, as it frequently does, it breaches, leaping clear of the water and falling back again with a tremendous splash. The various antics of the Humpback, recognized and given particular names by the American whalers in such words as " breaching ", " rolling ", " finning ", " lobtailing " and " scooping ", give some impression of the extent and variety of movement of which this animal is capable.

The Humpback is generally more heavily parasitized externally than are any of the Rorquals. Whale lice and two species of barnacle are commonly found. The lice cling to the skin by hooklike legs and occur on various parts of the body, whilst one of the species of barnacle has a special predilection for the summits of the tubercles and protuberances on the head and flippers, although it may be found also in other regions. A smaller species of barnacle occurs chiefly on the lips and on the posterior margin of the tail. It is more deeply sunk into the skin than is the other kind, so that usually only the star-shaped summit of the shell is seen. On the first-mentioned barnacle bunches of still another, a stalked barnacle, are often found, which very rarely indeed parasitizes the Humpback directly.

The Humpback is one of the few species other than the Right Whales that were hunted before the adoption of modern methods. Scammon describes how it used to be captured by the Eskimos and the natives of the Aleutian Islands. It was hunted, too, on the American coast with common hand harpoon or lance and, as the carcase sinks, the whalers had to wait till decomposition within the animal's body generated sufficient gas to inflate it and float it to the surface again.

Modern whaling methods concentrate first on the Humpback in any new area. It is a good oil producer for its size, and does not present the same difficulty of capture as the larger Rorquals. It is found close inshore, so that the catchers do not require to make long sea trips to find their quarry. The experience of whalers in pursuit of Humpbacks has been the same in whatever part of the world the work has been carried on. The Humpbacks, at first plentiful on the coast, diminish rapidly in

number, and there is still controversy as to whether the scarcity is a direct result of overfishing, or whether the animals are frightened away from the areas where they are pursued. South Georgia furnishes a typical example of what has so often happened. In 1910–11 Humpbacks formed 96·8% of the total catch, Finners and Blue Whales making up the insignificant balance. By 1916–17 the proportion of Humpbacks had dropped to 9·3% of the total, while Blue and Finner Whales constituted the remaining 90·7%. The diminution may have been more apparent than real, and may have been caused by the whalers preferring, in the later years, to hunt the larger, more valuable species of whales, but it has been pointed out in the Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands, " if selective hunting were the sole reason for the diminished capture of the small Humpback, it might be anticipated that in the years in which the larger whales were present in small numbers the percentage of Humpbacks would sensibly rise ". It has been established, nevertheless, that the percentage catch of Humpbacks has not increased in the lean years.

In the latest available statistics of whaling in 1934–35 and summer 1935, it is shown that more than 4000 Humpbacks were killed throughout the world. The pelagic factories in the Antarctic accounted for 1928 Humpbacks, or only 6·3% of the total catch of whales in that region. On the Congo coast 1241 Humpbacks formed the entire catch made in that area, with the exception of 10 Sei Whales. Moderate numbers of this species were taken off the coasts of Natal, Alaska and Kamchatka, and a few off the Japanese coast, Chile and South Georgia.

Family RHACHIANECTIDÆ.

Genus *Rhachianectes.*

THE CALIFORNIAN GREY WHALE (*Rhachianectes glaucus*). Fig. 66.

The name *Rhachianectes glaucus* means literally " the grey rocky-shore swimmer ", and with the common name it tells us something about the appearance, disposition and habits of

this singular whale. On the Japanese coast, where the Grey Whale was at one time hunted, it was called Koku kujira, the devil fish.

Rhachianectes is a whalebone whale which in many ways is intermediate between the Right Whales and the Rorquals, but it is sufficiently distinctive not to be included in either of these groups. It is of rather small size, as whalebone whales go, reaching a maximum length of not more than 45 feet and, as in other whalebone whales, the average length for females of this species is slightly greater than for males.

The head is small in proportion to the rest of the body, and the snout portion, while not so narrow or arched as in the Right Whales, is not so broad or flattened as in the Rorquals. From the tip of the snout the head curves gently upwards to just in front of the blowhole apertures and, behind these, the outline of the head passes with a very faint depression into the back. The dorsal surface of the body is slightly convex to the beginning of the tail region, where a succession of 8 to 10 or more low humps, starting about two-thirds of the body length from the snout, breaks up the evenness of the outline of the stock of the tail. There is no distinct dorsal fin; in this *Rhachianectes* resembles the Right Whale. R. C. Andrews in his memoir on the California Grey Whale states of the tail flukes: "They are strikingly different from the slender, graceful flukes of *Balænoptera* and equally so from *Balæna* . . ." The anterior margin of each fluke is, to a very small degree, convex, and the posterior margin of each is convex for most of its length, but near the tip is a very slight concavity, not generally obvious in adult specimens, in which the flukes are usually damaged. The hinder margin, instead of being thin as in the Rorquals, is about an inch thick and broken by shallow indentations, recalling, but to a very much less degree, the serrated margin of the Humpback's tail.

Andrews tells us that the flippers are intermediate in shape between those of the Right Whales and the Rorquals, being broader, thicker and not so pointed as the fins of the latter group, but more lanceolate and not so heavy, thick or broad as the flippers of the Right Whales. The anterior edge is regularly convex and the hinder edge strongly convex except just behind the rather blunt tip, where a shallow concavity is

formed. The 4 digits, the same author tells us, are prominently outlined.

In the throat region are 2 to 4 grooves upwards of 5 feet in length; the usual number is 2, 4 being very rare. In this feature the Grey Whale is again intermediate between the Right Whales in which furrows are absent, and the Rorquals in which they are abundant. Andrews has an interesting explanation for the reduced number of furrows in the Grey Whale: "In the existing Balænopterinæ" (*i.e.* Rorquals) "when the lungs are filled with air the whole thorax expands laterally, and with it the flexible skin between the folds. Thus the furrows, besides their original function of increasing the throat capacity during the feeding operation, are also in use during respiration. *Rhachianectes* being a shallow-water whale and a relatively primitive form has not yet developed the furrows on the breast and abdomen."

The baleen or whalebone is yellowish-white in colour and the individual blades are very thick and heavy. 138 to 174 blades make up a "side", the longest being 14 to 16 inches in length.

Hairs are more abundant on the Grey Whale's head than on those of other whalebone whales. They are to be found in irregular rows on the top of the fore part of the head and along the side of each lower jaw. The greatest concentrations are at the tip of the snout and at the point of the lower jaw.

The eye is situated, much as in other whalebone whales, above and behind, but in close proximity to, the angle of the gape. The iris is described by Andrews as "a clear dark-brown band 6 mm. wide, the outer edge of which shaded into a narrow whitish ring. Encircling the iris was a band of light grey which shaded off gradually into very dark grey". The pupil is oval with the upper edge rather flattened.

The external opening of the ear is, as in all Cetacea, an inconspicuous aperture situated at some little distance from the eye, in the area between that organ and the insertion of the flipper.

The colour of the Californian Grey Whale is indicated by its common name, but there may be a considerable amount of variation in the actual shade. As figured by Scammon, the back may bear a considerable number of white flecks. The colour of the flippers is similar to that of the rest of the body.

On the hinder part of their upper surface are white markings, whilst on their under surface these are more numerous, and there are also two irregular bands of white or light colour separating the second and third and third and fourth fingers.

The home of this species is the Pacific, where, according to the time of year, it is found from the Arctic Ocean to Lower California on the American side and to Korea on the western Pacific. It is an interesting fact, however, that there is evidence of this species, believed to be confined to the Pacific at the present time, having occurred in other parts of the world. Last year, when a part of the Zuyder Zee which had been drained became dry land, a skull and part of a skeleton undoubtedly belonging to a Californian Grey Whale came to light, and the Dutch cetologists who examined the specimen later identified another from the same region. Their investigation of this material, along with the consideration of the descriptions of certain whales previously placed (and it must be admitted rather arbitrarily) in other known genera, point to the occurrence of the Grey Whale in the Atlantic—and there is no fundamental reason why it should not have been found there.

In Captain Scammon's book, ' The Marine Mammals of the North Western Coast of North America ', there is an excellent and very detailed account of the habits and migrations of the Grey Whale. It is stated that this species was to be found on the coast of California from November to May, and that during these months the cows entered the lagoons on the lower coast to bring forth their young while the males remained outside along the sea-shore. The time of gestation is said to be about a year, usually one calf being produced at a birth, although twins sometimes occur. Occasionally a male was to be seen in the lagoons at the end of the season, and soon afterwards male and female with their young were to be observed working northward always keeping close inshore. In the summer the animals congregated in the Arctic Ocean and Okhotsk Sea.

In October and November, according to Scammon, the Grey Whales appear off the coast of Oregon and Upper California on their way southward, gathering in the lagoons in large numbers, at times lying quite motionless, and at others passing

and repassing into and out of the estuaries. He describes the animals' liking for shore water, and tells of how they would go through the surf where the depth of water was barely sufficient to float them: "One in particular lay for half an hour in the breakers, playing, as seals often do in a heavy surf; turning from side to side with half-extended fins, and moved apparently by the heavy ground swell which was breaking; at times making a playful spring with its bending flukes, throwing its body clear of the water, coming down with a heavy splash, then making two or three spouts, and again settling under water; perhaps the next moment its head would appear, and with the heavy swell the animal would roll over in a listless manner, to all appearance enjoying the sport intensely. We passed close to this sportive animal, and had only 13 feet of water." Frequently these whales are known to get stranded and lie, apparently without injury, in 2 or 3 feet of water until the rising tide floats them off again.

When swimming in open water this whale usually submerges for about 7 or 8 minutes and, on coming to the surface, blows two or three times between shallow dives before sounding again. The tail flukes usually appear above the surface of the water just before the whale dives deeply but are not to be seen before surface dives. Andrews compares the action with that of the Humpback, which it resembles to some extent, but the back is never arched before diving as it is in the latter species. The same author states that the speed of swimming cannot exceed 7 or 8 knots.

The Grey Whale's behaviour in the neighbourhood of ice fields has already been mentioned (p. 233). In Scammon's book there is a picture showing the animals thrusting their heads vertically out of the water between the floes, and it will be recalled that the Lesser and Common Rorquals do likewise in similar circumstances.

It was obvious that a creature with the habits of the Grey Whale should attract the attention of whale hunters, and for a number of years it was the source of a productive industry on the Californian coast, though this was not the only area in which it was pursued. All the way along the path of its migration it was attacked and slaughtered, with greatest thoroughness no doubt by the American whalers, but also by

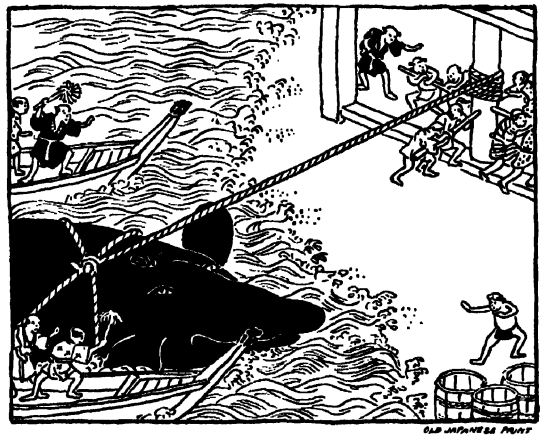
the Indians in the neighbourhood of Vancouver and Queen Charlotte's Islands, and by the Eskimos in the Arctic, who chased it in canoes, using hand harpoons and lances. The Americans, employing bomb-lances and a type of harpoon gun in addition to ordinary hand harpoons, made a great slaughter of the animals over a number of seasons. Various modifications in the method of approach had to be adopted as the whales became more and more wary. At first the ordinary whale boats were used, but later very small boats, each having one man to row and another to shoot, were sent shorewards from the whaling ships to harpoon the whales in shallow water. Boats provided with sails and making use of the strong northerly winds were at times used to overtake and harpoon the animals on their way southward; this method was known as "sailing them down". Sometimes the calves were harpooned first and hauled to land so that the bereaved parent animal, following close inshore, could be shot at from the beach.

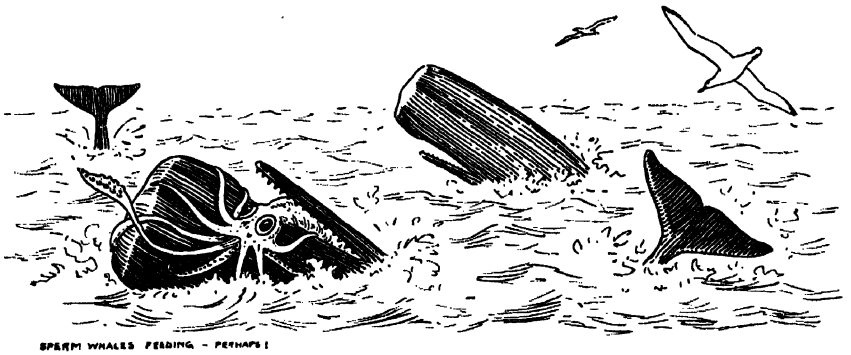
When shore whaling was first established it was estimated, according to Scammon, that on the California coast about a thousand whales passed southward daily from December 15th to February 1st. This was in 1851, but by the time that Scammon's account was written in 1874, the average number seen from the stations passing daily did not exceed 40. This author predicted that "ere long it may be questioned whether this mammal will not be numbered among the extinct species of the Pacific", and so nearly did this become the case that before R. C. Andrews went to one of the whaling stations in Korea in 1911–12 many naturalists, as he himself pointed out, believed the Grey Whale to be extinct. He found, however, that it was still considerably fished by the Japanese, and it is an interesting fact that there are early nineteenth century Japanese illustrations of whaling which indicate that this species, in addition to the Right and the Humpback, had been hunted in that region more than a hundred years ago.

Sir Sidney Harmer, in his 'History of Whaling', draws attention to more recent captures of *Rhachianectes*; in the 1925–26 season 42 were caught at Magdalena Bay, Lower California, and 11 off Japan and Korea. He states with reference to the far eastern fishery, "It is the general opinion of Japanese whalers that the industry is declining, and that

the fall is most marked in the case of the Grey Whale, of which an annual average of 81 is recorded for the period 1915 to 1919, but of only 21 for 1922 to 1926". In the latest available world-whaling statistics there is not a single California Grey Whale recorded.

The Grey Whale, like the Humpback, is usually heavily parasitized externally, and Andrews tells us that the entire body is more or less thickly infested with whale lice of the Amphipod genus *Cyamus*, and by a species of barnacle which embeds itself deeply on all parts of the body. On the snout, too, there is a structure similar in appearance and position to the bonnet of the Black Right Whale and, according to Andrews, it is produced as in that species by the action of the parasitic *Cyamus*.





SPERM WHALES FEEDING - PERHAPS !

CHAPTER XII: SPERM WHALES AND BOTTLE-NOSED OR BEAKED WHALES.

General features of Toothed Whales. Sperm Whale or Cachalot. Pigmy Sperm Whale. Bottle-nosed or Beaked Whales. Bottle-nosed Whale. *Berardius*. Cuvier's Beaked Whale. Sowerby's Whale. Other species of *Mesoplodon*.

THE second of the two great divisions of the Cetacea—the Odontoceti or Toothed Whales—includes all whales, dolphins and porpoises which do not possess whalebone, but instead are provided with teeth. Sperm Whales, Bottle-nosed or Beaked Whales, Killer Whales, Pilot Whales, all the Dolphins and Porpoises are placed in this group, but although teeth are present in all of them, these are not always very obvious. The range of variation in the number of teeth is very great; forms like the Common Dolphin have over 40 teeth on each side of upper and lower jaw, while at the other end of the scale is the Narwhal with one functional tooth so modified and enlarged that it projects forward from the head as a tusk, which is often more than 8 feet long. In the Beaked Whales the female animals are apparently quite toothless because the pair of teeth found in the lower jaw do not usually project through the gums.

Many other features besides the possession of teeth and the absence of baleen distinguish the Toothed Whales, notably the single blowhole and the small size of the mouth compared with that of the Whalebone Whales. The skeleton also differs

quite markedly from that of the whalebone whales. The upper surface of the skull is always asymmetrical about its long axis and the lower jaws are nearly straight, or with the two halves closely united in front. The ribs, which in the whalebone whales are loosely connected with the backbone, in this group are more firmly articulated. The number of digits in the flipper is never reduced; 5 are always present.

SPERM WHALES.

Family PHYSETERIDÆ.

The family Physeteridæ has two representatives, the Sperm Whale and the Pigmy Sperm Whale. As the name of the latter implies, the two differ considerably from one another in size, but in other respects they have much in common. In both genera functional teeth are restricted to the lower jaw, which itself does not extend to the end of the snout. The single blowhole is situated on the left side near the front end of the head, and the spermaceti organ, a reservoir of transparent oil lying above the bones of the fore part of the head, is characteristic of both forms.

Genus *Physeter*.

THE SPERM WHALE (*Physeter catodon*). Fig. 67.

The Sperm Whale or Cachalot is probably one of the best known of all the Cetacea, and although in the past it was identified by a considerable number of specific names, it is now generally accepted that only one widely distributed species called *Physeter catodon* exists. The name Sperm, a contraction of Spermaceti, refers to the oil contained in the reservoir in the front of the head, which used to be regarded as whale spawn. The other common name, "Cachalot", is from the Gascon "cachau", meaning a large tooth, and of course refers to the row of conspicuous teeth on each side of the lower jaw; "*catodon*" also refers to the teeth, implying that they are

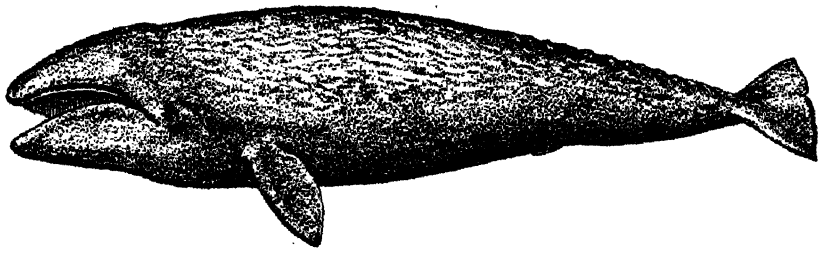


FIG. 66.—Californian Grey Whale (*Rhachianectes glaucus*). To 45 feet.

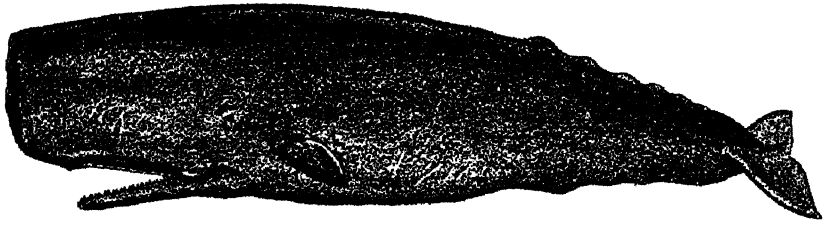


FIG. 67.—Sperm Whale (*Physeter catodon*). To 60 feet.

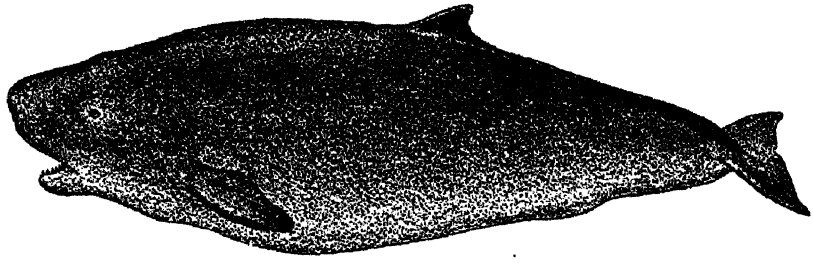


FIG. 68.—Pigmy Sperm Whale (*Kogia breviceps*). To 13 feet.

only to be found on the lower jaw; and "*Physeter*", from the Greek for a blowpipe, alludes to the single external breathing aperture with which the animal is provided.

Its external form makes it impossible for the Sperm Whale to be confused with any other species of Cetacean, whether toothed or not. It resembles a gigantic tadpole in that the most massive and conspicuous part of the body is the head, which comprises about one-third of the total length. The greatest body circumference is situated in the region between the eyes and the flippers, and from this point the body tapers backwards towards the stock of the tail, and forwards, in a lesser degree, to the front end of the blunt rounded head.

The head is not as box-shaped as it is frequently represented in pictures, and if a section were cut at right angles to the long axis just in front of the tip of the lower jaw, which, it will be remembered, does not extend to the front of the head, it would be seen that the upper surface is rounded off evenly to the sides. These are not quite flat, but each has a concavity which, seen in the head as a whole, is a depression running longitudinally, deepest near the front and fading out gradually as it passes backwards. Below this concavity the sides approximate to each other and meet at an acute angle, recalling in form that of the keel of a ship. The single external aperture of the blowhole is situated on the left side near the front of the head.

The lower jaw, although by itself it looks powerful enough, seems disproportionately small in the living animal when compared with the massive head. It may be described as Y-shaped, having the ends of the two branches articulating with the skull and the stem forming the tooth-bearing free end. The number of teeth on either side of the lower jaw is variable and may range from 18 to 28, nor need the number on either side be equal. The teeth are large and powerful, firmly fixed in the jaw-bone, conical in shape when unworn, and frequently attaining a length of over 8 inches. When the mouth is shut the points of the lower jaw teeth are accommodated in sockets in the strong fibrous tissue of the palate, so that even without functional teeth in the upper jaw very adequate provision is made for retaining the food. A few vestigial teeth, an inch or two in length, are sometimes to be

found in the upper jaw. The whole of the inner surface of the mouth and the inconspicuous tongue are of a pearly-white colour.

The Sperm Whale does not have a dorsal fin, but in its place a series of low ridges occupy the posterior third of the dorsal surface of the body, the front and most conspicuous of these being known to the old sperm whalers as the " hump ". The tail flukes are from 12 to 15 feet in width from tip to tip; and the flippers, broad and rounded, are comparatively small for the bulk of the animal. The eye is situated slightly above and behind the angle of the gape, and the small inconspicuous external opening of the ear is a little further back in the region between the eye and the insertion of the flipper.

The surface of the skin is smooth and without the well-defined folds seen in the Rorquals, but occasionally short ill-defined wrinkles or furrows are to be found in the throat region, and in very old animals the whole of the body may be covered with irregular corrugations.

The general body colour is very dark, nearly or quite black on the top of the head, back and flukes, and getting lighter on the sides, till on the ventral surface the colour is silvery grey or white. Considerable individual variation exists, however, and according to Beale in his book on ' Natural History of the Sperm Whale ', published in 1839, some of the animals may even be piebald. He says, too, that " old bulls . . . have generally a portion of grey on the nose immediately above the fore part of the upper jaw and they are then said to be ' grey-headed ' ". The true body colour is often modified, especially in the head region, by long white streaks and by circles—abundant evidence of the whale's struggles with the giant cuttlefish on which it preys for food.

Bull Sperm Whales of very great size have been reported, especially by some of the earlier whalers. Thus, F. D. Bennett in his ' Narrative of a Whaling Voyage round the Globe ', published in 1840, states that the greatest reported length of a male is 76 feet; and Beale, in the book already mentioned, talks of " a full-grown male of the largest size, or about 84 feet in length ". More recent measurements tend to show that the male Sperm Whale never grows much longer than 60 feet.

A striking difference between this species and all the whalebone whales is that, whereas in the latter the female animals are usually a little larger than the males, in the Sperm the female never attains a length greatly in excess of a half that of the full-grown male.

The Sperm Whale is widely distributed throughout the great oceans of the world, and although on the whole it prefers the warmer waters of tropical and subtropical regions, its range extends to the coldest polar seas. It is said of the wanderers into high latitudes that they are old male animals driven from the herd by the younger, stronger bulls ; for it must be remembered that this species is polygamous, and it is likely that struggles take place among the bulls to decide the leadership of the herd. However true this explanation may be, the fact remains that in the Antarctic the Sperm Whales caught are almost without exception old male animals, and on the British coast old males are most commonly stranded. But the remaining and main stock of Sperm Whales is to be found chiefly between the north and south latitudes of 40°. In 1935 the New York Zoological Society published a paper by the Director of the New York Aquarium, Mr. C. H. Townsend, on " The Distribution of Certain Whales as shown by Log-book Records of American Whaleships ", and a study of the charts accompanying the publication is most enlightening. The two charts showing Sperm Whale distribution are for the periods April–September and October–March, respectively. " It will be seen," says Mr. Townsend, " that in the North Atlantic . . . the platted (plotted) areas above latitude 25° are with a few exceptions for the April–September period " (northern summer). " Between north latitude 25° and the Equator Sperm Whales were taken chiefly during the October–March season. Along the east coast of South America . . . the catches were largely made during the same season, or summer-time in the southern hemisphere. Along latitude 35° south towards the Cape of Good Hope whaling data are also for the October–March season.

" Off Japan and along latitude 30° north the plattings are those of the April–September season. In the Pacific equatorial belt, catches for all months of the year are represented. Off the west coast of South America, south of the Equator, the

plattings pertain mostly to the summer season of the southern hemisphere. There was much whaling off Peru at this season. Off the west coast of South Africa the extensive whaling during all months of the year probably may be attributed to the effect of the cool northward-flowing Humboldt Current. This current, deflected westward at the Equator, is responsible for the uniformly cool sea temperatures about the Galapagos Archipelago, where large numbers of Sperm Whales were taken during more than half a century at all seasons of the year."

This species feeds almost exclusively on large squids or cuttlefishes, and the scars of wounds inflicted by the hooks and suckers of the cuttlefishes' tentacles can be seen on the skin of the whales. One author has described how he has seen a Sperm Whale vomit 75 to 100 squids when lanced; undigested fragments of cuttlefish of enormous size have frequently been found in stomachs examined for food contents. Although these great molluscs are its principal food, the Sperm Whale has been known to consume fish as well. A well-authenticated report of a whale in whose stomach a 10-foot shark was found intact, besides furnishing additional information of the range of creatures included in this whale's diet, furnishes the most positive evidence of its capacity to swallow a mass which must have exceeded the proportions of a fully-grown man. To those who are interested in the story of the prophet Jonah it is noteworthy that the Sperm Whale is known to occur in the Mediterranean.

Little is known about the breeding habits of this species. Sperm Whales are said to be polygamous, and the female, besides being smaller than the male, according to Scammon "is likewise more slender in form and has an effeminate appearance". This author puts the period of gestation at ten months, but Sir Sidney Harmer has suggested more recently that it is about twelve months, and perhaps rather more. One calf is usually produced at a birth, never, so far as is known, more than two. The size of the newly-born young one is about 12 to 14 feet; there is a record from South Africa of a fœtus 14 feet in length, but there is another instance of a living young one measuring only 13 feet 3 inches. This latter calf was captured among the reefs at the Bermudas and

was exhibited alive for two days before being killed. A Sperm Whale reported as measuring 18 feet long was stranded on the Irish coast some years ago, and it was evidently a very young animal, for the teeth in the lower jaw had not appeared through the gums.

It has been shown by Harmer that in the southern hemisphere the records of fœtal lengths indicate that the Sperm Whale has a period of maximum frequency of impregnation and births during the latter part of the year, but that the reproductive period is not limited to one part of the year.

In his description of suckling in this species Scammon says that the young calf " obtains its nourishment from two teats situated one on each side of the vaginal opening. In giving suck it is said the female reclines on her side, when the calf seizes the teat in the corner of its mouth, thereby giving the milk food immediate passage to its throat. The length of time the young follow the dam is not known ".

Various authors have drawn attention to the regularity of respiration in the Sperm Whale. The time occupied varies slightly from animal to animal, Beale tells us, but in each individual the period for each respiratory action is minutely regular. A full-grown bull, he says, remains at the surface 10 or 11 minutes, during which he makes 60 or 70 expirations ; he then submerges for an hour and ten minutes.

When a Sperm Whale comes up to blow the " hump " is the first part of the body to break surface ; then follows the upper surface of the head. The blow is easily distinguishable from that of any of the whalebone whales, for instead of rising perpendicularly, the condensed vapour is ejected obliquely from the blowhole. At the end of the respiratory period at the surface, when, as the whalers said, "his spoutings are out", the animal submerges rapidly ; the head is dipped, the body rounded, the flukes come completely out of the water and the creature finally disappears from sight, going down head foremost with the long axis of the body almost vertical.

When undisturbed the Sperm Whale swims along at a speed of 3 or 4 knots, but when pursued it is capable of a speed of 10 or 12 knots.

The blubber of the Sperm Whale, 14 inches thick in places, is a valuable source of oil, but the most important reservoir of the finest spermaceti oil is situated in the head. The skull in shape resembles a wheel-less chariot—indeed the whalers used to refer to it as the " coach " or " sleigh ". The bones forming the posterior portion rise vertically in a crest 3 or 4 feet high, concave towards the front, and from the base of this crest the upper jaw-bones project forward as a triangular rostrum with lateral edges curved upwards. A rough basin-shaped cavity is thus formed, in and above which lies the huge mass of tissue making up the bulk of the head. The lower part of this mass is fibrous, elastic and oily, the " junk " of the whaling men, whilst above and somewhat to the right of the canal passing from blowhole to lungs is the " case " or reservoir containing the clear liquid spermaceti. The function of the spermaceti organ is not clearly understood ; it is believed to be connected with the valvular mechanism for closing the blowhole when the animal descends to great depths, where increased pressure necessitates more complicated provision to prevent water getting into the lungs. It cannot be doubted, however, that in any case the spermaceti organ performs a hydrostatic function, and must contribute quite appreciably to the buoyancy of the body.

When the " case " is tapped a clear colourless oil pours out which in the air solidifies into a white soft wax. Scammon says that as much as 15 barrels of oil have been obtained from the case, and Beale states that a large whale not infrequently contains a ton of spermaceti. This substance is used in making candles, in the dressing of fabrics, for medical purposes, and in the preparation of cosmetics.

One reason for the Sperm Whale being so well known is unquestionably that it is the source of ambergris. This substance originates in the intestine of the whale as a concretion ; it is solid, grey or blackish in colour, lighter in weight than water, smelling offensively when fresh from the animal's body, but in time assuming what has been described as a peculiar sweet earthy odour. The horny beaks of the cuttlefishes which make up the whale's food are frequently embedded in it, and it has been suggested that they form the nucleus for the formation of the substance. Besides being collected from

the whale's body ambergris is found floating in the sea or cast up on the sea-shore. From the earliest times it has been greatly valued, chiefly for the medicinal qualities attributed to it, but in recent times it has been used almost exclusively as a vehicle for retaining the fragrance of the more expensive perfumes.

Robert Burton (1576–1639), in his ' Anatomy of Melancholy ', in the section treating of "Alternatives and Cordials, corroborating resolving the Reliques, and mending the Temperament", states: "After a purge, 3 or 4 grains of Bezoar stone, and 3 grains of Ambergrease drunk, or taken in Borage, or Bugloss water, in which gold hot hath been quenched, will do much good, and the purge shall diminish less (the heart so refreshed) of the strength and substance of the body."

A mass of ambergris, 400 pounds in weight, was found at St. Helena in the year 1716, and Burn Murdoch, in ' Whaling and Bear Hunting', says: "Some years ago Norwegians found 420 kilos in a Sperm on the Australian coast; this was valued at £27,000." Usually, however, the pieces of ambergris which are found are very much smaller, ranging upwards from a few ounces in weight.

The following properties help to distinguish this substance: It melts at 60° Centigrade and burns with a pale blue flame; it is soluble in absolute alcohol, ether, in fat or in volatile oils; the alcohol solution is fluorescent in sunlight, with a characteristic yellow-green rim on the surface of the solution. When heated it gives off an agreeable odour, melts without bubbles or scum, and on the heated point of a knife vaporizes completely away.

The economic importance of sperm oil in the eighteenth and nineteenth centuries put the Sperm Whale for a time in the forefront of commercially valuable Cetacea. The development and operation of the Sperm Whale fishery was mainly in the hands of American whalers and, according to Harmer's 'History of Whaling', to which I am indebted for many of the facts given here, it commenced on the New England coast about 1712. By 1770 the fleet had grown to 125 vessels fishing in an area which included the banks of Newfoundland, the Brazilian coast, the West Indies and, to the east, the Cape

Verde Islands. England entered into the industry in 1785, and it was an English ship which first sailed round the Horn into the Pacific in pursuit of the whales. Soon all the great oceans were being searched, and the animals were being pursued literally from China to Peru. The industry reached its maximum development in 1837, and before the middle of the nineteenth century had begun to decline.

For the ten years 1830–40, 41,241,310 gallons of sperm oil had been secured by American ships; for the decade 1870–80 the figure was reduced to 12,819,493, and, after 1884, the old method of sperm whaling became extinct. The reduction and final disappearance of the fishery was partly due to the extended use of mineral oil as an illuminant in place of sperm oil, but the decline had commenced before the petroleum industry was inaugurated in 1859, so that the decrease reflected a real reduction in the stock of available Sperm Whales. As Sir Sidney Harmer points out, "The naturalist may well feel that he owes much to petroleum", because but for its introduction into the market the Sperm Whale in the nineteenth century mught have been hunted to a point much nearer extinction.

At the present time this whale is again being hunted, but now, instead of being pursued by half a dozen men in a rowing boat and using hand harpoons, steam whale catchers with harpoon guns greatly reduce the hazards of the chase. In the whaling period covering the southern summer 1934–35 and the northern summer 1935, 2238 Sperm Whales were taken from the following regions: South Georgia and the Antarctic Continent, 577; coast of Natal, 595; Japan and Korea, 479; British Columbia, 175; Chile, 173; the Azores, 136; with lesser numbers for the Faroe Islands, Norway, Newfoundland, Alaska and Mexico. Attention may be drawn to the rapid increase in the number of Sperm Whales taken in the Antarctic in the last few years. From 1919–20 up to and including the season 1931–32 the Sperm catch was always less than 100 in any one season; in 1932–33 it reached 107; in 1933–34, 666; and in 1934–35, 577. These figures, together with those preceding them, have been extracted from the 'Norsk Hvalfangst-Tidende' for August, 1936. Apart from any consideration concerning the effect of this increasing

slaughter on the total stock of Sperm Whales, it is interesting to note the indication given by the figures of the abundance of these whales in high latitudes.

Genus *Kogia*.

THE PIGMY SPERM WHALE (*Kogia breviceps*). Fig. 68.

The Pigmy Sperm Whale or Lesser Cachalot, notwithstanding its small size compared with *Physeter*, is closely related to the great Sperm Whale. It agrees with the latter animal in having the single blowhole situated a little on the left side of the head, in the possession of a spermaceti organ, in having functional teeth restricted to the lower jaw, and in numerous osteological characters which need not be mentioned here.

The name *Kogia* is said to be the latinized form of the word " codger ", and *breviceps*—short-headed—the trivial name of the best known species, refers to a character common to all the forms of this genus which, at one time or another, have been given specific rank. The head of the Sperm Whale, it will be remembered, constitutes one-third of the total body length, whereas that of the Pigmy Sperm is about one-sixth. The rostrum or beak portion of the skull is not elongated in *Kogia* as in *Physeter* and, associated with this, the external outline of its head is not unlike that of the Common Porpoise. It differs from the Porpoise, however, in that the lower jaw, instead of extending forwards to the tip of the snout, ends several inches behind it. Indeed, the shape and position of the lower jaw recall to some extent that of a shark.

The external form of the body is like that of an ordinary dolphin; passing backwards from the roughly conical head the outline merges into that of the trunk without perceptible break. The greatest circumference is in the region between the flipper insertion and dorsal fin which, in *Kogia*, is well defined and well developed, not at all like the " hump " found on the Sperm Whale's back. This fin is situated midway along the body, and is falcate in form like that of the Common Dolphin. The body tapers from just in front of the dorsal fin to the stock of the tail which, before widening out to the tail

flukes, has a vertical height about double the transverse dimension. The pectoral flippers are tapering, not rounded as in the Sperm Whale, and are about one-sixth of the body length.

The blowhole, as described by Sir Richard Owen, "is crescentic, but curves obliquely from the mid line outward and backward with the convexity turned forward and to the left and the angles or 'cresses' directed backward and to the right".

The teeth, of which there are 9 to 14 pairs in the lower jaw, are pointed, slender and curved. They fit into sockets in the tissues of the upper jaw when the mouth is closed. Very rarely a pair of teeth have been found in the upper jaw.

The body colour is black on the back and light grey or pinkish on the under surface.

The Pigmy Sperm grows to a length of 9 to 13 feet, but the size at which it is fully grown has been partly responsible for the recognition of more than one species. "*Kogia breviceps*," says Sir Sidney Harmer, "appears to be fully adult at less than 10 feet, but *K. macleayi*, which I am inclined to regard as distinct, on the evidence of cranial characters, appears to reach a somewhat greater length."

The Pigmy Sperm has a wide distribution; stranded specimens have been recorded from New Zealand, Australia, Indo-China, India, South Africa, the east and west coasts of North America, and in Europe from France and Holland.

Little is known about its breeding habits. The Dutch specimen found on December 13th, 1925, was a female 9 feet 8 inches long, and had a fœtus about 8 inches long. Another 9-foot female, stranded on Trivandrum beach on December 19th, 1924, had a fœtus 9 inches long. Although certain conclusions cannot be drawn from so few data, the close correspondence in the size of the fœtuses at the same time of year suggests that in this genus breeding may be restricted to definite periods in the year.

There is as little information about feeding as breeding, but there is the record of the stomach contents of the specimen stranded on the French coast consisting of the remains of a shore crab and beaks of cuttlefishes.

It is not a very commonly occurring species, and is without

commercial importance of any kind. No information is available about its swimming habits, and it is not known whether or not it migrates.

BOTTLE-NOSED OR BEAKED WHALES.

Family ZIPHIIDÆ.

The group of Bottle-nosed or Beaked Whales is made up of a number of species of moderate-sized Cetaceans ranging from about 15 to 30 feet in length. They resemble the Sperm Whale in having functional teeth restricted to the lower jaws; also the skull bears a general similarity to that of the Sperm, for, as in the latter creature, the bones behind the breathing orifices are raised into a conspicuous crest, and the rostrum or forward extension of the skull is elongated and tapering. Unlike the Sperm Whale, however, which has a blunt and very massive head, the Ziphioid Whales are characterized by a long narrowed snout, which in some species is sharply defined from the rest of the head and in others merges gradually into it.

On the under surface of the throat are two deep longitudinally running grooves in the skin, which almost meet in front and diverge as they pass backward. The flippers are small in all members of the group, and the dorsal fin, always situated well behind the middle of the back, is triangular with concave posterior border. The middle of the hinder border of the flukes instead of being notched is slightly convex.

At least one pair of teeth of moderate size is to be found in the lower jaws, but in young specimens of both sexes and in females irrespective of age these are embedded in the tissues of the gums so that the animals appear to be toothless. In male animals the teeth erupt sooner or later and vary considerably in size in the different species; in old female animals also the tips of the teeth occasionally push through the gum. In addition to these larger teeth, series of very small vestigial teeth are fairly frequently found extending along the gums of upper and lower jaws. As many as 32 have been recorded in one row; they are relics of an earlier stage in the evolution of these animals when the dentition approximated more closely to that of existing dolphins.

Genus *Hyperoodon*.

THE BOTTLE-NOSED WHALES. Fig. 69.

The genus *Hyperoodon* includes the two species, *H. rostratus*, the northern Bottle-nosed Whale, and *H. planifrons*, its congener in the southern hemisphere. Little is known about the external form of the latter species, so that the description of the genus given here refers particularly to the more abundant northern form. The common Bottle-nosed Whale is, when fully grown, of moderate size, males attaining to a length of some 30 feet and females to about 24 feet. The front end of the body is characterized by a snout more sharply defined from the remainder of the head than in any of the other Ziphioids, and by the presence of a prominent " forehead " which in the male bulges more with age. Underlying the " forehead ", and responsible for its change in form, are two crests of bone, one on each side, on the forward extension or rostral portion of the skull. These crests are low and widely separated in the young *Hyperoodon*, but as the animals become adult they grow more and more massive, approximating to each other to form a boss of great compactness and solidity.

From the head the outline of the body passes evenly backward into that of the trunk, which has its greatest girth behind the insertion of the flippers, from whence it tapers towards the tail. The back fin is considerably behind the middle of the body, and neither in form nor in position is it distinguishable from that of any other Ziphioid. The flippers also, relatively small and pointed, are without characteristic generic distinction. The single blowhole, as in all Ziphioids, is crescentic in shape with the concave margin towards the snout. Grooves are to be found in the skin in the region of the throat and two seems to be the typical number, but in some embryos examined by one cetologist four were to be seen.

The general body colour is very dark grey to black on the dorsal surface, and somewhat lighter grey to white on the ventral surface. Flippers and flukes are dark coloured on both upper and under surface. Old animals tend to be generally lighter in colour than young ones.

The similarity of appearance in all Ziphioids makes the form

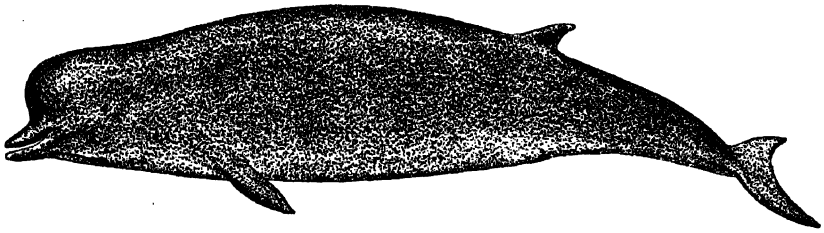


FIG. 69.—Bottle-nosed Whale (*Hyperoodon rostratus*).

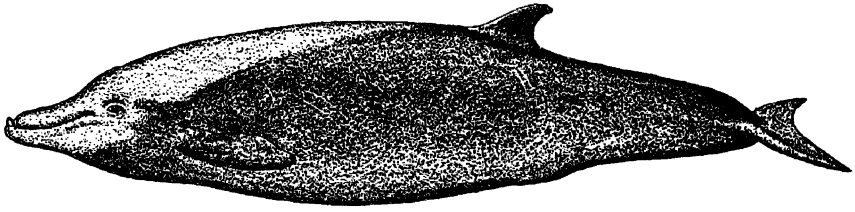


FIG. 70.—Cuvier's Beaked Whale (*Ziphius cavirostris*).

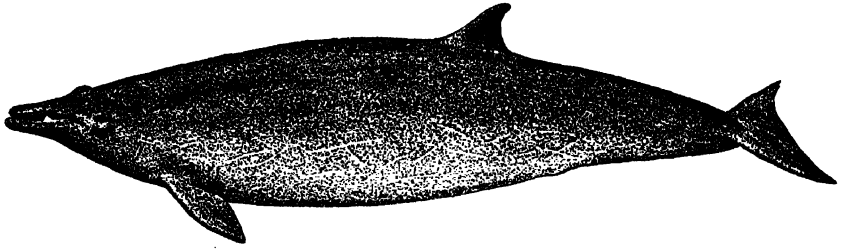


FIG. 71.—Sowerby's Whale (*Mesoplodon bidens*).

and position of the teeth of considerable diagnostic value; especially in view of the fact that in so many species the external form is very imperfectly known. In *Hyperoodon* a pair of large teeth are to be found at the tip of the lower jaws, usually concealed in the tissues of the gum, but in old specimens sometimes with the points projecting. Those taken from a stranded male Bottle-nosed Whale 26 feet long may be regarded as typical; they are conical, but expanding somewhat at about half their length, then narrowing slightly to the lower end. These teeth are about 1½ inches in length at their widest point, oval in cross-section, with the long axis about ¾ inch and the short axis about ½ inch. In adult females the teeth are smaller, but with the same general characteristics. Occasionally two pairs of teeth have been found in the lower jaws, the second pair situated a little behind the first and of much smaller size. Series of small vestigial teeth are also found extending along upper and lower jaws, but completely concealed in the gums.

A feature serving to distinguish *Hyperoodon* from the related genus *Ziphius*, with which it tends to be confused, is the proportion that the distance from the tip of the snout to blowhole length bears to the total length. Sir Sidney Harmer has pointed out that in *Ziphius* the proportion expressed as a percentage is from 10·4 to 12·6, with an average of 11·46, whilst in *Hyperoodon* it is from 14·0 to 22·0, with an average of 17·46, the beak increasing in length with age.

The Bottle-Nosed Whale, *Hyperoodon rostratus*, is an abundantly occurring boreal species, and is common off the British coast. The specimens stranded on our shores, for the most part in late autumn and winter, are believed to be migrating individuals which, having spent the summer months further to the north, are on the return journey southward. It can be inferred from the distribution of stranded specimens that, to quote Sir Sidney Harmer, " in the autumnal, southward migration at least, the Bottle-nosed Whale is indifferent as to the course it takes, since it has appeared in the North Sea and the English Channel, in the Irish Sea and on the Atlantic coast of Ireland ". Old male animals rarely strand on the British coast.

Females are believed to be more numerous than males and

the calves when born are about 10 feet in length, but little is known about the breeding habits of this species.

The food consists of cuttlefish and, as in other Ziphioids, the stomach is divided up into numerous compartments, and the intestine makes up for its shortness by the elaborate reticulated folding into which its internal lining is thrown.

Small schools of from four to a dozen animals move about together and occasionally they all become stranded at the same time as, for example, in 1927, when four were found on the coast of Sutherland, in Scotland. F. E. Beddard in 'A Book of Whales' says: "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." In the latter part of the nineteenth century when Greenland Right Whales had become scarce, and before the modern Rorqual fishery had developed, the Bottle-nosed Whale was hunted extensively in Arctic seas, for besides the oil yielded by the blubber, this species has in the head a reservoir in which spermaceti, not differing greatly from that of the Sperm Whale, is to be found.

The weight of a female Bottle-nosed Whale 21 feet 8 inches in length is recorded as 2 tons 18 cwt.

Genus *Berardius*.

Fig. 72.

Berardius is one of several cetacean genera not sufficiently well known to be identified by a common name. Two species are recognized, *B. bairdii* and *B. arnuxii*, the former from the North Pacific and Bering Sea, and the latter from the Southern Ocean—New Zealand, Falkland Islands, South Georgia and the South Shetlands.

Both species are distinguished by having two large teeth on each side of the lower jaw; the front pair, situated at the tip of the jaws, more massive than the others, but both pairs compressed laterally and roughly triangular in side view. The length of the front teeth is about 3 inches, and of the hinder as much as 2 inches.

The external form is like that of *Hyperoodon*, with tapering snout and well-defined forehead, but having the tip of the

lower jaw, at any rate in a specimen stranded at Ferndale, California, projecting beyond the tip of the upper. So far as is known there is little difference in colour between the species: both are black dorsally and light coloured or white below. A specimen of *B. arnuxii*, caught outside Deception Island, South Shetlands, is described as having " upper parts bluish-black, under parts greyish to white with tiny black flecks, to dark grey. A large number of white scars covered the body. The two large teeth are anterior to the front of the upper jaw ".

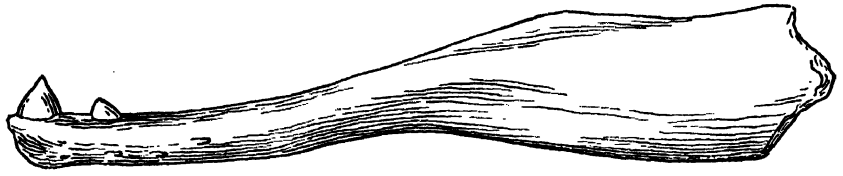


FIG. 72.—Lower jaw of *Berardius*.

B. bairdii is distinguished from *B. arnuxii* by its greater size; it reaches a length of about 42 feet—a giant among Ziphioid whales—whereas the other is full grown at 32 feet. Available knowledge of the two species indicates that their distribution does not overlap.

In *Berardius* the skull is much more nearly symmetrical about the middle line than in any other Ziphioid. The tubercles are present near the proximal end of the rostral portion of the skull, as in *Hyperoodon*, but are not nearly so greatly developed as in that species. In *B. arnuxii* the skull is one-seventh of the body length, in *B. bairdii* it is one-eighth, so that although the latter is the larger species, the head is relatively smaller. Besides the characters mentioned, many osteological differences distinguish the two *Berardius* species from one another and from the remaining Beaked Whales, but such internal distinctions are outside the scope of this work. Exceedingly little is known about the habits of this genus; the total number of known specimens is in itself quite small.

Genus *Ziphius*.

CUVIER'S BEAKED WHALE (*Ziphius cavirostris*). Fig. 70.

Cuvier's Beaked Whale or, as it is sometimes called, the Goose-beaked Whale, is the only known representative of the genus *Ziphius*. Its external form, although conforming generally to the typical Ziphioid pattern, is distinguished by the shortness of the beak compared, for instance, with that of the common Bottle-nosed Whale. There is no pronounced forehead, as in the latter species; instead the dorsal surface of the head behind the beak slopes backwards at quite an oblique angle from the snout. The distance from the tip of the snout to the blowhole is one-tenth to one-eighth the total length. It is difficult to pick out well-defined external characteristics which distinguish this whale, although certain cranial features isolate it from other Ziphioid genera.

The colour varies markedly in different specimens; thus a young animal from the New Zealand coast is described as " purplish-black above, brown on the sides, and white below, except towards the tail, where it was brown ". An aged female specimen from the same region was " bluish-black on the upper portion of the body, white beneath, the upper portion being marked with numerous oval spots 2 or 3 inches across like the skin of a leopard ". A young female from New Zealand and a specimen from the British coast figured in Sir Sidney Harmer's Report No. 10 on 'Stranded Cetacea' had this scheme of coloration reversed. Describing the English specimen Harmer states: " The whole of the head, including the lower jaw, and part of the body were cream-white, separated from the dark skin of the rest of the animal by an oblique line passing from the anterior end of the dorsal fin, in front of the flipper, to the posterior end of the lower jaw. Much of the skin was covered by long, linear streaks, resembling those usually found in *Grampus griseus*." It will be seen from these descriptions that body colour does not help very much in the identification of Cuvier's Whale.

The teeth, a single pair at the tip of the lower jaw, are visible during life in male animals of this species. They are rounded or conical at their tips, and have their greatest diameter

about midway between the tip and the tapered lower end. As a typical example the teeth of a male Cuvier's Whale 21 feet long may be taken ; they were 2¼ inches long and over 1¼ inches in diameter. In the female the teeth are not usually visible in the living animal, and never attain the massiveness found in males, but remain slender and tapering throughout life. Occasionally the tips of the teeth may be visible in the female. Vestigial teeth embedded in the gums of the upper and lower jaws are not uncommon in this species ; the occurrence of 28 or 30 in a row in young animals and reduced numbers in older ones suggests that as these whales grow to maturity the vestigial teeth are absorbed and disappear. The scratches and healed scars seen on the skin of Cuvier's Whale are believed to be caused by wounds inflicted by the teeth of animals of the same species.

Cuvier's Whale grows to a length of 26 feet, that is to say it is normally rather smaller than the common Bottle-nosed Whale. It is a widely distributed Cetacean, and one that until the recording of stranded specimens on the British coast was undertaken was believed to be but rarely found in the vicinity of the British Isles. Since 1913, however, there have been 20 well-authenticated records of this species. Some idea of its range may be obtained from the following list of localities from which specimens have been reported: Sweden, the Biscayan shores of France and Spain, Corsica, the mouth of the Rhone, Massachusetts, Buenos Aires, Cape of Good Hope, India, Queensland, Tasmania, New Zealand.

This whale is of no commercial importance and nothing is known of its habits.

Genus *Mesoplodon*.

Figs. 71, 73.

The genus *Mesoplodon* includes one or two moderately abundant forms, but for the most part the information concerning this group of Beaked Whales is exceedingly scanty, and amongst its species are some of the rarest and most aberrant Cetaceans known to exist. At least nine species are recognized at the present time, distinguished from one another, unfortunately for our present purpose, by osteological features in the skull and lower jaws. A single pair of large teeth is

found in the lower jaws, and their position and form gives some guide to the different species encountered, but as the teeth are usually concealed beneath the gums in female animals during life they are not very useful for distinguishing the species when only a superficial examination can be made. Within individual species the body colour itself is not constant, and external markings are insufficiently conspicuous to help in identification.

The name *Mesoplodon* implies " armed with a tooth in the middle of the jaw ", and refers to the position in the lower jaw of the teeth in the first species to be described—Sowerby's Whale (*M. bidens*). In this species the pair of teeth is situated at some distance behind the tips of the lower jaws. It is useful in the description of the species of *Mesoplodon* to have some fixed point of reference for the position of the teeth in the jaw, and for this purpose the hinder end of the junction (the mandibular symphysis) of the two branches of the lower jaw is used. It will be seen presently that not all the species of *Mesoplodon* conform to the description implied in the generic name where the position of the teeth is concerned, for in some the teeth are situated as near to the apex of the lower jaw as it is possible for them to be.

In adult animals belonging to this genus the forward extension of the skull forming the rostrum or beak is a dense rod-like mass of bone. It derives its solidity from the ossification of a cartilaginous structure situated between the bones of the upper jaw and its coalescence with them.

The commonest species is Sowerby's Whale, a creature which attains a length of some 16 feet. The head is more slender and tapering and the forehead more receding than in other Beaked Whales. The dorsal fin, flippers, flukes and throat grooves show no marked variation from the typical Ziphioid pattern. The body colour is black or bluish-black, sometimes grey or white on the under surface. Harmer, describing one specimen, says: " Certain parts were grey, namely the anterior edges of the tail-flukes, part of the lower jaw (which was partly white) and the upper jaw, which had white edges." As in Cuvier's Whale, scratches and marks on the skin are believed to be caused by the teeth of animals belonging to the same species.

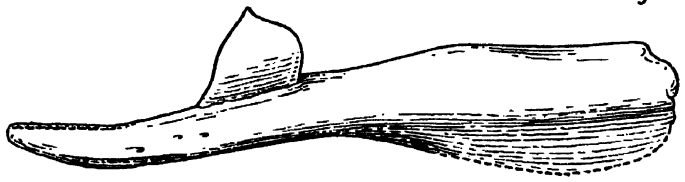
The teeth are situated at a distance of about one-third of the length of the jaw from the front end, near the hinder edge of the mandibular symphysis. In the male they appear above the gum as triangular flattened processes. The root portion of the tooth is set obliquely in a deep socket in the jaw, is about twice as long as the projecting apex and much roughened and scored. A typical example of a tooth from a male measured $3\frac{3}{4}$ inches in length and about $1\frac{1}{4}$ inches from front to back. In the female the teeth are triangular in outline, smaller than in the male, but similarly flattened in form. In a typical female specimen 15 feet 6 inches long each tooth was $1\frac{3}{4}$ inches in height, $1\frac{5}{8}$ inches along its posterior border, and $2\frac{1}{4}$ inches along the anterior border. Small vestigial teeth are sometimes concealed in the tissues of the gum.

Sowerby's Whale is a North Atlantic species, known from both eastern and western shores of that ocean. It has been recorded from Nantucket Island and Massachusetts in America, and from the coasts of Britain, France, Holland, Belgium, Germany and Scandinavia on the European side. British records of the species total about 22 since the beginning of last century, when the specimen from which the species was originally described was cast up on the shore of the Moray Firth. Beddard in 'A Book of Whales' mentions a Sowerby's Whale captured at Havre in 1828 and kept alive for two days out of water: "It was offered 'soaked bread and other alimentary substances'! 'It emitted a low cavernous sound like the lowing of a cow.'"

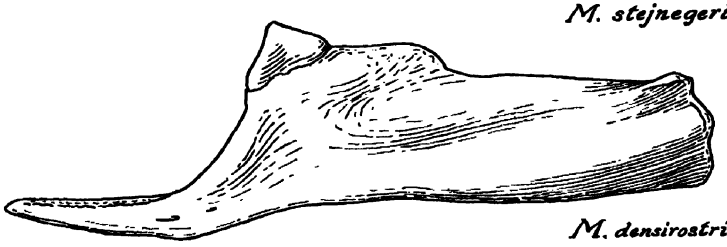
Two fœtal specimens are recorded, the one 5 feet 2 inches in length, from an animal stranded December 18th, 1892, and the other 3 feet $11\frac{1}{2}$ inches in length, from a female stranded February 3rd, 1926. It would appear from these records that one calf is normally produced at a time. The difference in the size of the fœtuses indicates no very restricted period of pairing.

Mesoplodon europæus is a very rare species, only three specimens being known, one found floating in the English Channel and the other two from the New Jersey coast of America. In many respects like Sowerby's Whale, this species is larger in size, growing to 22 feet in length. A feature which distinguishes *M. europæus* from *M. bidens* is the position of the teeth in front of the hinder edge of the mandibular symphysis.

M. layardi ×$\frac{1}{12}$



M. stejnegeri ×$\frac{1}{8}$



M. densirostris ×$\frac{1}{8}$

M. bidens ×$\frac{1}{8}$

M. europaeus ×$\frac{1}{8}$

M. hectori ×$\frac{1}{8}$

M. mirus ×$\frac{1}{8}$

Mesoplodon densirostris is another rare species, characterized by the massive development of the lower jaw teeth. They are so large that the lower jaw is greatly modified to accommodate the sockets in which the teeth roots are inserted. Where the teeth are situated, about halfway along the jaw from the tip, the upper margin of the jaw is raised into a crest from which the crown of the tooth protrudes. The point of each tooth is directed vertically upwards, and in a typical male specimen the dimensions were: Length 6 inches, width front to hinder margin $3\frac{3}{8}$ inches, width cheek side to tongue side $1\frac{3}{4}$ inches. The soft tissues of the lower jaw are modified to conform with the bony structure, the upper edge passes obliquely upwards from the tip to the region of the tubercle bearing the tooth, and then dips down again into a shallow concavity before reaching the angle of the gape.

The maximum length attained by this species is about 15 feet. Seven specimens are known from widely separated places, including the Seychelles, Lord Howe Island, South Africa, Massachusetts and New Jersey in the United States of America and Madeira.

In the Strap-toothed or Layard's Whale, *Mesoplodon layardi*, the tooth modification reaches its extreme limit. The single pair of teeth situated near the hinder end of the mandibular symphysis of the lower jaws has each a small pointed enamel-covered crown on the outside, borne on a flattened root portion which grows longer with age, so that the free tip curves at first upwards and backwards, then over the forward extension of the upper jaw and, with its fellow, finally forms an arch which only permits the lower jaw to open to a very limited extent.

A female specimen 16 feet in length is described by W. R. B. Oliver in the 'New Zealand Journal of Science and Technology', 1924. Referring to the dentition he says: "Each tooth is triangular with the denticle well developed and projecting outwards at right angles to the basal portion, which is entirely enclosed in the alveolus. Although in the adult the teeth are convex on the outer surface, in very young specimens the outward-projecting denticle gives the appearance of the teeth having the concave surface outwards."

The body colour is said to be black above and white beneath,

and the maximum length reached by this species is over 16 feet.

Up to the present the infrequent reports of the occurrence of this animal have been entirely restricted to the southern hemisphere, including New Zealand, Australia, South Africa and the Falkland Islands.

Mesoplodon stejnegeri is known from but two specimens, both from the Pacific coast of North America. The massive teeth are situated entirely behind the symphysis of the lower jaws, which itself is much shorter than in Sowerby's Whale. The teeth are " inclined slightly inward and backward, but the pointed tip curves outward so as to be vertical ". " The posterior angle is rounded and the anterior raised into an acute point by the projection of the dentine as a distinct, sharp cusp." In one of the specimens described, the tooth measured $5\frac{3}{4}$ inches along its anterior border, $8\frac{1}{4}$ inches along its posterior border, $3\frac{1}{4}$ inches fron anterior to posterior border, and just over $\frac{1}{2}$ inch in transverse thickness.

Of *Mesoplodon bowdoini* there are also only two known skeletons, both found on the coast of New Zealand. This species has a pair of large flattened teeth situated behind the short mandibular symphysis ; the apex of the tooth is directed upwards. Nothing is known about the external appearance, but the animal is closely related to Sowerby's Whale.

Mesoplodon grayi, the Southern Beaked Whale, has a pair of inconspicuous triangular teeth near the hinder edge of the mandibular symphysis. This form is said to be characterized by the row of small teeth on each side of the upper jaw, but as similar teeth are to be found occasionally in several other species as well it is not a very indicative character for this one. Like the preceding species, *M. grayi* is as yet only known from specimens in the southern hemisphere, from localities including the Chatham Islands, New Zealand, Australia and Patagonia.

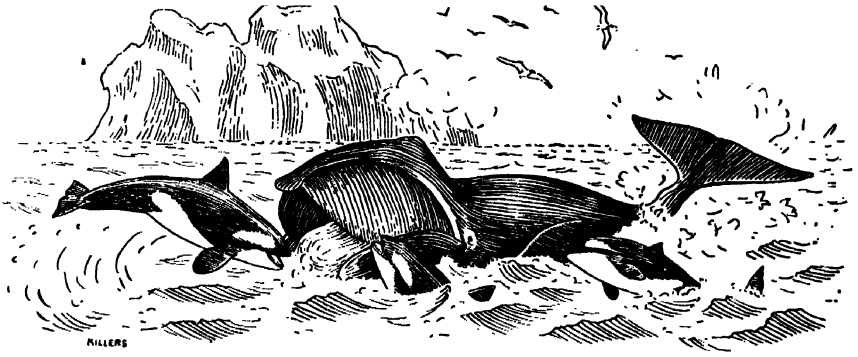
The two remaining species, *Mesoplodon hectori* and *Mesoplodon mirus*, differ from those already mentioned by having the two lower jaw teeth situated close to, or at, the apex of the lower jaw. *M. hectori*, the New Zealand Beaked Whale, is known from two specimens, both from New Zealand. The flat triangular teeth and their position close to the tip of the

jaw distinguish this species, about whose external appearance nothing whatsoever is known.

In *Mesoplodon mirus*, True's Beaked Whale, the teeth are inserted in sockets at the very tip of the lower jaw and project obliquely forward. They are easily distinguishable from those of Cuvier's Whale, with which this species might be confused, by being pronouncedly compressed laterally. The original specimen described by True in 1913 had the following body colouring: "back, slate black; lower sides, yellow purple, flecked with black; medium line of belly somewhat darker; a greyish area in front of the vent; fins the colour of the back." It was an adult female 16 feet long, and the two teeth entirely concealed beneath the gum were slender in form. In a male specimen 17 feet long, stranded on the coast of co. Clare, the teeth were much more massive than in the female just mentioned. They projected nearly an inch beyond the tooth sockets, and in the living animal the tips were probably exposed above the tissues of the gums. The flattened oval cross-section of the tooth was 1 inch by slightly more than $\frac{1}{2}$ inch.

Five specimens are at the present time known to have been stranded—one on the North Carolina and one on the New England coast, two on the coast of Ireland, and one on the Outer Hebrides.

The species of the genus *Mesoplodon* are difficult to describe by external characters alone, and the group is one about which much is still to be discovered. The rarity of occurrence of most of the forms focuses attention on the few that have been found; the reduction in the number of teeth, and the extreme modification of the functional pair that persist, contribute to the interest of a genus which must be considered extraordinary even in the highly specialized group of mammals that constitutes the Order Cetacea.



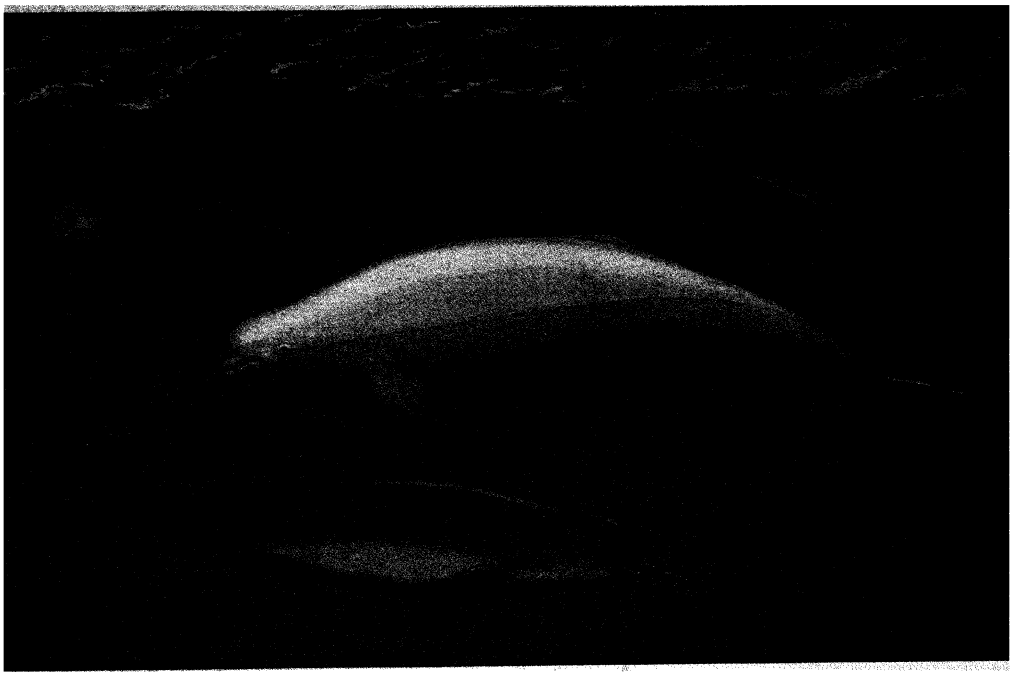
CHAPTER XIII: PORPOISES AND DOLPHINS.

General features of Porpoises and Dolphins. Narwhal. White Whale or Beluga. Killer Whale or Grampus. False Killer Whale. Irawadi Dolphin. Risso's Dolphin. Pilot Whale.

Family DELPHINIDÆ.

THE family Delphinidæ includes those Cetaceans popularly referred to as Dolphins and Porpoises; creatures of relatively small or moderate size, usually but not invariably having a dorsal fin about the middle of the back, and also, but again not invariably, possessing functional teeth in upper and lower jaws. The normal range in size is from 5 to 14 feet, but included in the family are some rather larger species which, although quite typical dolphins, have been dignified by the name of " whale ". Thus we have the Killer Whale, the False Killer Whale, the White Whale, the Pilot Whale—all of them true dolphins.

A single crescentic blowhole situated well back from the tip of the snout and having its concave margin forward is found in all members of the family. Many structural features distinguish the family; the absence of whalebone in the mouth separates its members at once from the Mystacoceti or Whalebone Whales, and of crests on the skull from the Beaked and Sperm Whales. From the River Dolphins the family Delphinidæ is distinguished by having only 4 or 5 pairs of double-headed ribs, whereas the former have 8 pairs.



A. Risso's Dolphin (*Grampus griseus*). B. White Whale (*Delphinapterus leucas*). C. Narwhal (*Monodon monoceros*). D. Chinese River Dolphin (*Lipotes vexillifer*).

Scoresby gives the adult length as from 13 to 16 feet, exclusive of the tusk, but some other writers have not been so conservative in their estimates. Confusion has no doubt sometimes been caused by the tusk length being included with that of the body in statements of total length.

The Narwhal is an Arctic species, seldom found far from the icy regions of the northern polar seas, but stragglers occasionally wander away so that we have a few records of strandings on the coast of Norway, Holland and the shores of Great Britain.

" Narwhals," says Scoresby, " are quick, active, inoffensive animals. They swim with considerable velocity. When respiring at the surface they frequently lie motionless for several minutes, with their backs and heads just appearing above the water. They are of a somewhat gregarious disposition, often appearing in numerous little herds of half a dozen, or more, together. Each herd is most frequently composed of animals of the same sex."

The function of the tusk is not certainly known, although several ingenious suggestions have been advanced as to its probable use ; as an instrument for breaking ice for the animal to come to the surface to breathe in frozen regions, as a rake for obtaining food from the bottom of the sea, even as a sort of skewer for transfixing the animals upon which the Narwhal feeds ; but most of these suggested reasons for having a tusk are open to the objection that the females manage to survive equally well without. Another suggestion, and the most likely, is that the tusk is a sexual specialization of the male used when in combat with his fellows for the possession of the females.

Cuttlefishes are the main food of Narwhals, but fishes and crustaceans have occasionally been found in their stomachs.

This species was formally of considerable economic importance, chiefly on account of the ivory obtained from the tusks, but also because of the rather superior quality of the oil secured from the blubber. The whalers hunted it by methods similar to those employed in pursuit of the Greenland Right Whale, and Scoresby tells us that when harpooned the Narwhal dives in the same way and with almost the same velocity as the Greenland Whale, but not to the same extent. " It

generally descends about 200 fathoms, then returns to the surface, and is despatched with a lance in a few minutes."

In the 'Geographical Review' (New York) for September, 1918, there is an account by M. P. Porsild "On 'Savssats': A Crowding of Arctic Animals at Holes in the Sea Ice". He describes how, near Disko Island, by the freezing of the ice, Narwhals and White Whales are restricted to bays from which they cannot escape. They crowd at these holes—Eskimo 'savssat'—which are apparently made by the cushion on the head in front of the blowhole and not by the tusks. He states too that the male rests, sometimes asleep, with its tusk on the ice through one of these holes. Great numbers are slaughtered at the savssats, and one of the figures shows a pile of 200 tusks obtained during the winter of 1914–15.

An interesting account from the log of a famous whaling captain, David Gray, of Peterhead, is given by Frank Buckland in 'Animal Life' of a fight between a Narwhal and a Walrus. Both creatures were eventually killed by the whalers, and when the Narwhal was examined it was found to have been disembowelled, and had had much of the blubber of the belly region eaten away. The Walrus's stomach, when examined, was found to contain, besides pieces of sealskin, the part of the Narwhal it had eaten. Captain Gray suggested that the Walrus had come upon the sleeping Narwhal, had gone underneath it, and, digging its tusk into the cetacean's belly, had clasped it round the body with its flippers and later assumed the position in which the whalers discovered it—the Walrus uppermost and the Narwhal underneath.

Genus *Delphinapterus*.

THE WHITE WHALE OR BELUGA (*Delphinapterus leucas*). Pl. VII B.

The only other representative of the sub-family Delphinapterinæ besides the Narwhal is the White Whale or Beluga, the latter a Russian word having the same meaning.

It is closely akin to the Narwhal, and indeed a young White Whale might easily be confused with a tuskless Narwhal except that the former creature has teeth in both jaws. Like

its relative the White Whale has no dorsal fin, but is almost unique amongst cetaceans in having, in an ill-defined constriction behind the head, some semblance of a neck. The head itself is without a constricted beak, and its outline is convex from tip of upper jaw to blowhole. The girth of the body at the middle is somewhat greater than that of the Narwhal, and the flippers are broader and more rounded than in that species.

Eight to 10 teeth are to be found on each side of upper and lower jaws, and in the young animal they may bear little lobular processes in front of and behind the apex. In a specimen taken in the River Forth in 1932 some of the teeth had two lobes, one in front of and the other behind the main cusp, and others had three little subsidiary cusps. The teeth of the adult become worn down, are thicker and longer than in immature specimens and have a diameter of about four-fifths of an inch.

The whiteness, without spots or markings of any kind, of the adult Beluga distinguishes this species from all other Cetaceans. The animal assumes this colour when it is four or five years old, before which it is, when very young, very dark grey; later it is mottled, and then yellow, before becoming completely unpigmented.

The White Whale grows to a length of 12 to 14 feet, but sometimes attains a rather larger size; 18 feet has been quoted as the upper limit.

Like the Narwhal it is a boreal species, circumpolar in its distribution and usually limited in its range to high Arctic latitudes. On the east coast of America it is abundant in Davis Strait, Hudson Bay, and the Gulf of St. Lawrence, going as far up river as Quebec. On the western side of America it occurs off the coast of Alaska, and there is a record of one taken by the Russians in 1863 at Nulato on the Yukon River, about 700 miles from the open sea. It is plentiful in the White, Kara and Okhotsk Seas, where it enters the mouths of rivers, nets being used in its capture during a fishing season which extends from June to September. It is to be seen, according to the Norwegian authority, Collett, almost every year off the northern Norwegian coast and in Veranger Fjord. In hard winters it has been known to go further south, along

the coast, and records exist of its occurrence in the Baltic Sea.

The White Whale is only an occasional visitor to the British coast, there being less than a dozen records of its occurrence in the last 140 years. The latest instance to be reported was the young animal already mentioned captured near Stirling on the Firth of Forth in 1932. It was a young male, 8 feet 6 inches long, having the dark mouse-grey colour of immaturity.

The food of the White Whale consists of fish of considerable size, cuttlefishes and crustaceans. Scammon tells us that " when making prey of such bottom fish as flounder and halibut it often darts into shallows where it can hardly float".

The species is gregarious, moving about according to Scoresby in families or herds five or ten together. It is said to advance in lines seldom more than two or three abreast, or more frequently in single file, spouting irregularly and showing little of its form above the water. " When undulating along," says Scammon, " it often makes a noise at the moment of coming to the surface to respire which may be likened to the faint lowing of an ox ; but the strain is not so prolonged."

The skin of the White Whale is manufactured into valuable leather, generally called " porpoise-hide ", which is used for making boots and bootlaces. The animal is also hunted for its oil and, in the Arctic, its flesh and blubber are used as food for men and sledge dogs.

Sir Sidney Harmer, in his ' History of Whaling ', states on the authority of Collett: " The schools now found there (Spitzbergen) during the summer months are inconsiderable compared with those of the seventies of the last century. The Tromso vessels were formerly able to kill about 2000 White Whales annually, but since the nineties they have seldom caught more than 300, and in certain years less than 20. Collett adds: The capture of White Whales at Spitzbergen may be said to be almost discontinued. Year by year they go further to the east to find an unmolested place for breeding."

Before ending the account of this species, reference should be made to two attempts to keep specimens in the old Westminster Aquarium. The first animal was brought across from Labrador in 1877 and died four days after its arrival in London. The second one, caught in the following year, was transported

from Newfoundland in a packing-case filled with seaweed. Five weeks elapsed between the animal's capture and its return to its natural element in the Aquarium. That it should have survived out of water for so long is very remarkable, for a day or two is the most that stranded animals usually remain alive when they are cast up on the beach. The animal's own weight when it is out of water is normally sufficient to restrict breathing to such an extent that death quickly ensues. The second White Whale did not live long in the Aquarium, but while it was there it was quite tame and swam round the tank, coming up to blow at regular intervals and being fed on eels, tench and roach.

Sub-family DELPHININÆ.

All the remaining species of the family Delphinidæ are included in the sub-family Delphininæ, distinguished by certain osteological characters, of which the most obvious is that at least the first and second neck vertebræ are fused together. The assemblage of genera and species in this sub-division is of considerable dimensions. Some of the forms are common, well known and well defined, but many of the species are based on few or even single specimens of which the external appearance may have been described, or of which nothing may be known except the form of the skull and skeleton. It must be understood, therefore, that in a work of this kind in which we are concentrating on external body characters we cannot hope to have the completeness that may be desirable. A great deal has still to be discovered concerning not only the Delphininæ, but the whole Order of Cetacea.

Genus *Orcinus*.

THE KILLER WHALE OR GRAMPUS (*Orcinus orca*). Fig. 74.

The Delphininæ may conveniently be divided into two groups, of which the one lacks the well-defined constricted beak possessed by the other. The Killer Whale or Grampus, *Orcinus orca*, is one of the most noteworthy of the first group. Its general body form gives the impression of great strength

coupled with rapidity of movement. The head passes backwards without break of any sort into the beautiful streamlining of the body. The flippers are rounded in outline and do not taper to a point as in most typical dolphins; the back fin is a conspicuous feature situated about midway along the dorsal surface of the body. The flippers, dorsal fin and tail flukes are remarkable in this species for the great disproportionate increase in size which takes place in old males. In young animals of both sexes, and in the female irrespective of age, the flipper length is about one-ninth of the total body length. In the old male animal the flipper has grown enormously, so that it is one-fifth of the entire length. A cast of a flipper from a 30-foot animal exhibited in the British Museum (Natural History) is equivalent in size to that of a Right Whale more than double the Killer's length. Coinciding with the enlargement of the flipper the dorsal fin, from being recurved and a foot or two in height, lengthens to about 6 feet, and becomes triangular and attenuated in form. This elongation of the dorsal fin gives the Killer the alternative name of " Swordfish " by which it is sometimes popularly known, and it is this which probably accounts for some at least of the description of attacks on the largest of whales by so-called swordfish. It would seem doubtful whether the true Swordfish habitually attacks the great cetaceans; certainly there is nothing in the form of wounds either recent or healed on the bodies of Rorquals which have been examined that can be definitely attributed to the Swordfish, whereas every person who has had experience of whaling has had abundant evidence of the voracity of the Killer, and of its daring attacks both on living whales and on the carcasses of freshly killed animals being towed to the whaling factory. It has been stated by old writers that the Killer Whale uses its dorsal fin as a weapon when attacking the large whales on which it sometimes preys, but little credit can be attached to this story, for the fin is not supported by any bony skeleton, and is so flexible that it has been observed to bend over to one side or the other when projecting out of the water. It can obviously be of little use except as a balancing mechanism to keep the animal upright when it is swimming at great speed through the water.

The colour of the Killer is well marked and is distinctive for

the species. The back is black and the belly white. Just behind and above the eye is a lens-shaped area of white which projects backwards and slightly upwards. Behind the dorsal fin is an ill-defined saddle-shaped light area enclosed in the blackness of the back; this patch is sometimes absent, and when present is rather variable in form. The chin is white; the flippers, which are black on upper and under surfaces, are inserted in the black area on the sides of the body, which here is extended downward almost to the under surface. Towards the tail end on either side of the body the white of the under surface invades the predominating black of the sides in an upward and backward direction. This lateral white patch is a most conspicuous and very constant feature. The under surface of the tail is white.

In this as in other dolphins the number of teeth and their size are useful guides in determining the species to which the animal belongs, and in stranded specimens where an opportunity for detailed examination presents itself the mouth should always be inspected. The Killer Whale has 10 to 12 large and powerful, conically-pointed teeth on each side of upper and lower jaws. The teeth are flattened in front and behind so that their cross-section is not circular, but roughly elliptical. The major axis is thus in the transverse plane of the head and may be up to 2 inches in length. The upper and lower teeth interlock and, being set in massive jaws, demonstrate that the animal is most efficiently equipped for its predatory mode of life.

A feature unusual in cetaceans is the great discrepancy in size between the male and female Killer Whale, the only other instance in any way comparable being found in the Sperm Whale. The fully-grown male Killer attains a length of about 30 feet and the female approximately half that size.

Very little is known of the breeding habits of the Killer, but it is believed from the scanty evidence available that pairing takes place about the end of the year, that the gestation period is twelve months, and that the young are about 7 feet long at birth. In this connection it is interesting to note the stranding of a specimen 7 feet 9 inches long on the Yorkshire coast in November, 1927. The time of stranding and the size

of the animal fit in very well with the suggested time of pairing just mentioned.

The Killer is world-wide in its distribution in areas as far apart as the Greenland Sea and Bering Sea in the north and the Ross Sea and the Scotia Sea in the south. It is naturally most abundant in the Arctic and Antarctic, where there is a never-failing supply of food in the form of whales, seals and aquatic birds to draw from, and it is from these parts of the world that descriptions of the habits of this Cetacean have mostly been obtained.

It is a not infrequent visitor round the British Isles; since 1911, when the systematic recording of whale strandings was commenced, twelve have been washed up on various parts of the coast, and others have been observed swimming offshore. There is nothing, judging from the position of stranded specimens, to indicate that the Killer has a predilection for any particular area and it may turn up at any time of year. Of recently-stranded British Killers the largest was a male 26 feet long, washed up on the Kentish coast in 1926, but there is an earlier record of one killed at Greenwich which measured 31 feet. It is not usual for Killers to occur far from the sea, so that the capture of one at Alloa, thirty miles up the river Forth, beyond the Forth Bridge, is noteworthy. This animal, a female 12 feet 6 inches long, was believed by the fishermen who secured it to have been chasing salmon in the estuary when it got into difficulties in shallow water and so was easily captured.

But salmon hunting is of little significance when one thinks of the bigger quarries which the Killer Whale usually seeks out. The large whalebone whales, dolphins, porpoises, seals and penguins are all attacked by this animal and, from the published accounts of Antarctic voyages, it is only by chance that man has not been added to the list. Bell in 'British Quadrupeds' instances an *Orcinus* 21 feet long in the stomach of which were found remains of thirteen porpoises and fourteen seals. In a report on sealing in the Pribilof Islands there is a record of another killer having fourteen seals in its stomach. Scammon, in 'Marine Mammalia and American Whale Fishery', describes how three or four Killers do not hesitate to grapple with the largest baleen whale and attributes to the species a " boldness

and cunning peculiar to their carnivorous propensities". The same author mentions instances where a band of Killers laid siege to a whale in tow and, though frequently lanced and cut with boat spades, made away with their prey.

Killers hunt in packs varying in number from two or three to thirty or forty, and when attacking large baleen whales their behaviour is comparable to that of a pack of wolves attacking a deer. An early account states that some of the Killers " will lay hold of a whale's tail to keep him from threshing while others lay hold of his head and bite and thresh him ; the poor creature being thus held, 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 putrify they leave him ". The most recent accounts appear to substantiate, in general at any rate, the mode of attack just described.

In the Arctic the White Whale and the Walrus are sought by the Killer, and Scammon in the book already quoted tells how in the vicinity of the seal rookeries Killers will hover about so that even the largest male sea lions endeavour to avoid an encounter. Worthy of mention too is Scammon's description of the manner in which the young Walrus will mount upon its mother's back for refuge from the Killer. It is dislodged, however, and eventually devoured by the attacking animal quickly diving, coming up under the parent Walrus, and with a spiteful thud throwing the young one from the dam's back. This method of securing food is the same as that used to obtain seals which have taken refuge on ice floes.

There are several accounts of Killers bumping the under surface of ice floes whilst men were standing on top and, most exciting of all, was Mr. Ponting's narrow escape when with the British Antarctic " Terra Nova " Expedition. Captain Scott writes that Ponting was taking photographs on the floe edge when the whole floe heaved up and was broken into fragments as the photographer sped to safety. A booming noise could be heard as the Killers rose under the ice and struck it with their backs. He and other Antarctic writers tell of the Killers' behaviour at the ice edge, of how they will

rear their heads vertically out of the water and seemingly peer across the floe looking for food. Scott agrees with Scammon in attributing to the animal a deliberate cunning and the possession of singular intelligence. On the other hand it should be remembered that the Killer is not alone in this habit of pushing the head vertically out of the water; the Rorquals and the Grey Whale are known to behave in a similar manner when their swimming space is restricted by the presence of ice. Certainly in the whalebone whales there can be no question of connection with feeding to make these animals alter their normal manner of breaking surface; the reason for coming up to blow in this way is undoubtedly that it is the best method in the circumstances, and it seems likely that the same reason accounts for the Killer's actions. It is easy to imagine, too, that the bumping of the under surface of the floe may be quite accidental, and not a reasoned sequel to seeing a potential supply of food on the floe surface.

The vigorous aggressiveness of the Killer is in marked contrast to the defencelessness of the large whalebone whales and, when stating that the former animal is of no commercial importance, one might sometimes wish that the Rorquals and Right Whales were imbued with some of the Killer's pugnacity to make them less attractive quarries for pursuit, and to render more likely their chance of continued existence.

Genus *Pseudorca*.

THE FALSE KILLER WHALE (*Pseudorca crassidens*). Fig. 75.

In the genus *Pseudorca*, as in *Orcinus*, there is only one species admitted, *P. crassidens*, the False Killer Whale. It is nearly related to the true Killer, but many external differences distinguish the two forms from each other. The False Killer is more slenderly built than the Killer and the outline of the head in side view is more acutely tapering than in that species, although in both it terminates in a rounded snout without sharply constricted beak. In the False Killer the snout projects a little way beyond the tip of the lower jaw.

The dorsal fin is small with the apex directed backwards

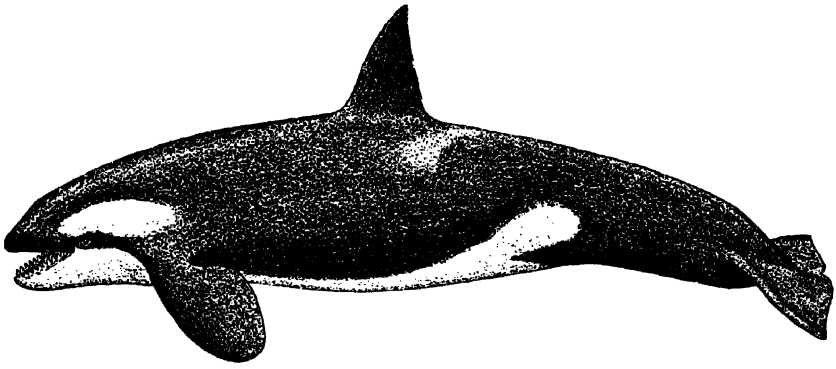


FIG. 74.—Killer Whale (*Orcinus orca*). To 30 feet.

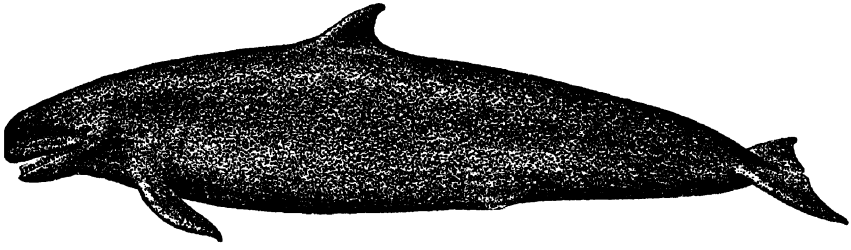


FIG. 75.—False Killer (*Pseudorca crassidens*).

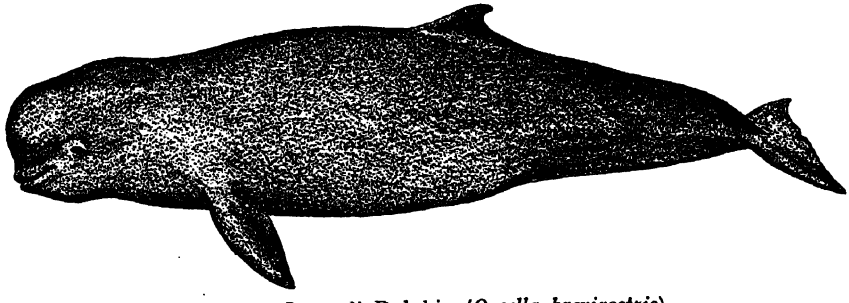


FIG. 76.—Irawadi Dolphin (*Orcella brevirostris*).

and the posterior border concave; it is situated very slightly in front of the middle of the back. The flippers are tapering, not rounded as in *Orcinus*, and are in length about one-tenth of the body length. The proportion of the length of the flipper to body length is a useful feature in distinguishing the False Killer from the Pilot Whale, *Globicephala melæna*, with which it has more than once been confused. The flipper of the Pilot Whale is very long, narrow and tapering, about one-fifth of the body length.

The body colour of the False Killer is entirely black, relieved occasionally by sparsely-scattered white star-shaped scar marks similar to those found on the skin of Blue and Fin Whales.

The teeth are large and powerful, recalling those of the Killer, but are circular in cross-section instead of oval as in that animal. Eight to 11 pairs in upper and lower jaws is the number commonly found, and at the gum they have a diameter of $\frac{1}{2}$ inch to $\frac{3}{4}$ inch.

A length of 18 feet 6 inches may be reached by adults of this species, the average length of males being two feet more than that of females.

Like the Killer the False Killer is a pelagic species, world-wide in its distribution, with the probable exception of polar seas, from which it has not as yet been recorded.

For the original description of the False Killer we are indebted to Sir Richard Owen, who examined a sub-fossil skeleton dug up in the Lincolnshire fens in 1846. He considered this specimen to belong to an extinct species, qualifying his view with the proviso " until it should be proved that it still existed in our seas ". Sixteen years after Owen's description was published, in 1861, a school of about a hundred False Killers appeared in the Bay of Kiel, and from animals that stranded the external form was made known to zoologists in the following year.

From the time of the first appearance of *Pseudorca* in the flesh down to the present, if there is one feature more than any other which has characterized this species it is its irregular occurrence in different and widely-separated parts of the world, normally making its presence known by large numbers becoming stranded and dying on the shore. On the Atlantic

and Pacific coasts of North and South America, on the shores of Tasmania, India, Africa and the British Isles, *Pseudorca* has been found, sometimes it is true in inconsiderable numbers, but more often in strandings involving hundreds of animals. The following records give some idea of numbers concerned: " several hundreds " on Chatham Island in 1906; about 150 in the Dornoch Firth, Scotland, in 1927; over 100 near Capetown in 1928; 167 on the Island of Velanai in 1933; 75 along the east coast of England and Scotland in 1935; and in the same year and at very nearly the same time a school of between 200 and 300 at Mamre, 50 miles from Capetown.

From its sporadic occurrence in inshore waters and its widely distributed range it may be concluded that the False Killer is a truly oceanic species, as distinct from a shore-frequenting species. On the rare occasions when it invades shoal water it comes into an environment outside the range of its normal deep-water experience, for to such a creature the conditions found in calm water over a shallow sand or mud flat or in heavy seas breaking on a rocky coast must be quite novel. The want of periodicity in the inshore migrations suggests that it is some cause other than breeding which leads them towards the coast. With reference to the most recent British stranding, when seventy-five animals were found distributed along the east coast from north of the Tay to the Wash, it was suggested by the writer in ' The Scottish Naturalist ' that the phenomenon was probably associated with feeding. Alteration in the usual distribution of water masses in the ocean would cause alteration in the distribution of the animals on which the False Killers feed, and might bring them into areas where they are not usually to be found. From 1930 to 1935 there had been an increasing strength of flow of Atlantic water into the North Sea, and it is possible that the *Pseudorca* invasion was linked up, either directly or indirectly with that fact.

The nature of the shore on which British specimens have been found gives a clue to the immediate cause of stranding. Where considerable numbers of animals have been involved the shore in each instance extends into the sea as a wide flat expanse of mud and sand, uncovered at low water, covered a foot or two deep at high tide. At Donna Nook, Lincolnshire,

which may be taken as typical of the rest, the animals had grounded on the outer edge of the sand flat just on neap tide high-water mark. In 'The Scottish Naturalist' article already referred to, it is stated: "They (the False Killers) had struggled vigorously and some were still alive more than twenty-four hours after stranding. By their exertions they only succeeded in embedding themselves more firmly in the sand, so that when examination was made some were half buried in silted sand and others were lying partly immersed in troughs they themselves had made. . . . It is easy to imagine that, when the animals do get away from their normal environment, the form of coast on which they have habitually been found would be precisely the one to present the greatest degree of embarrassment to animals accustomed to deep water."

The False Killer is gregarious, and judging from the numbers stranded in the same place at one time it must move about in schools composed of hundreds of individuals of both sexes and all stages of maturity.

Cuttlefishes are the chief source of food, but remains of fishes such as the ordinary cod have occasionally been found in their stomachs along with the horny beaks of the cuttlefishes.

Males and females appear to be represented in the schools in approximately equal numbers, and in both sexes maturity is attained when the animals are from 12 to 14 feet in length.

The considerable range in size of the fœtuses found at approximately the same time indicates that the breeding season in this species must be spread over a fairly extensive part of the year. In the strandings of November-December, 1935, the smallest fœtus was 2 feet 1½ inches and the largest 3 feet 10 inches. The largest in the Dornoch stranding of October, 1927, was over 6 feet long.

The False Killer is not less adequately supplied with blubber from which oil could be obtained than are other species which are hunted for this purpose, but it is so irregular in its appearances and so little is known about it except what has been gained by its occasional visits to coastal waters that it has not up to the present been made the object of commercial exploitation.

Genus *Orcella*.

THE IRAWADI DOLPHIN (*Orcella brevirostris*). Fig. 76.

The Irawadi Dolphin is a small-sized creature of comparatively restricted distribution. The head is convex from blowhole to upper lip. The line of the mouth, horizontal in front, curves upwards further back to the angle of the gape. The crescentic blowhole is more to the left than to the right side on the top of the head. There is an inconspicuous constriction in the neck region recalling that already described in the White Whale, but the definition of this " neck " depends on the physical condition of the creature, being more obvious when the animal is under-nourished than when it is fat and in good condition.

The flippers are moderately long and broad triangular structures, the breadth about one-half the length, and the width at the junction with the body about one-half the greatest length. The centre of the dorsal fin is behind the middle of the body. The fin is small and falcate with a rounded point. Behind it on the back and on the under surface posterior to the vent a well-defined ridge extends backward towards the flukes, and ends some 5 inches in front of the notch of the tail.

The colour of the Irawadi Dolphin is either entirely slate-blue or the ventral surface may be very little paler than the rest. Anderson, in his ' Account of the Zoological Results of two Expeditions to Western Yunnan', from which most of the present description is taken, states that " the young have a distinct moustache occurring about one-half inch above the upper lip and consisting of five brownish bristles . . . the line of the bristles occupying an area of three-quarter inch ".

The external aperture of the ear in one of Anderson's specimens was 0·08 inches in diameter—a dimension which indicates the almost microscopic size of this opening, as it is found not only in the Irawadi Dolphin, but in members of the family Delphinidæ generally.

There are from 12 to 19 teeth on each side of upper and lower jaws. The number of teeth on one side of the jaw may

not be equal to that on the other, and Anderson states that fewer teeth are to be found in upper than in lower jaws. They are small and sharply conical in young animals, but become worn flat as the animal ages. The tooth diameter is about $\frac{1}{5}$ inch.

The body length is from 7 to $7\frac{1}{2}$ feet.

Anderson recognized two species of *Orcella*, the form just described, *O. brevirostris*, and *O. fluminalis*, which, he states, "differs from *O. brevirostris* in its rather smaller, lower and more falcate dorsal fin, its more pointed and less anteriorly bulging head and rather shorter and broader pectoral fins: the colour in both is much alike being pale slaty above and whitish on the under parts, but the skin of *O. fluminalis* is streaked somewhat as in Risso's Dolphin."

Whether two distinct species do in fact exist is questionable, and as far as our present purpose is concerned the differences between them are so slight that they may be considered together.

O. fluminalis is said to be restricted in its distribution to the Irawadi River from above the limit of tidal effects 300 miles from the open sea to 900 miles up the river. *O. brevirostris* is known from the Bay of Bengal, Vizagapatam, Singapore and the Chantabun coast of Siam. The genus has never been found away from this south-east corner of Asia.

Orcella, according to Anderson, is generally seen in small schools which frequently accompany the river steamers. The habits of marine and fluviatile forms do not differ. They breathe at intervals of from 70 to 150 seconds, although at times the interval may be greater. "The blowhole is first seen, then at the end of inspiration the head disappears and the back comes into view and is gradually exposed as far as the dorsal fin but the tail flippers are rarely visible. The act of breathing is rapid. . . ."

The food of this animal is exclusively fish. "The fishermen," writes Anderson with reference to *O. fluminalis*, "believe that the dolphin purposely draws fish to their nets, and each fishing village has its particular guardian dolphin which receives a name common to all the fellows of his school; and it is this superstition which makes it so difficult to obtain specimens of this Cetacean. Colonel Sladen has told me that suits are not

infrequently brought into the native courts to recover a share in the capture of fish, in which a plaintiff's dolphin has been held to have filled the nets of a rival fisherman."

One of the specimens described by Anderson was a pregnant female 6 feet 10½ inches in length, carrying a full-time fœtus 2 feet 9¾ inches long or about two-fifths the length of the parent animal.

Genus *Grampus*.

RISSO'S DOLPHIN (*Grampus griseus*). Pl. VII A.

Risso's Dolphin is the only representative of the genus in which it is placed. It is unfortunate that the name "*Grampus*" has had to be used for the generic name as it makes for confusion with the alternative popular name of the Killer Whale which, it will be remembered, is also "Grampus", so that a point to be borne in mind is that the two animals are by no means closely related, and neither in their external appearance nor in their habits do they in the least resemble one another. According to Beddard the derivation of the word "grampus" is variously given as "grand poisson" and "gras poisson".

In this beakless dolphin the front of the head rises almost perpendicularly from the tip of the upper jaw, and there is only the very faintest depression of the "forehead" before it bends round on to the dorsal surface. The line of the mouth as seen in side view is at first horizontal, but presently is directed upward and backward in a curve which ends just in front of and below the eye. The dorsal fin, placed midway along the back, is high, pointed and with concave hinder margin. The flippers are moderately long and narrow and the flukes have the normal dolphin-like outline.

The body colour is grey, which on the fins and tail deepens to black, and on the under surface becomes much lighter or even white; there is no sharp delimitation of pigmented and unpigmented areas. Very commonly the skin is scored with long, narrow, white marks—a most conspicuous feature when they are present. It is believed that they are the healed scars of wounds caused by the teeth of other individuals of the same species.

The teeth number 3 to 7 on each half of the lower jaw. They are usually wanting altogether in the upper jaw, but very occasionally a tooth or two may be found there. The lower jaw teeth in the adult are quite conspicuous objects, more than ½ inch in diameter at the gum and projecting from it about ¾ inch. They are placed near the tip of the jaw, the space occupied by them being only about a fifth of the jaw length.

The adult length is 12 to 13 feet.

Risso's Dolphin is widely distributed; it is known to occur in the North Atlantic and Mediterranean, and in the southern hemisphere it has been recorded from the coast of New Zealand and at the Cape of Good Hope.

The animals stranded on the British coast, eighteen in the last twenty-five years, have been concentrated in the south and west, very rarely on the east coast; this distribution points to the Atlantic origin of the British specimens. British strandings have been most common in the summer months, and it is likely that this species, like so many others, undertakes migrations which bring it into higher latitudes during the warmer months of the year.

It occurs solitarily or in small schools of less than a dozen. Cuttlefishes are, so far as is known, the only food of this species.

Little is known about the breeding habits of Risso's Dolphin, but an indication that parturition takes place about the end of the year is given by a specimen found in December. It carried a full-time fœtus, 5 feet 5½ inches long, or more than half the length of the 10 foot 6 inch parent. It should be said, however, that the unborn calf lies with its tail curled round under its body, so that the total length when the tail is extended gives a false impression of the bulk of the fœtus as compared with that of the mother.

In a young specimen described by Sir William Flower, the upper lip on either side bore 8 whitish bristles arranged in two rows, 6 in the lower and 2 in the upper.

The celebrated Pelorus Jack was a Risso's Dolphin which haunted Pelorus Sound, and used to swim at the bows of ships on the route between Nelson and Wellington, New Zealand. So well known was it that it was protected by Order in Council.

Genus *Globicephala*.

THE PILOT WHALE (*Globicephala melæna*). Fig. 77.

The Pilot Whale of North Atlantic waters may be taken as typical of a genus world-wide in range, and including a number of different forms which have been given specific rank. While it may be difficult to distinguish individual species, certain features of the external appearance common to all members of the genus are sufficiently marked to make generic identification, at any rate, a very easy matter. The Pilot Whale is known alternatively as the Caa'ing Whale, Grindhval or Blackfish, and the scientific name *Globicephala* refers to the peculiar conformation of the head which forms a character exclusive to this group of cetaceans. The head is greatly swollen in front, so that the forehead bulges out as a rounded almost globular projection above the upper jaw. The line of the mouth in lateral view is directed upwards and backwards towards the eye in a sinuous curve which, in conjunction with the bulging forehead, gives the animal an expression of intelligence which nothing in its behaviour can specially justify.

The dorsal fin, situated slightly in front of the middle of the back is rather low, and the base is long in comparison with the vertical height. The tip of the fin is bluntly rounded and the concavity of the hinder margin very pronounced.

The body colour is almost entirely black, but on the under surface below the chin is usually a white area, the anterior margin of which is sharply marked off from the general blackness of the body, but which behind merges gradually into it. A little promontory of pigment projects into the white area at its forward end, and posteriorly the whiteness may persist as a light-coloured streak along the middle of the belly region.

The teeth number 10 on each side of upper and lower jaws and are slightly less than $\frac{1}{2}$ inch in diameter. They are confined to the front portion of the jaws.

The adult size is as much as 28 feet.

G. melæna is a boreal species occurring abundantly off the Faroes, Orkney and Shetland, and less commonly on the coasts of England and Scotland. On the American side of the

Atlantic it extends southward to New Jersey. Specimens said to be specifically indistinguishable have been reported from the Cape of Good Hope and New Zealand.

Cuttlefishes form the food of this animal.

It is a gregarious species which moves about in schools often numbering many hundreds of individuals.

A female specimen caught in the Forth at the end of April was found to be carrying an unborn young one 3 feet long. At Lofoton, in a school of about a thousand examined at the beginning of September in the year 1880, the females either had full-time fœtuses or were accompanied by newly-born calves. These observations are in accord with the cetologist Van Beneden's conclusions, from an accumulation of records which he cites, that the Pilot Whales pair in warm water during the northern winter and bring forth their young on their return northwards in the following year.

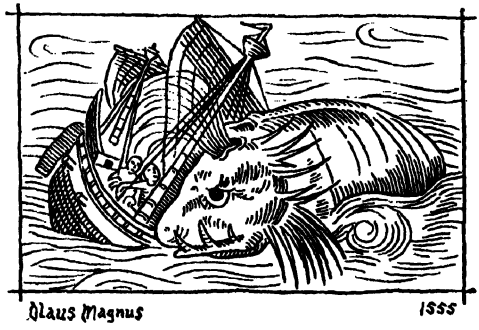
That migration of the herds does take place is indicated by the analysis by H. C. Müller of records of three hundred years' hunting of this species in the Faroe Islands. The period covered is 1584–1883, and 117,456 whales are involved. It is shown that in January the catches are very small, and that until June, when the number taken suddenly rises, the monthly increase is very gradual. August is the best month, and from then on to the end of the year numbers slowly diminish.

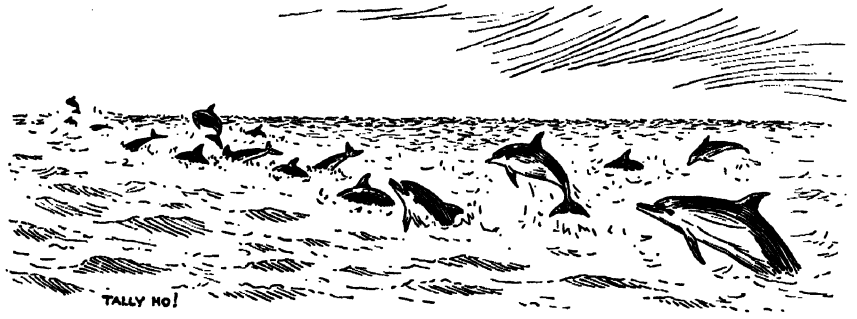
The method of hunting the Pilot Whale is similar in Orkney, Shetland and the Faroes, although at the present time, so far as the two former localities are concerned, its practice has now fallen into disuse. A watch is kept from the shore for the appearance of the school in conveniently situated bays which the animals are known to frequent. When the signal is given the hunters in the district jump into their boats and manœuvre so that the line of boats is between the whales and their way of escape to the open sea. The animals are driven towards the beach, and when they are sufficiently close inshore those that do not eventually strand are slaughtered with harpoons and lances. It may be stated that the Scottish name Caa'ing Whale is connected with the practice of driving or herding the animals, and has nothing to do with calling or vocal expression of any sort.

In the Faroe Islands the natural tendency for the Pilot

Whale to follow a leader as sheep do is taken advantage of in its pursuit. It is said that the hunters, when driving the animals towards the shore, only lance one or two and these, maddened with pain, get panic-stricken, and rushing forward to become the leaders finally strand on the beach and are followed to their death by the rest of the herd.

The Pilot Whale of the North Pacific, *G. scammoni*, is entirely black, as indeed are *G. indica* of the Indian coast and *G. brachyptera* of the north coast of America. The last species mentioned, as its trivial name implies, has shorter pectoral fins than other members of this genus, their length being about one-sixth of the total body length. The other species are not subject to distinction by external characters, their claims to specific rank being based chiefly on differences of the bones of the skull.





CHAPTER XIV: PORPOISES AND DOLPHINS (*continued*).

The terms "porpoise" and "dolphin". Common Porpoise and other species. Finless Black Porpoise. Right Whale Dolphins. Hector's Dolphin. Heaviside's Dolphin and related species. White-sided Dolphin. White-beaked Dolphin and related species. Bottle-nosed Dolphin. Common Dolphin. Rough-toothed Dolphin. Genera *Prodelphinus* and *Sotalia*.

IN this chapter we shall begin by describing the remaining "beakless" members of the family Delphinidæ before going on to those having the distinctly marked snout which the word "dolphin" generally connotes.

The question of the difference between "porpoise" and "dolphin" must certainly have been asked hundreds of times, and it is unfortunate that it is one which involves the difficulties associated with the use of popular terms. The name "dolphin" itself is used to describe a fish (*Coryphæna*, see p. 127) and a group of cetacean mammals, so that when the word is employed it is necessary to ascertain first of all whether fish or mammal is being discussed. Again, the term "common porpoise" is loosely used, for although to people in this country it applies to the beakless little cetacean *Phocæna phocæna* so frequently seen around our coasts, in America the name is used for what we call the Bottle-nosed Dolphin, and in New Zealand for an animal which, though beakless, is in a different genus altogether from *Phocæna*.

With these complications in mind it may be said, however, that " porpoise " refers to those members of the family Delphinidæ that are small in size, are beakless, have a triangular dorsal fin and spade-shaped teeth; and that " dolphin " embraces the remaining members of the family except the larger forms, as for instance the Killer, dignified by the name of " whale ".

Genus *Phocæna.*

THE COMMON PORPOISE (*Phocæna phocæna*). Pl. VIII A. Fig. 94.

The Common Porpoise is by far the most abundantly-occurring Cetacean in British seas; to such an extent does it predominate that even when rarer visitors make an appearance the tendency is to say that they are also porpoises if they approximate at all to the size of this species. Yet the Common Porpoise is very easy to distinguish, even in the water, by its small size, beakless head and triangular back fin. It is a rather stoutly built little animal, having its greatest diameter in the region midway between insertion of flippers and dorsal fin. Behind the dorsal fin the body tapers off to the junction of tail stock with flukes, without either dorsal or ventral ridges such as are found in some related species. The dorsal fin is situated slightly behind the middle of the body, and is low and only very slightly, if at all, concave on its posterior border. The flippers are almost oval in outline, rather blunt at the tip and small in proportion to the size of the animal.

Sometimes the front margins of flippers and dorsal fin have on them a number of little prominences or blunt spines. The species *P. tuberculifera* was created to receive animals so adorned, but now it is not usual to regard them as distinct from the Common Porpoise.

The Common Porpoise is black on the back and white on the belly; the flippers, flukes and the stock of the tail are also black. Between the pigmentation of the back and the white of the belly is on the sides a grey or whitish area which varies in size and in shade. The junction of the flipper with the body is usually in the white region, and from the flipper

base a streak of pigment extends forwards to the angle of the mouth.

The teeth are strange, for instead of being conically pointed as in typical dolphins they are spade-shaped, and the genus *Phocæna* shares this peculiarity with the very closely allied Finless Black Porpoise, *Neomeris*. Twenty-three to 27 teeth are found on each side of upper and lower jaws, the number visible being commonly 23. The diameter of the teeth at the gum is about a tenth of an inch.

The maximum length reached by the adult is never greater than 6 feet.

The Common Porpoise has a wide distribution in the north Atlantic, and has even been described from the Rio de la Plata and off the western American coast, but in the last two localities a different species may possibly be involved. A typical coast-loving species, it is an inhabitant of the North Sea and the Baltic, and its range extends north to the White Sea and Greenland ; it is not unknown in the Mediterranean. On the western side of the Atlantic its distribution extends from Davis Strait to the coast of New Jersey.

Although commonest off the coast, it sometimes ascends rivers to considerable distances from the sea, having been observed, for instance, in the Thames near Teddington, and in Holland more than 200 miles up the River Maas.

The Porpoise's food consists mainly of such fishes as herring, whiting and sole. Crustacea, cuttlefishes and even marine plants have been found in their stomachs. Instances are known of Porpoises meeting their death by getting entangled in herring nets and drowning whilst in pursuit of food.

Pairing takes place in the summer months and gestation lasts for nearly a year. The newly-born young, which are about a half the length of the parent, have seldom been observed before June. An interesting account of suckling has been given to the writer by Mr. C. J. Williamson, Scalloway, Shetland. He states: " Some years ago I had the good fortune to observe a Common Porpoise in the act of suckling a young one which was swimming alongside the mother. I remember the occasion well. My wife and I were walking on a little headland about two miles from Scalloway, the sea being absolutely calm and still. We both noticed a Porpoise approaching

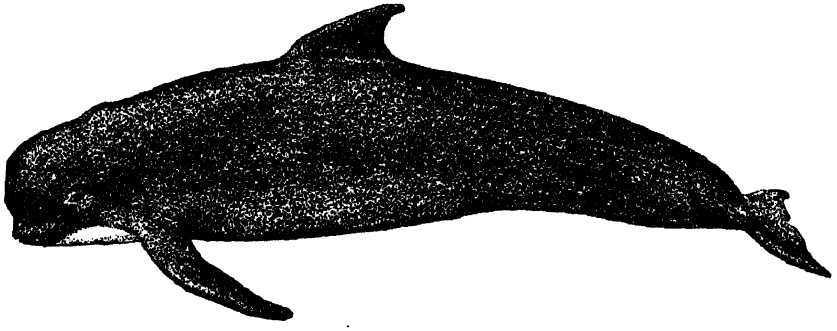


FIG. 77.—Pilot Whale (*Globicephala melæna*).

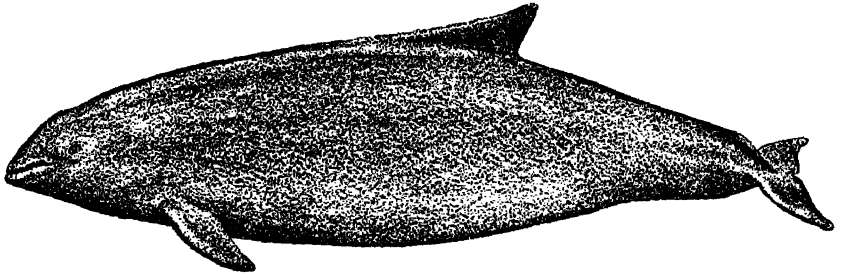


FIG. 78.—Burmeister's Porpoise (*Phocæna spinipinnis*).

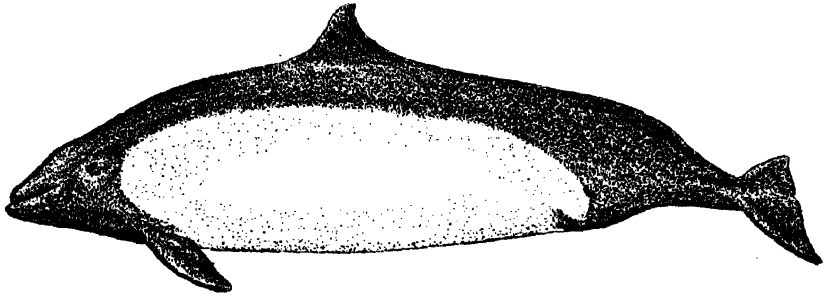


FIG. 79.—True's Porpoise (*Phocænoides truei*).

with its back breaking water every few minutes, heard its characteristic ' puff ', and knew by the direction it was making that it would pass quite close to where we stood, so we waited to watch it. When it got near we noticed that the animal did not come to the surface as is usual, with its dorsal fin quite upright, but rather it was blowing lying very much on its side. We were a trifle puzzled about its behaviour until we noticed that there were two, a young one holding on to its mother's white belly. The reason for the parent lying slightly on its side when blowing was obvious: it allowed the baby's little blowhole to break water, otherwise breathing would have been impossible." This method of suckling is identical with that observed in Whalebone Whales as described in Chapter XI.

As an article of food the Porpoise was formerly much more in demand than at the present time. Beddard says, " it formed a royal dish even so recently as the time of Henry VIII ", and another authority, Fischer, states that there was formerly a considerable porpoise fishery along the whole coast of Normandy, with laws on the subject as early as 1098. The flesh was sold in markets and the oil used for lamps.

A fully-grown Common Porpoise weighs from 100 to 120 lb.

BURMEISTER'S PORPOISE (*Phocæna spinipinnis*). Fig. 78.

This species is in general form like the Common Porpoise, but as seen in profile the head is less rounded. The flippers are more pointed and larger than in the Common Porpoise. The shape of the dorsal fin is unlike that of any other species its front edge being concave and its hinder one convex. It is the series of blunt little spines or tubercles on the front margin of the dorsal fin that is referred to in the trivial name *spinipinnis*. Behind the dorsal fin on the back and behind the vent on the under surface the tail stock is raised into two ridges. The colour of this species is entirely black. On each side of upper and lower jaw are 16 or 17 teeth. The size of the animal is comparable to that of the Common Porpoise It is a rarely-occurring species, ranging from La Plata, round the Horn to Peru.

DALL'S HARBOUR PORPOISE (*Phocæna dallii*).

This Porpoise differs from the Common Porpoise in coloration, the shape of the back fin and tail stock. The body is black except for an area of white on under surface and sides in the hinder half of the body. The dorsal fin is white at the tip, and has a slight concavity on the hinder margin just below it. The front margin bears faintly marked tubercles. The tail stock is furnished with a dorsal and ventral ridge, as in Burmeister's Porpoise. The lower jaw projects slightly beyond the upper. The teeth are very small; there are 23 on each side of the upper jaw and 27 on each side of the lower. The total length is less than 5 feet. It is known from the coast of Alaska and is very rare.

TRUE'S PORPOISE (*Phocæna* [*Phocænoides*] *truei*).

Fig. 79.

This species and the preceding one have been placed by Dr. R. C. Andrews in a genus by themselves—*Phocænoides*—on account of distinctive colour, extremely small teeth and greatly increased number of vertebræ in the backbone—there are about 30 more than in the Common Porpoise and Burmeister's Porpoise which have just over 60. *P. truei* is like Dall's Porpoise, but is distinguished from it by having the white area on the sides extending forward beyond the insertion of the flippers. The back between dorsal fin and tail is raised into a ridge so that the outline of this region of the body is almost horizontal until near the flukes, where it dips down abruptly to the junction of these with the tail stock. There is a distinctive trident-shaped extension of the black into the whiteness of the ventral surface in the region of the vent. As in Dall's Porpoise, the lower lip projects slightly beyond the upper. The teeth are exceedingly small, 19 on each side of the upper jaw and 22 on each side of the lower. The length of *P. truei* is just under 5 feet, and it is only known from the coast of Japan.

SPECTACLED PORPOISE (*Phocæna dioptrica*). Fig. 80.

This species, which may be the same as *P. obtusata*, is a southern one, having a range from the River Plate to South Georgia. In the latter place one is reported to have gone ashore at a whaling station! In general form it resembles the Common Porpoise more closely than the three previously described species. The back fin is triangular, relatively large and more rounded at the tip in the male than in the female.

The colour is most distinctive, brilliant black on the back and white on the whole of the under surface. On the sides the black and white are sharply marked off from each other; near the tail the white extends upwards to the dorsal outline. The upper lip, the under surface of the flukes and flippers are white. There is no pigment round the aperture of the eye. In the specimen taken at South Georgia a dark streak similar to that found in the Common Porpoise extended from the flipper insertion to the lower lip. The 19 to 21 teeth on each side of upper and lower jaws are very small and spade-shaped.

Genus *Neomeris*.

THE FINLESS BLACK PORPOISE (*Neomeris phocænoides*). Fig. 81.

The Finless Black Porpoise, Indian Porpoise or Nameno-Juo is easily recognized by the characters mentioned in the first common name. Except for the absence of the dorsal fin this form is in general build exceedingly like the Common Porpoise of British waters. The forehead is rounded, almost protuberant in profile, and from the top of the head to the tail flukes the outline of the back forms a smooth and uninterrupted curve. Along the middle of the back is an elongated depressed area in which is a very low ridge bearing minute tubercles or horny scales. The tubercles in this species, as in *Phocæna*, are believed to be the last remnants of a scaly armour covering the whole of the body in the ancestors of these animals. Associated with this it is interesting to note that in the embryos of *Neomeris* the distribution of the tubercles is much more general than it is later in life.

The body colour is black except for a dark grey patch

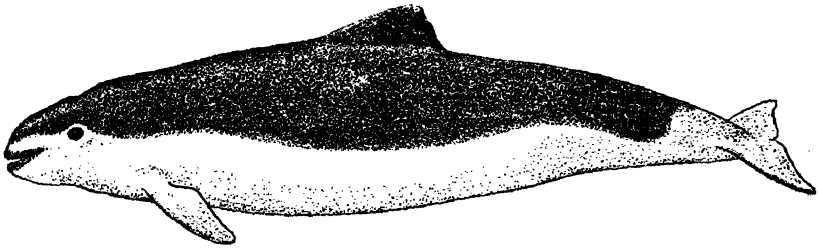


FIG. 80.—Spectacled Porpoise (*Phocæna dioptrica*).

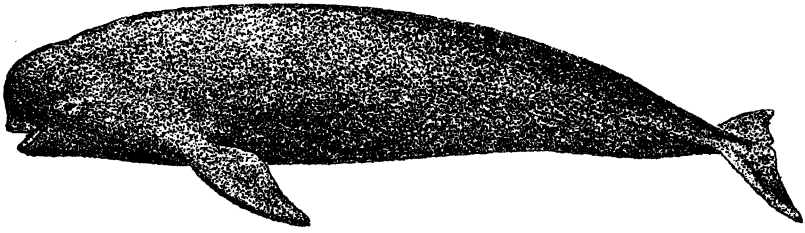


FIG. 81.—Finless Black Porpoise (*Neomeris phocænoides*).

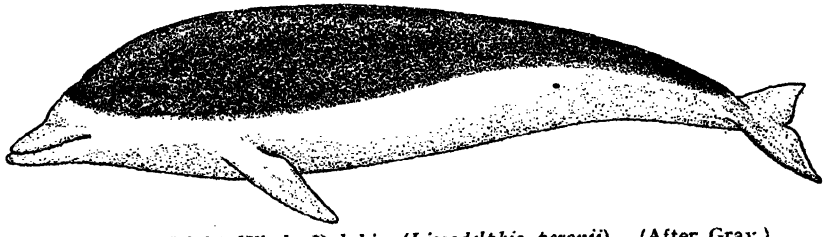


FIG. 82.—Right Whale Dolphin (*Lissodelphis peronii*). (After Gray.)

between the flippers and another of the same shade in the region of the vent. The external aperture of the ear is also surrounded by a small patch of dark grey.

The teeth are very *Phocæna*-like, but are not so numerous as in that species; from 15 to 19 are found on each side of upper and lower jaws.

Neomeris attains an adult length of about 4 feet 6 inches; it is thus less in size than the Common Porpoise.

Its range extends from the Cape of Good Hope to Japan. It is abundant off the coast of Bombay, and even more so than the Common Porpoise tends to frequent estuaries and rivers. In China it ascends the Yangtze Kiang beyond the Tung Ting Lake to nearly a thousand miles from the sea.

The food of this species consists of fishes, prawns and cuttle-fishes.

It is not markedly gregarious and solitary specimens are most frequently seen. The young are born about October. This Porpoise is said to be a sluggish little creature, not given to the playful antics of the Common Porpoise.

Genus *Lissodelphis*.

THE RIGHT WHALE DOLPHINS (*Lissodelphis peronii* and *L. borealis*). Fig. 82.

The Right Whale Dolphins receive their common name on account of the absence of a back fin, in which they resemble the Right Whales of the genus *Balæna*. Slender in form they have a distinct short beak behind which, in profile, the forehead rises in a low curve. The flippers are tapering, with convex lower margin, and convex and then concave upper margin. From the forehead to the flukes the outline of the back presents a low smooth uninterrupted curve.

The two species, *L. peronii* and *L. borealis*, are alike in external form but differ in coloration. *L. peronii* of southern seas, chiefly in the neighbourhood of New Zealand and Tasmania, has the upper part of the head, back and flukes black, and the rest of the body, including the flippers, white. Black and white are distinctly marked off from each other with no intervening shaded areas. This species is so strikingly marked as to be very easily distinguishable from any other dolphin.

L. borealis of the North Pacific is more generally pigmented, but has a white area on the under surface between the flippers and a strip of white extending from it to the flukes. In this species the flippers are pigmented.

The length of *L. peronii* is stated to be nearly 6 feet, and of *L. borealis* slightly over 8 feet.

The teeth are small, sharply pointed and numerous, 43 pairs in the upper and lower jaws of *L. peronii*, and 44 pairs in the upper and 47 pairs in the lower jaws of *L. borealis*.

Lillie, writing of *L. peronii* in the 'British Antarctic ("Terra Nova") Expedition Report on Cetacea', states that he observed a pair on two different occasions playing under the bows of the ship. "They seemed to roll over more than the other dolphins we saw. On October 20th the *L. peronii* came with a herd of Dusky Dolphins, but they kept separate."

Genus *Cephalorhynchus*.

In the genus *Cephalorhynchus* are included a number of southern, mostly cold-water dolphins of small size, porpoise-like form and striking black and white coloration. The beak, if it justifies such a name, is only very indistinctly marked off from the rest of the head, and in profile its outline merges almost imperceptibly into that of the "forehead". In all, about a dozen species have been included in the genus, several of them known only from skeletons or skulls. Description here will be confined to the better-known members of the group.

HEAVISIDE'S DOLPHIN (*Cephalorhynchus heavisidei*). Fig. 83.

The type of the genus, this conspicuously marked form recalls in its coloration the Killer Whale. The shape of the head is as described in the preceding paragraph. The dorsal fin is triangular and the flippers ovate in shape as in the Common Porpoise. The tail flukes are rather narrow and tapering and the concavity of the hinder margin is pronounced.

The back is black and the under surface from chin to tail-flukes white or yellowish white. Black and white are sharply

marked off from each other. On the sides the black pigmentation is invaded by upward extensions of white. Some variation exists, but the lobes of white, one in front and one behind the flipper, appear to be fairly constant, as is also the longer, more conspicuous prolongation originating near the ventral surface about half-way along the body and projecting obliquely backwards towards the tail.

The teeth are small, pointed and moderately numerous, 25 to 30 pairs in upper and lower jaws.

The adult length is about 4 feet. This species is known from the neighbourhood of the Cape of Good Hope.

HECTOR'S DOLPHIN (*Cephalorhynchus hectori*). Fig. 84.

This species is very like Heaviside's Dolphin, but the head is more elongated and the beak is indistinctly defined. The flippers have almost parallel upper and lower margins and bluntly rounded tips. The back fin is low, rounded at the tip and reclines backwards.

In its distribution the body colour is strikingly like that of Heaviside's Dolphin, but on the under surface in the region of the flippers the pigment is continued from one side of the body to the other, and a promontory from this black area extends forward to end just behind the under surface of the head. The oblique extension of white into black on the flanks is very like that found in Heaviside's Dolphin, but, like the forward-extending bar of pigment below it, is more attenuated in shape. The teeth number 30 to 32 pairs, and the total body length is about 6 feet. This species is found off New Zealand.

WHITE-HEADED DOLPHIN (*Cephalorhynchus albifrons*).

C. albifrons is a New Zealand species, and according to the authority, Hector, who described it is the commonest dolphin in that part of the world. The head is conical, the dorsal fin rounded and inclined backwards, the tail flukes with pronounced posterior concavity and the flippers narrow and curved.

The whiteness of the head distinguishes this species from

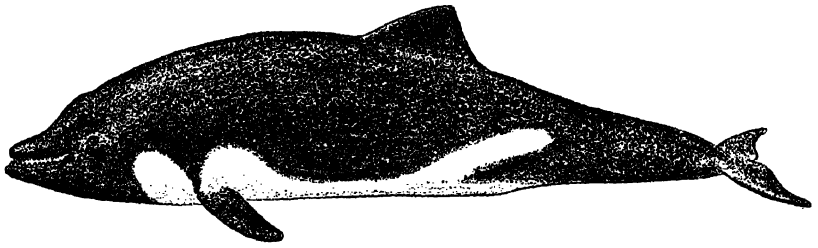


FIG. 83.—Heaviside's Dolphin (*Cephalorhynchus heavisidei*).

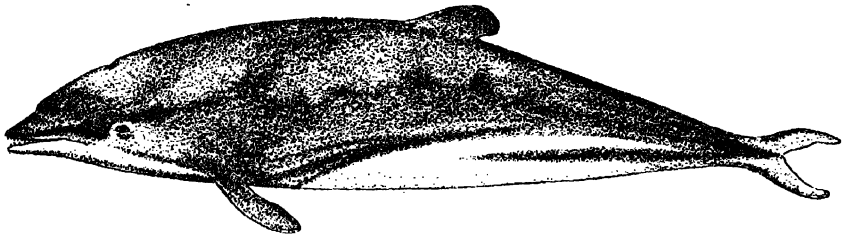


FIG. 84.—Hector's Dolphin (*Cephalorhynchus hectori*). (After Van Beneden.)

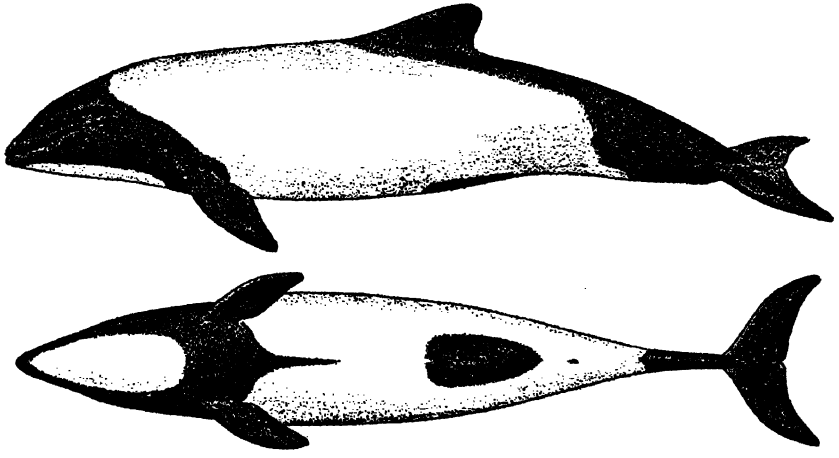


FIG. 85.—Commerson's Dolphin (*Cephalorhynchus commersonii*).

those nearly allied to it. Hector, describing the colour, states: "Nose and forehead pure white bounded by a crescent of black behind the blowhole, sharply defined in front but shading off behind to light grey which is the uniform colour of the upper surface of the body. Fins are all darker than the trunk; there is also pure black round the blowhole, cloaca and vent. The white of the snout extends behind the eye but the dusky colour extends forward beneath the angle of the mouth. The lower aspect is white as far back as the vent but is crossed by an isthmus of dark grey beneath the pectorals. The white band is continued by two lateral stripes that ascend the flanks."

The length of this animal is little more than 4 feet. It has 31 or 32 teeth on each side of upper and lower jaws.

WHITE-BELLIED DOLPHIN (*Cephalorhynchus albiventris*).

C. albiventris is a rare South American species. Its form is like that of previously described species with rounded dorsal fin, short flipper and very concave posterior border to tail flukes.

Most of the body is darkly pigmented, but there are patches of white on the throat, behind the flippers and on the belly. It grows to a length of about 4 feet 6 inches.

COMMERSON'S DOLPHIN (*Cephalorhynchus commersonii*). Pl. VIII B. Fig. 85.

Commerson's Dolphin is perhaps the most conspicuously marked small cetacean to be found in the Southern Ocean. It has the alternative common names of Piebald Porpoise and Le Jacobite, the latter Commerson's own name for it; both names refer to the striking black and white colour of the body.

The head is conical in form with very ill-defined or indistinguishable beak. The dorsal fin, situated slightly behind the middle of the back, is broadly rounded at the tip and reclined backward. The flippers are rounded, not tapering at the tip, and the general outline is elliptical. The posterior margin of the flukes is not so pronouncedly concave as in some of the foregoing species. The distribution of pigmentation, which is

a deep black, sharply separated from the pure whiteness of the unpigmented portion, makes this species unmistakable. The whole of the head is black, but enclosed within the pigmented under surface is a pear-shaped area of white in the region of the chin and throat. The flippers are inserted in the backward extension of the blackness of the head and are themselves pigmented. A promontory of black on the under surface projects back towards the middle of the belly. The greater part of the belly is white, but surrounding the reproductive aperture is a patch of pigment. On the back pigment extends obliquely from in front of the back fin to the tail flukes. There are 29 or 30 pairs of teeth in upper and lower jaws.

The body length is up to $5\frac{1}{4}$ feet.

The range of distribution of this species is in the region at the southern end of South America. It has been observed in the Straits of Magellan, near Tierra del Fuego and at the Falkland Islands.

Sir Sidney Harmer suggests in a paper dealing with this species that the striking markings on the body may have protective value to the animal: "As seen in the water, the white area probably divides the body into two parts, which seem to have little if any connection with one another. The dolphin is in fact effectively camouflaged, and perhaps the protection is specially successful in water liable to contain floating ice. The principal enemy of Commerson's Dolphin is probably *Orcinus*, the Killer Whale."

The stomach of one Commerson's Dolphin contained, as well as the pens of cuttlefishes, shrimps similar to those which form the food of the whalebone whales.

Genus *Lagenorhynchus*.

The characters which most definitely separate *Lagenorhynchus* from nearly related genera are, unfortunately for our present purpose, osteological ones such as the great number of vertebræ (80 to 90), the great length of the transverse and vertical bony processes from the vertebræ and features of the skull which need not be mentioned here. Of distinguishing external characters the following are noteworthy, namely, the

short, rather ill-marked beak, the moderately high pointed back fin having concave posterior border, the prominent dorsal and ventral ridges behind dorsal fin and vent and the moderately-sized pointed flippers.

THE WHITE-SIDED DOLPHIN (*Lagenorhynchus acutus*). Fig. 86.

This species, which presents all the external features mentioned above in the generic description, may be recognized by the distribution of pigmentation on the body, but the extreme development of the dorsal and ventral ridges on the tail is worthy of notice. As its common name implies, there is an area of light colour on each flank enclosed by the more heavy pigmentation general to that region. The light area forms a longitudinal band extending from below the dorsal fin almost to the tail flukes. It is made up of two portions, an upper part having little or no pigment and a lower yellowish portion. The back is black from the tip of the snout to the flukes. The under surface is mainly white, but shades into grey forwards to the chin and in the region of the vent is a small black area. The flukes and flippers are pigmented, and from the latter a narrow black streak runs forward to the angle of the mouth.

The teeth number 30 to 34 pairs in upper and lower jaws; they are small and pointed, with diameter up to $\frac{3}{16}$ inch.

The White-sided Dolphin is a North Atlantic species, the range of which extends from Greenland as far south as the British coast and on the western side of the Atlantic south to Cape Cod.

In British waters it is more abundant in the north, in the neighbourhood of Orkney and Shetland, but has been reported as far south as Lincolnshire on the mainland. It has not been known to strand on the west or south coasts of England, and only a solitary record comes from Ireland—from Co. Sligo.

Off the Norwegian coast this dolphin is the next commonest species to the most abundantly-occurring Common Porpoise.

A length of just over 9 feet is attained by adults.

Schools composed of large numbers of White-sided Dolphins are common; the species is a gregarious one. In 1926 about

thirty stranded at Scalloway, Shetland, part of a much larger school observed off shore on the same day; again in 1929 thirty-five, on this occasion the entire school, stranded at Weisdale Voe, also in Shetland.

Pregnancy lasts for about ten months, and it is suggested by Guildberg and Nansen that the young of this species are born in the spring and not later than midsummer.

Closely allied and similar in appearance and form to the White-sided Dolphin of the Atlantic is *Lagenorhynchus obliquidens*, found in the North Pacific and south as far as California.

THE WHITE-BEAKED DOLPHIN (*Lagenorhynchus albirostris*). Pl. VIII c.

The White-beaked Dolphin may be recognized by the description expressed in its common name. The body form is not unlike that of the White-sided Dolphin, but the ridges behind back fin and vent are not so pronounced. The under margin of the flipper is less curved and the back fin somewhat higher and more reclined than in the White-sided Dolphin. The beak, 2 inches in length, is made conspicuous by its lightness of colour. The margin of the upper lip is dark grey or black, and some pigment may be found on the lower lip as well. The flippers are black on both surfaces, and are usually inserted on the extension on to the sides of the pigmentation of the back. Variation occurs, however, so that grey may be found above the flippers, and a streak of dark pigment connecting base of flipper and angle of mouth.

Twenty-seven teeth are present on each side of upper and lower jaws—22 to 25 of which are usually visible. They are more massive than those of the White-sided Dolphin, having a diameter of about a quarter of an inch.

The total length of the adult is 9 to 10 feet.

The White-beaked Dolphin is a northern species, its range being very similar to that of the White-sided Dolphin, including the North Atlantic Ocean, Baltic Sea, Faroe Islands, Greenland, Davis Strait and the British coast. Nearly every British stranded specimen has been recorded on the east coast, very few indeed on the western, or Atlantic coast.

The young are born about the middle of the summer. Stranded specimens include several very small newly-born animals about 4 feet in length, and all reported after the middle of the year.

Like *L. acutus* this species is gregarious in habit. Beddard states—"It occurs in vast herds of as many as 1500 individuals on the coast of Norway; it is then in pursuit of herrings." Other common fishes such as whiting are included in its diet.

Lagenorhynchus cruciger. Fig. 87.

In general form *L. cruciger* is like the White-sided Dolphin, but is rather smaller in size, 5 to 6 feet being given as the adult length. It is a more conspicuously marked species than either of those described above, and is South Pacific in range.

The beak is short and indistinctly marked off from the forehead; the dorsal fin is large, and with pronounced concavity of hinder margin. The colour distinguishes this species. The snout and lower jaw are black and this colour extends along the back to the tail flukes. On the sides a second band of pigment, originating at the eye and stretching to the tail flukes, widens out just behind the flipper so that its upper edge merges with the black of the back. It then narrows near the level of the vent and again widens out before reaching the tail flukes, in front of which it merges with the black of the back and ventrally with the corresponding band on the other side of the body. Occasionally the lateral black area does not make contact with the dorsal one behind the flipper, so that an uneven white band extends from above the eye to the tail.

Teeth number 28 pairs in upper and lower jaws.

Nearly allied to if specifically distinguishable from this species is Wilson's Hour-glass Dolphin (*L. wilsoni*), which differs in having a more pronounced snout, and in having the lower black band on the one side meeting on the under surface with that of the other side of the body in the region of flipper insertion. It is also believed to be somewhat larger in size. This form was frequently seen just north of the pack-ice during both the "Discovery" 1902 Expedition and the "Terra Nova" Expedition to the Antarctic. No specimens have yet been caught.

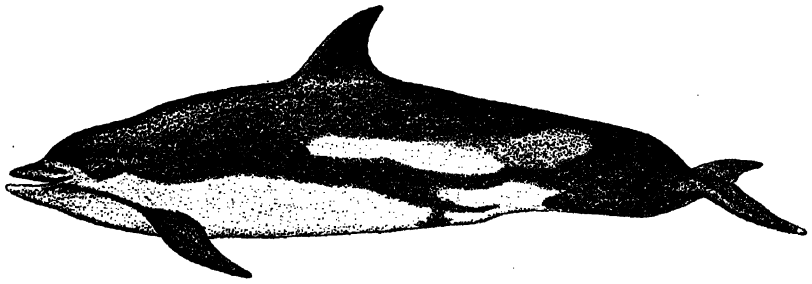


FIG. 86.—White-sided Dolphin (*Lagenorhynchus acutus*).

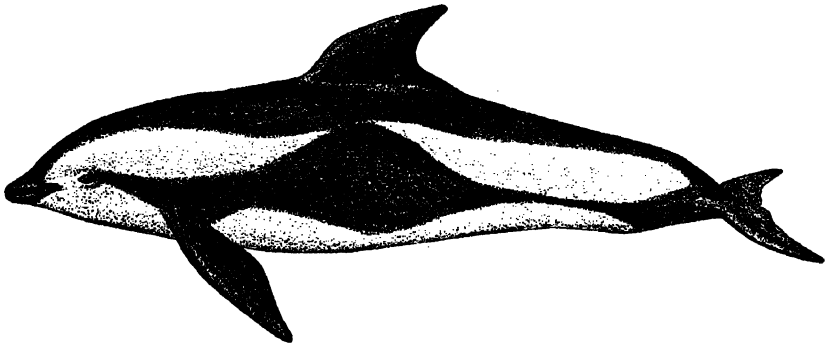


FIG. 87.—*Lagenorhynchus cruciger.*

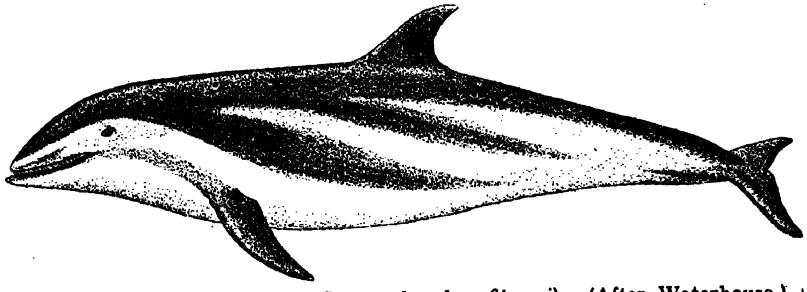


FIG. 88.—Fitzroy's Dolphin (*Lagenorhynchus fitzroyi*). (After Waterhouse.)

FITZROY'S DOLPHIN (*Lagenorhynchus fitzroyi*). Fig. 88.

This species, known from the seas off the southern end of South America, is again distinguishable by its colour, there being no very conspicuous external structural features to mark it off from the other members of the genus. The original description of the species was founded on a specimen harpooned from the " Beagle " in the Bay of St. Joseph, Patagonia, and measured immediately after capture by Charles Darwin. At the same time a coloured drawing was made by Captain Fitzroy, after whom the species is called.

The following is based on Waterhouse's original description : The head is conical and arched above. The back is black and the belly white, the pigmented and unpigmented portions blending into each other at their junction. The end of the snout, a ring round the eye, the edge of the under lip and the tail fin are black. The back fin and flippers are dark grey. A grey streak, recalling that in *L. acutus* but much broader, connects the flipper and angle of mouth. Above this bar is a streak of white which includes the eye. On the flanks two elongated promontories of pigment, directed backwards and downwards, invade the white, and still another projects upwards and forwards from the junction of the tail stock with the flukes.

The teeth number 28 pairs in upper jaw and 24 pairs in lower jaw ; they are slightly curved and conical. The length of the original specimen was 5 feet 4 inches.

Nothing is known of this creature's habits.

THE DUSKY DOLPHIN (*Lagenorhynchus obscurus*). Fig. 89.

The Dusky Dolphin is like the White-sided Dolphin in form, but the snout is longer and narrower and not so distinctly marked off from the " forehead ". The back fin is moderate in size and the concavity of the hinder margin is less than in the White-sided Dolphin.

The body colour is subject to considerable range of variation,

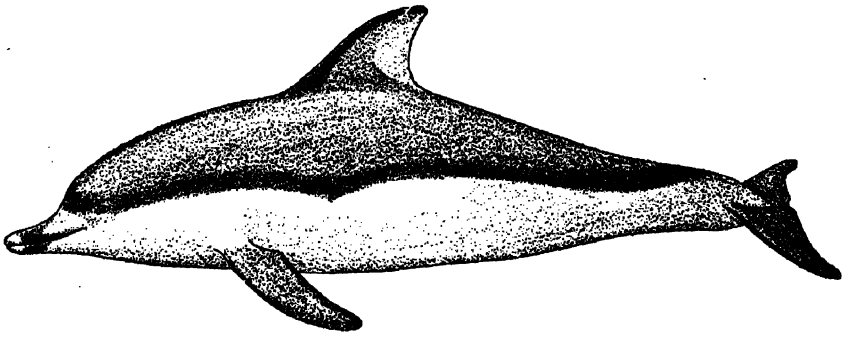


FIG. 89.—Dusky Dolphin (*Lagenorhynchus obscurus*). (After Lillie.)

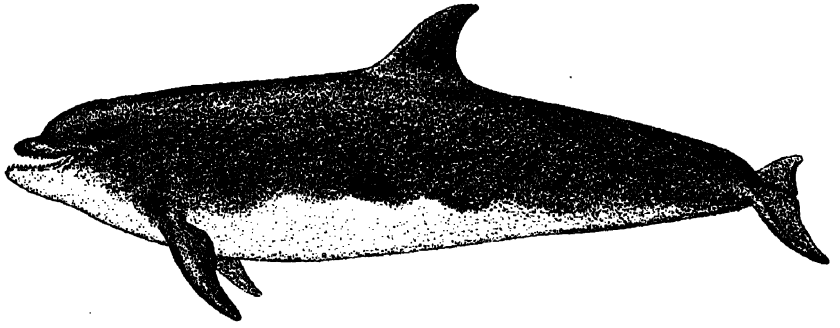


FIG. 90—Bottle-nosed Dolphin (*Tursiops truncatus*).

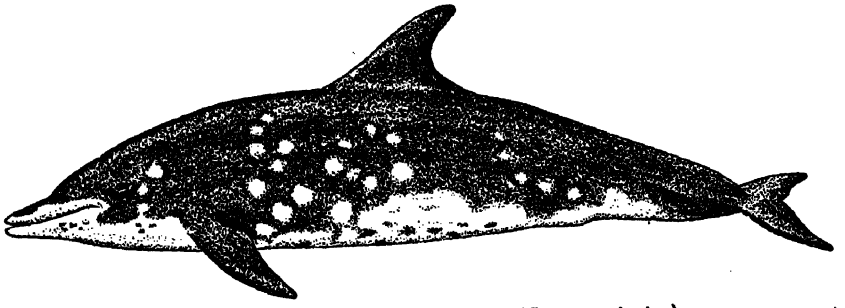


FIG. 91.—Rough-toothed Dolphin (*Steno rostratus*).

but in three specimens figured by Lillie in the ' British Antarctic (" Terra Nova ") Report on Cetacea ' the back fin is shown having a lightly pigmented or white portion posteriorly—a feature which may be used to distinguish this form from all other species of *Lagenorhynchus*. The back is dark brown and the belly white. Extending back from the base of the snout along the sides of the body is an uneven bar of black, which may, in different specimens, either extend almost to the tail, dip down obliquely to the under surface, to end halfway between back fin and tail or come to an end in a bilobed promontory a little way behind the level of the back fin. The flippers may be pigmented or white and the amount of white on the snout is also variable. Teeth number 30–32 in each row.

The length of this dolphin when adult is about 7 feet.

It is one of the commonest dolphins in New Zealand waters, and is also known from the Falkland Islands. Lillie, in the publication already mentioned, writing of this species says: " This dolphin does not seem to occur further south than about Lat. 58° S. but when we were approaching, or leaving, the coast of New Zealand we invariably met large schools of ' Dusky Dolphin ' which used to follow us and play round the bows of the ship, as though they were seeing us off or welcoming us back to temperate lands."

In the stomach of a specimen taken in the Falkland Islands were found cuttlefishes.

Three more species, the external form of which is not adequately known, may, however, be mentioned here: *L. superciliosus* from the Cape of Good Hope, *L. electra* from the Indian Ocean and tropical Pacific Ocean, and *L. thicolea* from the west coast of North America.

Genus *Tursiops*.

THE BOTTLE-NOSED DOLPHIN (*Tursiops truncatus*). Fig. 90.

The only well-known member of the genus *Tursiops*, the Bottle-nosed Dolphin *T. truncatus* may be taken as representative of the group to which it belongs. The similarity of its common name to that of the Bottle-nosed Whale (*Hyperoodon*)

should be noted for, of course, the two forms are quite unlike one another, and placed in different families of the Toothed Whales. In America the Bottle-nosed Dolphin is sometimes referred to as the Common Porpoise, but it is preferable to use the former name and to retain the other for *Phocæna phocæna*.

The Bottle-nosed Dolphin is larger in size than any of the "beaked" dolphins already dealt with, and is distinguished by its short, well-defined snout 2 or 3 inches long. Placed in the middle of the back is a prominent fin, the sharp apex of which points backwards, so that the hinder margin of the fin is concave. The flippers are moderate in size, tapering to a point, with convex lower border and upper border convex near the junction with the body and concave nearer the tip.

The back is black or dark grey-brown and the belly is white. The area on the under surface from vent to flukes is pigmented. The head and snout are dark, but the upper lip edges and the whole of the lower jaw are white, although the latter has some mottling of pigment. Flippers and tail flukes are pigmented.

The number and size of the teeth help to distinguish this species. Twenty to 22 pairs are visible on upper and lower jaws, and the diameter of $\frac{3}{8}$ inch is greater than in any of the species of the preceding genus *Lagenorhynchus*, or of *Delphinus*, the next genus to be described.

The adult size is between 11 and 12 feet. Some of the large specimens stranded on the British coast have shown signs of advanced age in the form of diseased toothless gums and arthritic backbones.

The range of this dolphin is very wide. It is the commonest species on the Atlantic coast of America, occurring from Maine to Florida. It is found also in the Bay of Biscay in the Mediterranean Sea, and has even been reported from New Zealand.

Its distribution in British waters, as indicated by stranded specimens, is almost entirely confined to the west, south and southern North Sea coasts. Sir Sidney Harmer pointed out that its distribution is almost completely complementary to that of the White-beaked Dolphin, the latter species having a decided preference for the northern North Sea.

In a recent report on stranded cetacea the writer drew attention to data which indicated an approach of this species to the British coast from the south-west. In the English Channel and southern North Sea the records had a definite relation to the time of year. Strandings were restricted in the early months of the year to Devon, Cornwall and the Scilly Isles; the first record for Dorset was in July, for Sussex and Kent in August, and for Essex in September.

The food of the Bottle-nosed Dolphin consists of fishes. One of the specimens stranded on the British coast was reported as having "swallowed a small shark, 4 feet long, head first, the tail remaining in the dolphin's mouth; this was believed to have been the cause of death."

The breeding season extends from spring to summer. A female animal accompanied by newly-born calf 3 feet 10 inches long was stranded on the coast of Glamorgan at the beginning of July, 1927. It seems likely that in this species, as in many other dolphins, pregnancy lasts from ten months to a year. The teeth of the young specimen just referred to had not cut the gum, and it may be noted that in all members of the Delphinidæ, so far as is known, the young are born in this toothless condition.

A fishery for the capture of the Bottle-nosed Dolphin was at one time carried on from Cape Hatteras, North Carolina. The animals collected in schools which, in the spring, were made up almost equally of males and females, but later in the year the sexes segregated. Nets were used to entrap the animals and, says Lydekker, "some idea of the number of these dolphins frequenting the Carolina seas may be gathered from the fact that between the 15th November 1884 and the middle of the following May, no less than twelve hundred and sixty-eight of them were caught at Hatteras".

Closely allied to the Bottle-nosed Dolphin are *Tursiops abusalam* of the Red Sea, which is dark green dorsally, whitish on the belly with irregularly distributed dark green spots, and adult length upwards of 6 feet; and *Tursiops catalania*, of Indian and Australian seas, which is lead-coloured dorsally and white on the under surface, and has its sides, lower surface and flippers covered with blotches of dark lead colour.

Genus *Delphinus*.

THE COMMON DOLPHIN (*Delphinus delphis*). Pl. VIII D. Fig. 94.

The Common Dolphin is readily recognized by its well-defined narrow beak and distinctive coloration. The beak, 5–6 inches in length, is narrower and finer than that of the Bottle-nosed Dolphin, and is sharply marked off by a deep V-shaped groove from the low reclining forehead. The dorsal fin is moderately developed, tapers to a backwardly-projecting tip and has concave hinder margin. There are no pronounced ridges like those found on the tails of the White-beaked and White-sided Dolphins. The flippers are of moderate size and tapering.

The body is black or dark brown on the back and white on the belly; on each side is an area occupied by undulating bands or stripes of grey, yellow and white, which give the impression of overlapping one another in the region below the back fin. The more delicate details of pigmentation, especially of the sides, become quickly obliterated on the death of the animal. A ring of black encircles the eye, and from it a darkly pigmented narrow streak extends towards the snout. Flippers and flukes are darkly pigmented.

Upper and lower jaws bear 40 to 50 pairs of very small teeth, measuring at most $\frac{1}{8}$ inch in diameter.

The adult length of the Common Dolphin may be as much as 8 feet 6 inches, although lengths over 8 feet are uncommon.

This species has a very wide range of distribution; it may be met with in any temperate or warm sea throughout the world, and occurs at times in vast schools. It is the common dolphin of the Mediterranean, and the one depicted in ancient works of art and mentioned in classic fable. We are told that Arion of Lesbos, lyric, poet and famous player on the cithara, was saved by these song-loving dolphins. He was returning to Corinth from Sicily carrying the trophies he had won in some musical contest when the sailors, jealous of his wealth, determined to kill him. He attracted the dolphins to the ship by his playing, and casting himself into the sea was borne to safety on the back of one of them.

The distribution of the Common Dolphin in British waters, as indicated by stranded specimens, is very like that of the Bottle-nosed Dolphin. Strandings are concentrated on the south and west coasts, with a few on the east coast of Scotland but between Firth of Forth and English Channel are no strandings whatsoever. It has been suggested that the dolphins approach, as do the Bottle-nosed Dolphins, from the south-west, and that those invading the North Sea coast of Scotland, do so in the Atlantic water which flows into it round the north coast of Scotland.

The food of this species consists mainly of fishes of various kinds, such as herrings and pilchards. Harmer, in one of his reports on stranded whales, quotes an instance of a Mediterranean Common Dolphin in the stomach of which were the ear stones of what was estimated as not less than 7596 little fishes.

The young, it is believed, are born in the summer. All the very small specimens stranded on the British coast have occurred in the second half of the year, and of a large school observed off the east coast of Scotland in July a year or two ago, numbers of the animals were very small calves.

No definite figure can be given of the speed of swimming of which this animal may be capable, but it must be one of the swiftest of all the cetacea. Its slender lines suggest great rapidity and ease of movement; it commonly plays about, zigzagging in front of the bows of vessels capable of speeds of 15 or 30 knots, often leaping clear of the water, to return sometimes head foremost, and at others falling sideways to hit the surface with a loud splash.

The flesh of the Common Dolphin used in former times to be eaten in England, but the animal nowadays is without commercial value.

There have been described, as distinct from *Delphinus delphis*, a host of forms which, almost without exception, may be regarded as synonymous with the common species, but mention should be made of the Red-bellied Dolphin (*D. roseiventris*), which has the under part of the body pale rose colour. It is small in size, 3 feet 10 inches, stout in form and frequents the Molucca Sea and Torres Strait.

Genus *Steno*.

THE ROUGH-TOOTHED DOLPHIN (*Steno rostratus*). Fig. 91.

The species *Steno rostratus* may be taken as typical of a group of long-beaked dolphins whose most obvious claim to generic distinction is that the teeth, instead of being smooth on the crown, are roughened or furrowed.

The beak is long and distinctly marked off from the "forehead" as in the Common Dolphin, from which *Steno* is distinguished in addition to the character already mentioned by the smaller number and greater size of the teeth. From the Bottle-nosed Dolphin it is distinguished by having the beak compressed rather than depressed, and by having a much longer bony union of the two branches of the lower jaw.

The general body form is slender, very like that of the Common Dolphin, which it resembles also in shape and size of dorsal fin and flippers.

Teeth number 20 to 27 on each side of upper and lower jaws and, being about $\frac{3}{8}$ inch in diameter, compare in size with those of the Bottle-nosed Dolphin.

The upper surface of the body is slate coloured or purplish black, with irregularly scattered star-shaped marks. Flippers, flukes and dorsal fin are dark. The ventral surface of the body is mainly pinkish white or rose colour, but speckled with slate-coloured spots. The beak is white.

The adult length is about 8 feet.

This species is found in the warmer parts of the Atlantic and in the Indian Ocean. In 1930 a specimen stranded on the Biscay coast of France.

Nothing is known concerning the habits of this animal.

Several forms which may be distinct have been given specific names, but they are of rare occurrence and need not concern us here.

Genus *Prodelphinus*. Fig. 92.

What Cuvier said about the cetacea in general applies with particular aptness to the two remaining imperfectly-known genera of the Delphinidæ to be described. In 'Le Règne Animal' he states: "Il n'est point de famille de Mammifères

plus difficile à observer et dont les descriptions soient plus incomplètes et la synonymie plus vacilante que celle des Cetacées."

Very nearly allied to the genus *Steno* is *Prodelphinus*, which is distinguished from that form, however, by the teeth being smooth and the union of the two branches of the lower jaw a short one. Again, *Prodelphinus* is distinguished from the Common Dolphin by an osteological character. The palate in the Common Dolphin is deeply grooved on the inner side of the tooth row, but no such grooving is found in *Prodelphinus*. It is seen, then, that it is necessary to use internal features to distinguish this genus from those which it so closely resembles in external appearance.

In all members of the genus the beak is elongated and narrow; the dorsal fin and flippers are as in the Common Dolphin, and in none of the species is coloration sufficiently distinctive to make identification an easy matter. Teeth are small, pointed and numerous, 37 to 52 pairs in each jaw.

A host of species has been described, about none of which is there very much information concerning habits. Many of the forms are known only from skulls, but here we shall confine description to the more noteworthy species of which there is at least some account of external appearance.

The Slender Dolphin, *Prodelphinus attenuatus*, is black dorsally and blackish grey on the sides; an oblique band of the latter colour invades the dorsal blackness in the region of the tail. The sides are speckled with little white spots. Teeth number 35 to 44 in each side of upper and lower jaws and the animal attains a length of 6 feet. It is found in the tropical and sub-tropical parts of the Atlantic Ocean.

Prodelphinus plagiodon occurs on the Atlantic coast of North America from Cape Hatteras and the Gulf of Mexico. It is described as " dark coloured upper half of the body and the fins spotted with white or light grey; light coloured lower half of the body with oblong spots of dark grey ". Its length is 7 feet and teeth number 34 to 37 in each series.

The Bridled Dolphin, *Prodelphinus frœnatus*, resembles the last described, but is smaller in size, reaching a length of about 6 feet. It is found in the Atlantic and Indian Oceans. Teeth number 37 or 38 in each jaw.

Prodelphinus malayanus is found in the waters of the East Indies. Its colour is a uniform ashy grey. Teeth number 39 in each jaw, and the length attained is upwards of 6 feet.

The Blue-White Dolphin, *Prodelphinus cæruleo-albus*, is a stoutly built animal; the specimen from which the form was described was only 3 feet 10 inches long. True's description states: " Back and forehead dark steel blue. A very dark blue stripe starts from the dorsal fin, and, passing forward, ends abruptly in front. A narrow blue stripe on the sides from the eye to the vent, expanded at the posterior end. Pectoral fins (flippers) blue grey connected by a coloured band with the ring which surrounds the eye. Belly, snout and other parts of the body white."

It is found on the coast of South America, near the mouth of the River Plate. It has 50 teeth on each side of upper and lower jaws.

Prodelphinus euphrosyne resembles the last very closely. The back is black, the belly white but, in contrast to the Blue-white Dolphin, the extremities of both jaws are black. A narrow band runs along the side from eye to vent, giving off a short branch in the region above insertion of flipper. As in the Blue-white Dolphin, a black band connects eye and base of flipper, but it has in its centre an area of white. The fins are black with a narrow line of white on their lower margin. Teeth number 45, and the total length of the animal is about 8 feet. Its range extends in the Atlantic Ocean from the coast of Europe to South Africa. It has been reported from Jamaica, St. Paul and Ascension Island.

Genus *Sotalia*. Fig. 93.

The genus *Sotalia* includes a considerable number of species which frequent estuaries and rivers, but a few are to be found in the open sea. They have been given the common name of Long-beaked River Dolphins, but as this leads to confusion with the true Fresh-water Dolphins, a group of cetaceans outside the Delphinidæ, its use should be avoided.

The species of *Sotalia* are concentrated in tropical seas or rivers of South America, Africa, India and the Far East. None are known from the cold waters of higher latitudes.

Sotalia resembles the Bottle-nosed Dolphin, *Tursiops*, and the Rough-toothed Dolphin, *Steno*, but is distinguished from them, among other features, by the backbone having 10 to 15 less vertebræ and, more obviously, by the increased number of teeth, the number in *Sotalia* ranging from 26 to 35, whereas in *Steno* and *Tursiops* it is 20 to 27.

Sotalia species do not reach a large size; they are none of them conspicuously coloured, grey of various shades and white predominating. The beak is long and distinct, and the dorsal fin usually has a concave posterior border. Flippers are recurved and distinctly broad at the base.

The first three species to be described are all from the Amazon.

Sotalia pallida, the " Buffeo blanco " of the missionaries of the upper Amazon, is a little dolphin about 5 feet 5 inches long, yellowish white above, white below, with triangular dorsal fin and 30 or 31 teeth on each side of upper and lower jaws. It is recorded from Nauta, Peru, a distance of over 1600 miles from the mouth of the Amazon.

Sotalia fluviatilis, the " Buffeo negro " of the missionaries, is smaller than the preceding species, 3 feet 7 inches being a recorded length. Its colour is dark grey on the back and pinkish on the under surface. A broad band of dark colour extends obliquely upwards from the dark-coloured flipper and merges with the black of the back. Behind the eye the light ventral colouring invades the dorsal black in a rounded tongue-shaped projection. Teeth number 28 in each row. This species is seen in troops of twenty or thirty, and is said to attack the Bouto, the River Dolphin *Inia*. It is recorded from the upper Amazon near Pébas, Peru.

The Tucuxi, *Sotalia tucuxi*, was given its common name by the natives of the upper Amazon. It is sombre, dark blackish in colour. Teeth number 30 in each row.

It is not quite certain whether the three forms just mentioned are separate, or are only colour variations of a single species.

Sotalia guianensis is found on the north-east coast of South America. It is black or brown on the back and white underneath, and but for the typical *Sotalia* body form—long beak, falcate dorsal fin and broadened flipper—there is no outstanding feature by which to distinguish it. It is the dolphin commonly

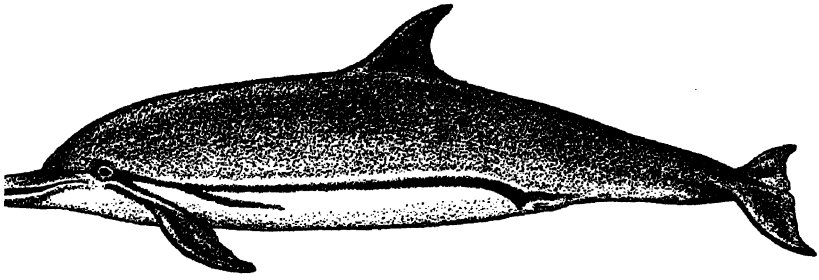


FIG. 92.—*Prodelphinus euphrosyne*. (After Pucheran.)

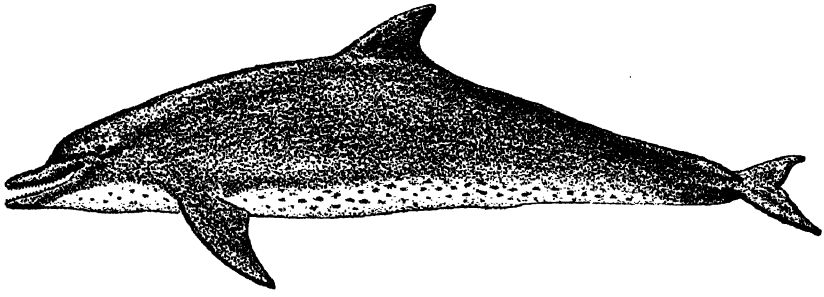


FIG. 93.—Gadamu (*Sotalia gadamu*).

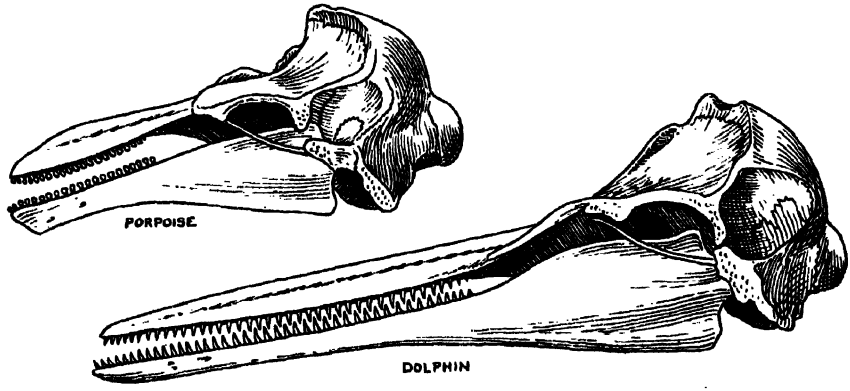


FIG. 94.—Skulls of Common Porpoise and Common Dolphin.

seen in Rio de Janeiro harbour. Beddard says: " 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 teuszii from the Kamerun River is noteworthy as being the one cetacean believed to feed exclusively on vegetable matter. In the one specimen found the stomach was filled with leaves, mangrove fruits and grass. The skin of the animal was very thick and the nostrils protruded as tubular prolongations.

Sotalia gadamu, the Gadamu of the Vizagapatam fishermen, averages about 7 feet in length, and is lead grey on the back, almost black on the flippers, pinkish ashy grey underneath, with a few irregular blotches of darker colour. The broad base of the pectoral flipper is conspicuous, although the attachment of the flipper to the body is of normal extent. The snout is well defined and about 6 inches long. The dorsal fin is moderately high with pronounced posterior concavity Teeth number 23 to 28 in each row.

Sotalia lentiginosa is another Indian species known to the Vizagapatam fishermen as the Bolla Gadimi and entitled by Owen, who described both this and the last species, the Freckled Dolphin. Its size compares with that of the previous species. " Colour," says Owen, " is pretty uniformly bluish cinereous, or slaty, freckled with irregular small spots or streaks of brown or plumbeous pigment, the streaks longitudinally and flecked with white ; the under surface a shade lighter than the rest of the body." The dorsal fin is much smaller than in the Gadamu, " and the hinder border slopes away gradually to an extensive base of attachment which is continued as a ridge halfway between dorsal and caudal fin". The forward margin of the flipper is very slightly convex, whereas in the Gadamu it is pronouncedly so. Teeth number 36 in each row.

Sotalia plumbea is a marine species from the Malabar coast of India. The snout is very long; from its tip to the eye is

one-sixth of the total body length. The dorsal fin is long, but little elevated, and the posterior border is only feebly indented. The colour, as expressed in the trivial name, is a uniform lead grey except the tip and under surface of the lower jaw, which is white. Teeth number 34 to 37 in each row, and the length of the animal is about 8 feet.

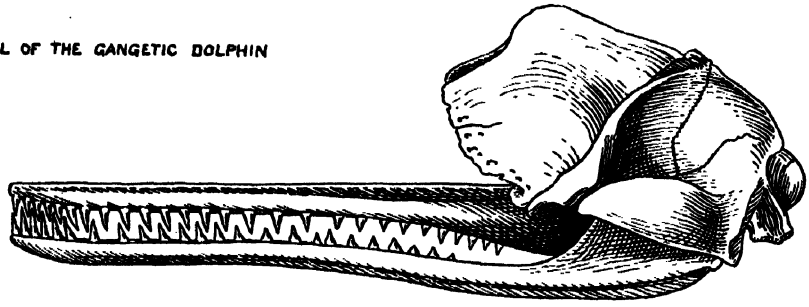
Sotalia borneensis in life is a beautiful glossy white colour dappled with grey. The dorsal fin is low and not concave behind; its base is continued as a low ridge along the back. The range of this species extends from the Gulf of Siam to the coast of Sarawak in Borneo. Teeth number 37 to 39.

Sotalia sinensis, the Chinese White Dolphin, is milky white with pinkish fins and black eyes. It frequents the Chinese coast in small schools at certain times of the year. Teeth number 32 in each row.

From the foregoing descriptions of species of *Prodelphinus* and *Sotalia* no more is expected than that some of the more outstanding forms may be recognized by combining information concerning shape, size and colour with locality of occurrence.

Humpback suckling young. after Scammon

SKULL OF THE GANGETIC DOLPHIN



CHAPTER XV: FRESH-WATER DOLPHINS.

Susu or Gangetic Dolphin. Amazonian Dolphin or Boutu.
La Plata Dolphin. Chinese River Dolphin.

(Family PLATANISTIDÆ.)

FOUR different kinds of dolphin, the Susu or Gangetic Dolphin, the Boutu or Amazonian Dolphin, the La Plata Dolphin and the Chinese River Dolphin are separated from the Delphinidæ because of lesser specialization of body structure; they are more primitive cetaceans which approximate closely in skeleton form to certain fossil dolphins.

The skull is not so compressed from front to back as in the higher whales so that the bones of a typical mammal are somewhat more easily traceable. The neck vertebræ are of considerable size and, as in the more primitive higher cetaceans, are all separate from one another. Eight pairs of double-headed ribs are usually found, and the breast bone is well developed. The flippers are short and broad. The Platanistids, although in many features relatively so unspecialized, are noteworthy for the unusual length and slenderness of upper and lower jaws.

Genus *Platanista*.

THE SUSU OR GANGETIC DOLPHIN (*Platanista gangetica*). Fig. 95.

The Gangetic Dolphin attains an adult length of about 8 feet. The snout and lower jaws are drawn out into a long forceps-like beak, 7 or 8 inches long, behind which the wedge-shaped

forehead rises rather steeply to the upper surface of the head. The blowhole, slitlike in form, is placed longitudinally on the summit of the head. Behind it the head dips down slightly before rising to the gentle curve of the back. The dorsal fin is a very low, almost ridge-like triangular eminence, about two-thirds of the body length from the snout. The tail flukes are broad and have a concave posterior border with a notch in the middle. The flippers are short and very broad at their outer end, nearly fan-shaped in form.

The colour of the body is lead black. The eyes are diminutive in size, and the animal, which is sightless, procures its food by probing the mud of the rivers in which it lives.

Teeth number about 29 in each half of upper and lower jaw. The tooth rows in the upper jaws are so closely approximated that they are almost in contact with each other. In the young animal the teeth are sharply tapering and conical, but with age their bases become massive and flattened sideways and the tips worn down.

A feature exclusive to *Platanista* is found in the skull. Two plates of bone, one on either side of the head, project out from the facial portion of the skull and almost meet in front of the nasal channel.

Platanista is confined to the River Ganges and River Indus, in each ranging from the sea as far up stream as depth and absence of rocky barriers will permit.

Anderson, in his 'Account of the Zoological Results of two Expeditions to Western Yunnan', states: "In rising to breathe the Platanist may either simply expose the upper surface of its head sufficiently to bring its blowhole above water, or, what is more common, plunge out of the water upwards, forwards and downwards, first exhibiting its long snout, followed by two-thirds of its back. . . . Respirations are tolerably frequent, occurring at intervals of about one-half to three-quarters of a minute."

The Susu feeds on mud-frequenting fishes and fresh-water shrimps.

The young are born between April and July, after a period of development lasting eight to nine months. Anderson tells us that the young, clinging to their mothers, are sometimes captured in the nets of the fishermen.

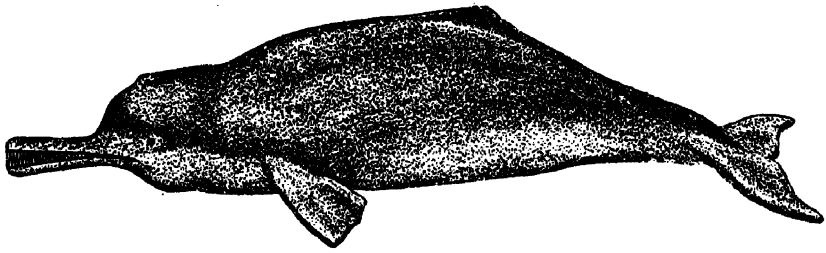


FIG. 95.—Gangetic Dolphin (*Platanista gangetica*).

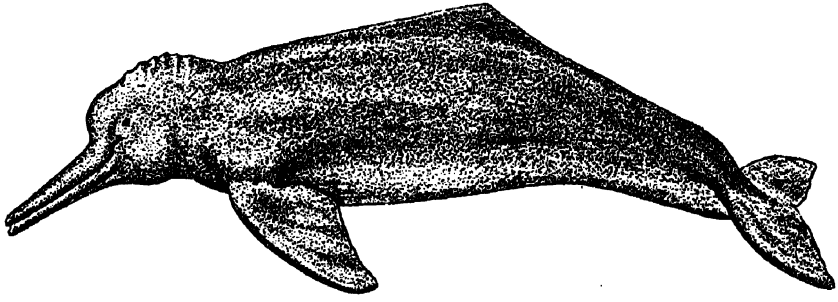


FIG. 96.—Amazonian Dolphin (*Inia geoffrensis*).

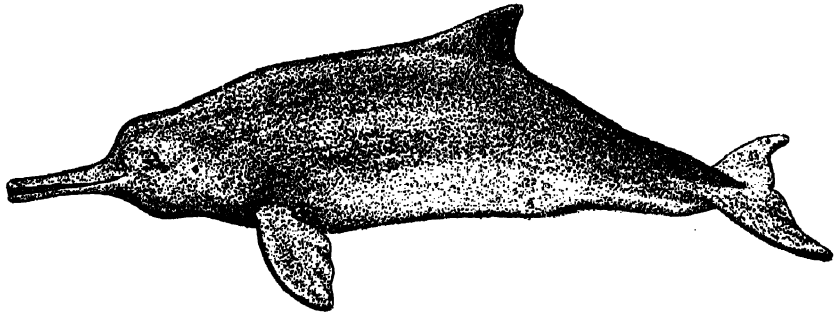


FIG. 97.—La Plata Dolphin (*Pontoporia blainvillei*).

The flesh and blubber are occasionally eaten, and "all along the Ganges, Brahmaputra and Indus the oil is universally considered as of great value as an embrocation in rheumatism and for giving much strength when rubbed on the back and loins".

The oil is also used as an illuminant.

Genus *Inia*.

THE AMAZONIAN DOLPHIN OR BOUTU (*Inia geoffrensis*). Fig. 96.

The Boutu of the Amazon, *Inia geoffrensis*, grows to a length of 7 feet and, like the Gangetic Dolphin, is characterized by its long slender beak which bears scattered bristly hairs. The head behind the beak is rounded and, on its summit, is the transversely placed blowhole. The dorsal fin is low and very long at the base. The tail flukes are disproportionately large, and the broad, cumbersome flippers have a convex lower margin, more or less straight upper margin and oblique hinder margin. The aperture of the eye is very small and that of the ear rather conspicuous.

The teeth, numbering about 30 on each side of upper and lower jaws, are conical, with crowns roughened in a manner reminiscent of the Rough-toothed Dolphin. The hinder 8 or 9 have a distinct internal heel. As in *Platanista*, the two halves of the lower jaw are fused together for a considerable portion of their entire length.

The body colour is blackish above and pink underneath, but specimens completely flesh coloured are known to occur.

The species is found in the Upper Amazon, and occurs together with *Sotalia tueuxi* and *Sotalia pallida* 1500 miles from the open sea. It is entirely fluviatile in distribution.

Bates in 'A Naturalist in the Amazons' states that the Boutos generally go in pairs, and in another publication says, "I have seen them rear themselves entirely above the surface of the water when the sexes are sporting in shoaly bays". "It is not killed willingly by the natives, who believe that blindness would result from the use of its oil in lamps."

Genus *Pontoporia* (*Stenodelphis*).

THE LA PLATA DOLPHIN (*Pontoporia* [*Stenodelphis*] *blainvillei*). Fig. 97.

The La Plata Dolphin is smaller than the two genera just described; it does not grow to a length of much more than 5 feet. In this creature the attenuation of the beak is greater than in any other dolphin. Upper and lower jaws are armed with finely pointed small teeth, between 50 and 60 in each row. The forehead behind the beak is rounded and, as in *Inia*, the blowhole is crescentic in outline. There is no depression between head and trunk. About midway along the back is a conspicuous triangular dorsal fin. The flippers are broad and bluntly rounded at the tip.

In many respects *Pontoporia* is more specialized than other Fresh-water Dolphins. In the articulation of the ribs, for instance, only 3 or 4 pairs have a double-headed connection with the backbone.

The colour of this animal is palish brown and it occurs in the estuary of the Rio de la Plata.

Genus *Lipotes*.

THE CHINESE RIVER DOLPHIN (*Lipotes vexillifer*). Pl. VII D.

In 1918 Mr. G. S. Miller described a new species of River Dolphin from the Tung Ting Lake, about 600 miles up the Yangtze Kiang.

This dolphin, which grows to a length of 7 feet 6 inches, is greyish or blue grey on the back and white on the belly.

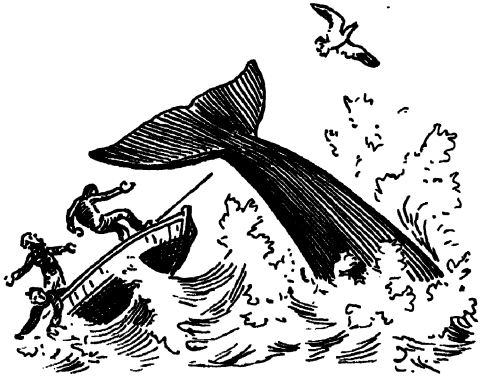
The beak, about 1 foot in length, is attenuated and curved upwards. The blowhole, very asymmetrical and distinctly on the left side, is situated just behind the crest of the pronounced forehead. The dorsal fin, which is behind the middle of the back, is bluntly triangular and the flippers are broad and blunt at the free end.

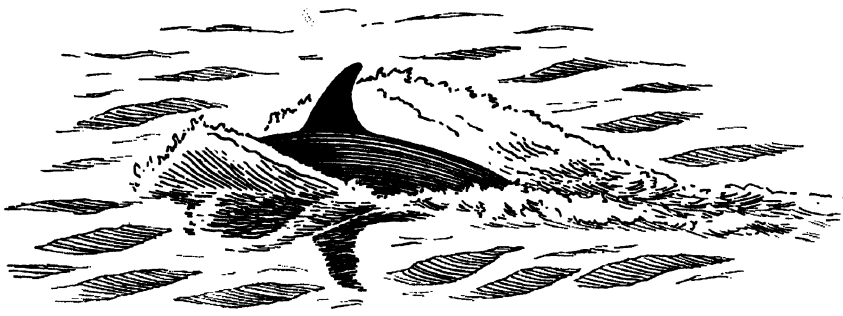
Teeth number 33 to 36 in each side of upper and lower jaws, and the enamel is roughened much as in the Rough-toothed Dolphin.

The inclusion of this species in the Fresh-water Dolphins is beyond doubt, but its affinities with *Inia* and *Platanista* have been made the subject of discussion.

The Chinese River Dolphin is never seen except in the Tung Ting Lake and around its mouth. A letter quoted in Mr. Miller's paper states : " In winter when the water in the lake is so low that there is scarcely more than the river channel left, they are easily seen and are found in great numbers in bunches of usually three or four, but occasionally of as many as 10 or 12 individuals. They are often seen in shallow water working up the mud in their search for fish. The one I killed had about two quarts of catfish in its stomach . . . the natives say that in the late spring when the lake is rising the dolphins make their way up the small, clear rivers, and that these are their breeding grounds."

The distinctness of this species from the Chinese White Dolphin, *Sotalia sinensis*, is mentioned by the author of the original description ; the similarity in the colour of the two species might suggest affinity, but actually in external form and in body structure they are quite widely separated.





CHAPTER XVI: KEY TO THE PRINCIPAL CETACEA DESCRIBED IN THIS BOOK.

THE arrangement of this key is similar to that for the identification of fishes. For the method of using it the reader is referred to p. 188 *supra*.

1. Whalebone present (**Whalebone Whales**).
  - A. Upper border of lower lip much arched. Surface of throat not grooved externally. Whalebone long and narrow.
    - B. Dorsal fin absent. Size up to 60 feet.
      - C. Chin white. Head one-third total body length — GREENLAND RIGHT WHALE (p. 205).
      - CC. Chin not white. Head one-quarter total body length. "Bonnet" on head — BLACK RIGHT WHALES (p. 211).
    - BB. Dorsal fin present. Size less than 30 feet — PIGMY RIGHT WHALE (p. 217).
  - AA. Mouth and upper border of lower lip not greatly arched. Whalebone short. Throat with grooving externally.
    - D. Only 2 to 4 grooves on throat. No dorsal fin — CALIFORNIAN GREY WHALE (p. 249).
    - DD. Numerous grooves on throat. Dorsal fin present.
      - E. Flippers extremely long, one-third length of body. Lower margin of flippers scalloped — HUMPBACK WHALE (p. 242).
      - EE. Flippers much less than one-third body length. Not scalloped below.
        - F. Whalebone plates yellowish-white, or slate coloured, or both.
          - G. Size up to 33 feet. Whalebone and whalebone fringes all white or yellowish. A white area on the outer side of flipper — LESSER RORQUAL (p. 231).

GG. Size 42 feet to over 70 feet. No definite white patch on outer side of flipper.

H. Size up to 49 feet. Whalebone for first 2 feet from tip of jaw generally white but frequently with grey stripes, remainder greyish black. Inner side of flipper bluish-grey . . BRYDE'S WHALE (p. 234).

HH. Size 70 to 80 feet. Whalebone yellow and slate coloured except in front on right side where it is white. Inner side of flipper white . . . COMMON RORQUAL (p. 223).

FF. Whalebone plates black.

I. Size up to 100 feet. Body colour blue-grey. No large white area on under surface of throat. Whalebone with coarse black fringes. Throat grooves extending at least to navel . . . . BLUE WHALE (p. 219).

II. Size up to 52 feet. White area of varying extent on throat. Whalebone with fine soft white fringes. Throat grooves ending some distance in front of navel . SEI WHALE (p. 227).

2. Whalebone absent. Teeth present though sometimes concealed (**Toothed Whales**).

A. Tip of lower jaw ending an appreciable distance behind foremost part of the head. Blowhole far forward on head.

B. Size 30 to 60 feet. Head massive, one-third body length. Teeth large, 18 to 28 pairs in number, confined to lower jaw. Dorsal fin an ill-defined lump. Flippers rounded . SPERM WHALE (p. 257).

BB. Size small, 9 to 13 feet. Head one-sixth body length. Teeth 9 to 14 pairs, confined to lower jaw, slender and curved. Dorsal fin well developed. Flippers tapering . . . PIGMY SPERM WHALE (p. 267).

AA. Lower jaw extending at least as far as tip of snout. Blowhole some distance from tip of snout.

C. Two conspicuous grooves forming a Λ-shape on the skin of outer surface of throat. Dorsal fin always present, considerably behind middle of body. No notch in middle of hinder margin of flukes (BOTTLE-NOSED or BEAKED WHALES).

D. Prominent forehead rising abruptly from, and almost at right angles to, axis of beak BOTTLE-NOSED WHALES, *Hyperoodon* and *Berardius* (pp. 270, 273).

DD. Forehead not prominent, merging gradually into beak BEAKED WHALES, *Ziphius* and *Mesoplodon* (pp. 275, 276).

CC. No grooving on throat. Dorsal fin when present at or near middle of body. Notch in middle of hinder margin of flukes.

E. Beak extremely long, narrow and forceps-like, one-sixth to one-seventh body length. Teeth very numerous in upper and lower jaws (FRESH-WATER DOLPHINS).

F. Blowhole not crescentic in outline.

G. Blowhole slit-like, longitudinally placed. Beak straight. Teeth 29 in each row. Dorsal fin an indefinite triangular ridge. Body colour lead black. Length about 8 feet. Confined to Indian rivers

GANGETIC DOLPHIN (p. 338).

GG. Blowhole a rough oval, distinctly on left side of head. Beak with distinct upward curve. Teeth 33 to 36 in each row. Dorsal fin triangular, moderate in height. Body colour light grey and white. Length about 7 feet 6 inches. Confined to Yangtse-Kiang

CHINESE RIVER DOLPHIN (p. 342).

FF. Blowhole crescentic in outline.

H. Dorsal fin high, short based, triangular. Teeth 50 to 60 in each row. Length about 4 feet. Inhabits estuary of River Plate

LA PLATA DOLPHIN (p. 342).

HH. Dorsal fin very low. Teeth 26 to 32 in each row. Length about 8 feet. Found in River Amazon . . AMAZONIAN DOLPHIN (p. 341).

EE. Snout either beakless, or beak when present never more than one-tenth body length (DELPHINIDÆ).

I. Dorsal fin absent or rudimentary.

J. Head without beak.

K. Teeth in upper and lower jaws.

L. Teeth spade-shaped, 15 to 19 in each row. Body colour black. Length about 4 feet 6 inches

FINLESS BLACK PORPOISE (p. 312).

LL. Teeth not spade-shaped, 8 to 10 in each jaw. Body colour (in adult) white. Length 12 to 14 feet

WHITE WHALE (p. 286).

KK. Either without visible teeth or with a tusk-like tooth several feet long projecting from the front of the upper jaw. Body colour mottled grey. Length 13 to 16 feet

NARWHAL (p. 284).

JJ. Head with a distinct short beak.
M. Black pigment restricted to upper parts of head, back and tail. Length up to 6 feet
SOUTHERN RIGHT WHALE DOLPHIN (p. 314).
MM. Black pigment more general, white between flippers and on belly. Length about 8 feet
NORTHERN RIGHT WHALE DOLPHIN (p. 314).
II. Dorsal fin present.
N. Head without distinct beak.
O. Size small up to 6 feet.
P. Teeth spade-shaped.
Q. Colour entirely black. Dorsal fin with concave anterior margin and convex posterior border. Teeth 16 or 17 in each row
BURMEISTER'S PORPOISE (p. 310).
QQ. Colour black and white.
R. Dorsal fin triangular.
S. Black of back and white of belly merging into each other in area of grey on sides
COMMON PORPOISE (p. 307).
SS. Black of back and white of belly sharply contrasted on sides
SPECTACLED PORPOISE (p. 312).
RR. Dorsal fin concave posterior margin.
T. White area on side confined to hinder half of body
DALL'S PORPOISE (p. 311).
TT. White area on side extending forward beyond insertion of flippers . TRUE'S PORPOISE (p. 311).
PP. Teeth conically pointed.
U. Upper surface of head unpigmented
WHITE-HEADED DOLPHIN (p. 316).
UU. Upper surface of head black.
V. Part of beak between head and dorsal fin unpigmented. Striking piebald appearance
COMMERSON'S DOLPHIN (p. 318).
VV. Back entirely pigmented.
W. A distinct promontory of white extending upwards and backwards on flank from white of belly.

x. Pigment continued from one side of body to the other on under surface in region of flippers
HECTOR'S DOLPHIN (p. 316).

xx. Unpigmented area between flippers on under surface
HEAVISIDE'S DOLPHIN (p. 315).

ww. Unpigmented portions of body entirely restricted to ventral surface. No elongated promontories of white on flank
WHITE-BELLIED DOLPHIN (p. 318).

oo. Size 7½ to 30 feet.

y. Teeth absent in upper jaw; those in lower jaw few in number and limited to front portion of jaw. Colour grey, deepening to black on fins and tail
RISSO'S DOLPHIN (p. 301).

yy. Teeth in both jaws.

z. Flippers very long and narrow. Teeth limited to forward part of jaws. Head conspicuously bulging in front
PILOT WHALE (p. 303).

zz. Flippers of moderate length. Head not conspicuously bulging. Teeth not restricted to forward part of jaws.

a. Flippers rounded in outline. Body colour conspicuously black and white. Teeth powerful, elliptical in cross section
KILLER WHALE (p. 289).

aa. Flippers tapering to a point. Teeth circular in cross section.

b. Colour entirely black. Size up to 18 feet. Teeth diameter ½ to ¾ inch . FALSE KILLER (p. 294).

bb. Colour slate blue. Size up to 7½ feet. Teeth diameter ⅕ inch
IRAWADI DOLPHIN (p. 299).

nn. Head with beak marked off from "forehead".

c. Beak short, 2 to 3 inches in length.

d. Body size moderately large, 9 to 12 feet. Teeth few, 20 to 22 visible in each jaw, ⅜ inch diameter
BOTTLE-NOSED DOLPHIN (p. 326).

dd. Size small to moderate, 5 to 10 feet. Teeth 22 to 34, diameter up to ¼ inch.

e. Beak white. Teeth 22 to 25 visible in each row
WHITE-BEAKED DOLPHIN (p. 321).

ee. Beak darkly pigmented. Teeth 24 to 34.

f. Broad oblique band of white and yellow enclosed in darkly pigmented portion of flank
WHITE-SIDED DOLPHIN (p. 320).

ff. No such enclosed light area.

g. Flattened diamond-shaped dark band on side, separate or almost separate from pigment of back
Lagenorhynchus cruciger (p. 322).

gg. Pigment on sides forming promontories projecting obliquely from pigment of back, or in the form of a darker longitudinal bar.

h. Teeth 24 to 28
FITZROY'S DOLPHIN (p. 324).

hh. Teeth 30 to 32
DUSKY DOLPHIN (p. 324).

cc. Beak long, up to 6 inches.

i. Crowns of teeth distinctly corrugated
ROUGH-TOOTHED DOLPHIN (p. 331).

ii. Teeth with smooth crowns.

j. Between black of back and white of belly an area of undulating bands of grey, yellow and white, giving impression of overlapping in region behind flipper COMMON DOLPHIN (p. 329).

jj. No such overlapping of bands of colour evident
Prodelphinus and *Sotalia*.* (pp. 331, 333).

* To include the species of *Prodelphinus* and *Sotalia* in the key would amount to repetition of the descriptions given in the text. It is suggested therefore that the reader should refer to the latter part of Chapter XV for further information concerning these somewhat imperfectly known genera.

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