CHAPTER I

INTRODUCTORY

General Review of the Resources of the Sea and the Influence of Man thereon

In this chapter is a general statement of facts which point to the conclusion that, with some exceptions, the fauna of the open sea, from its nature and environment, would appear, to a large extent, to be independent of man's influence.

In examining the resources of the sea[1] we are confronted with very different problems from those which meet us in the consideration of the fresh waters and the land. Moreover, this peculiar divergence has a tendency to mislead those whose experiences have been accumulated in surroundings in which all the operations of nature and of man are readily observed and easily understood.

It is but recently since we relied, for instance, on the knowledge derived from the effects of the non-protection of land-animals as a guide in dealing with the sea-fishes. It satisfied some to urge that man's influence had swept off the larger mammals from great areas, and at the present moment is rapidly diminishing the numbers of such forms as the right and other whales, the elephants, giraffes, elks, buffaloes and bisons. Comparatively recent legislation in our own country has year by year rendered the hare rarer than it has ever been previously, indeed it has swept this graceful denizen of the fields, this delight of every lover of nature, as well as unrivalled nourishment for the sick, nearly out of certain counties, and may lead to its almost total extinction; the wolf has disappeared, while the badger is scarce, and where, we may ask, would the red deer, the roe and the fox have

[1] By the sea is meant the open ocean and the exposed shores, for enclosed seas, like the Mediterranean, are placed under different conditions as regards the fisheries. Consequently the effect of man's interference in certain cases is distinguishable—were it only in the single feature of the size of marine fishes offered for consumption.

been if a measure of protection had not been meted out to them? Man's interference caused the extinction within a generation of the huge *Rhytina* (sea-cow), though it was more or less marine in habit, and in the present day the dugong and the manatee are diminishing and may follow their relative. As a rule, it is not difficult for man to influence land-animals whether for abundance or scarcity. Yet even here, under favourable surroundings, certain forms, as the rabbit in Australia, the lemmings in Norway and Sweden, the rats and mice of our houses, the voles of our meadows, occasionally prove more than a match for his most potent checks. In the vegetable world, again, it is an arduous and often fruitless task to extirpate many plants—even with man's ingenuity and opportunities. Nature provides in the majority a vast number of seeds, far beyond what is required for the preservation of the species, indeed the older naturalists pointed to this as a wise provision for the support of animals. Such a plant, for instance, as the marsh-thistle on the Scotch moors seems even to excel the common thistle in its fecundity, since its seeds germinate not only on broken ground but on the surface of the turf and moss. On sandy (easy) soil the "quicken" and "knot-grass" almost defy the efforts of the farmer. It is only when we come to the larger slow-growing kinds that the action of man is so destructive, and yet the number of seeds in the larger trees, as the pines, acacias and others, is very great, 30,000 for instance occurring in such as *Mimosa Lebbec*. Man's easy access and abundant opportunities are, however, very different from the conditions existing in the ocean.

Even in the domain of the air, which in its vastness excels that of the sea, the effects of man's interference—secondary though it may be—is often noteworthy, mainly because its denizens deposit their eggs or young on the surface of the land, and thus, though the adults may wing their way into the ether, and even feed therein, as in the case of the bats and swallows, the helpless young and eggs are within his reach. In the flightless birds the same rules apply as in the land-mammals, and how few of these now live! The moa, the great auk, the dodo, have gone, and the ostrich, emu, cassowary and kiwi (*Apteryx*) will require protection to retain them. In a few instances, as in the penguins,

remote haunts, active aquatic habits and great boldness have aided the several species in warding off destruction and placed them in a different category. The agency of man quickly diminishes many of the larger birds of flight, and this notwithstanding legislative protection. Without the latter where would our wild swans, geese and ducks have been? where the capercaillie, black-cock, grouse, pheasant and partridge? Like the passenger-pigeon of the United States they would have disappeared. The same lesson is learned when we contrast the former condition of the rook with the present one of modified protection. A few birds, as the sparrow, cushat and starling, appear to be exceptions under certain conditions; but these in the former case are due to the complications of civilized life itself, and in the latter often depend on immigration, and thus are seldom altogether beyond man's influence.

The air, however, differs from the land not only in its vastness, but in the fact that certain of its inhabitants, *e.g.* the insects, seem to defy man's power and ingenuity in limiting their numbers. Thus, is the house-fly less abundant now than in the days of the ancient Egyptians? Do the hordes of locusts, gnats, Hessian flies, mosquitoes, or other forms show marked diminution? Yet in all these instances the eggs are deposited on or near the surface of the earth and within man's reach. Even where elaborate measures are taken to encompass the destruction of a noxious form, *e.g.* the larvæ of disease-bearing Diptera in pools, or the vine-parasite, *Phylloxera*, on plants under man's immediate care, how difficult is it, with all the resources of modern chemistry, to attain success. The same applies to the larger insects, such as wasps, the nests of which are easily reached.

From age to age these denizens of the air have kept their ground against all the forces man could bring against them, and yet aërial eggs would have been required to have placed them on a similar footing to most of the food-fishes in our waters.

The elaborate laws framed for the protection of the more valuable fishes of the fresh waters of our country are sufficient proofs of the care which is necessary for their safety. Diminution of these is readily caused by explosives, poisons, and the various nets and other instruments used by man for capture. But just as—even in large areas of fresh water—the stock of fishes may

be reduced to small dimensions by over-fishing, so restoration by artificial measures can be effectively carried out. In both respects, therefore, fresh waters offer a contrast to the sea.

When we come to the ocean the problems connected with man's influence on certain of its denizens assume a much greater degree of complexity. In the first place, though the almost boundless space of the air far surpasses the sea, the latter greatly exceeds the land, since it occupies about three-fourths of the earth's surface. Yet this gives but an imperfect comparison, for, whereas it is chiefly on the surface of the earth that terrestrial animals are found, it is altogether different with the ocean, the inhabitants of which not only people the bottom, but glide over the latter, frequent mid-water and the surface, indeed, may be said to be scattered everywhere throughout its mass as well as fringe its margins. Moreover, while we can pursue the mammal on land, entrap the fish in the stream or lake, or follow the flight of the bird to a certain extent in the air, it is otherwise with the sea. Its ever-changing and often opaque and tempestuous waters offer a barrier to the pursuit of its larger forms, even were it possible to track them to its distant abysses, while the more minute for the most part escape observation. Thus with all the skill and perseverance of ages much yet remains to be accomplished in regard to our knowledge of the sea and its inhabitants, both plant and animal, though it is long since Risso, the naturalist of the seas of Nice, called attention to the distribution of marine life which is dependent on depth. One feature, however, sufficiently distinguishes the sea from the air, viz. its being almost everywhere permeated by life—both plant and animal, and thus it affords a never-failing supply of food to its inhabitants, each of which finds in the surrounding water the nourishment best suited for it.

The resources of the ocean, however, are limited in the case of the large air-breathing forms pursued by man, such as the right whale or "bow-head," which has steadily decreased in numbers during the present century. The reckless slaughter of the young whales accompanying their dams, a sure method of capturing the unfortunate and solicitous mothers, has intensified the effect of this eager chase by various nations for whalebone and oil. Producing but a single young one at a birth, this huge

and harmless mammal will probably disappear unless measures are taken for its preservation. The same may be said of the other whalebone whales which are pursued for profit, and of the dugong and manatee, the oil, skin and skeletons of which are of value. The huge Pacific grey whale (*Rhachinectes glaucus*[1]) of the lagoons of the Californian coast and which could rest on the bottom in shallow water, has, indeed, been entirely destroyed by man. The number of whales caught in recent years at the whaling stations reveals the vast resources in the ocean, though the effect of such captures on the species and on the fisheries has not been ascertained. In any case the inhabitants of Britain have a store of food in these marine mammals which may be made available in critical times; and there would be no novelty in this procedure. The Japanese have long eaten the flesh of the largest whales, like Sibbald's rorqual, as well as that of dolphins and porpoises, the whalebone of the former being likewise used for knife-handles, and the Canadians have lately canned the flesh in great quantities with success. It would not be unreasonable on this head alone to preserve these wonderful denizens of the sea by international agreement. On the other hand porpoises show no diminution round the shores of Britain and France, and the same may be said of those of other countries.

The effect of the slaughter of hundreds of the ca'ing whale (*Globiocephalus melas*) and of the white whale, is not so clear, but the xiphoid whales captured in the north seas for their oil are in greater danger. In no species has the inability of recuperation from constant attacks been better illustrated than in the sperm-whale, the numbers of which have been seriously diminished within recent times.

The effect of man's keen pursuit is also well shown in the seals, which are now so scarce on many parts of our own shores. Only in the more remote regions (as in the sound of Harris) are they to be met with in considerable numbers. Yet here and there the absence of interference and the presence of a favourite food may occasionally lead to their appearance in larger numbers, as at the mouth of the Tay. In the Baltic, though Sweden lately paid

[1] Held by some to be a variety of Sibbald's rorqual.

a premium on 4087 seals, it does not appear that the number of these predatory animals has decreased in recent years. Their recuperation after serious diminution is also shown by the remarks of Prof. D'Arcy Thompson thus:—"On the Galapagos every fur seal that could be found was killed by 1887, and the fur-trade was surprised when ten years later a vessel came into San Francisco with over 200 seals from the abandoned rookery. In like manner the seals from Robben Island were practically exterminated about the time of the Crimean War, when for a year or two 15 to 20,000 skins were taken in single voyages, and finally the place was abandoned. After 14 or 15 years of quiet, the rock was again covered with seals, as when first discovered." The Report[1] of Dr Hugh M. Smith for the United States' Fishery Department also bears out the wonderful power of recuperation in the fur-seals of Alaska and the Pribilof Islands. Man's effective influence on them in their headquarters in the Arctic seas is unchallenged, since their breeding places are on land.

It is curious that another group of marine vertebrates, viz. the turtles, has not been so seriously reduced in numbers as might have been anticipated, since the adult females come on shore to deposit their eggs, and are easily captured for food. Further, the scanty knowledge of such as the leathery turtle (*Sphargis coriacea*) is shown by the fact that so few have been found between 4 inches and 3 feet, though they breed regularly every year in the Bahamas and Tortugas as well as on the south coast of Brazil. Only large specimens are captured. The sea appears to be a sufficient protection for the smaller forms.

Most of these large air-breathing marine animals, therefore, occupy a special position, and make a contrast with the majority of the types we have now to consider.

Of great importance in connection with the subsequent groups is the plenitude and variety of marine plants. Familiar forms of these are the green, red and olive weeds of the rocky shores and tidal pools, and the grass-wrack of the muddy flats—of use in feeding cattle and producing explosives. In certain places indeed the perennial growth of the olive weeds was formerly of at least

[1] *Annual Report, Commissioner of Fisheries*, 1918, pp. 87—90.

as much importance to the inhabitants as their grain-crops. The immense Sargasso-sea off the Azores, and the smaller ones in the Atlantic, again, have long been a source of interest and wonder. Various naturalists further have noted the discoloration of the sea from the abundance of microscopic plants, have observed the occurrence of vast masses of diatoms in the south Pacific, and as an ancient marine deposit on land; while others have secured many in the stomachs of ascidians.

Though it is not so long since the intimate connection between this ubiquitous plant-life as food for the higher marine forms has been prominently demonstrated, yet it had not altogether been overlooked. The herbivorous cetaceans, as the manatees and dugongs were called, are well-known instances. From time immemorial dulce, Irish moss, many other algæ, and edible swallows' nests (an algoid substance), have been esteemed by man; and certain land-animals, as pigs, cattle, horses and ponies, eat with avidity tangles or other olive sea-weeds. Even the microscopic plants of the ocean (viz., diatoms) in their innutritious condition as a deposit on land (mountain-flour) were formerly, in times of scarcity, mixed with the pounded inner bark of the Scotch fir to satisfy the simple appetites of the Norse peasantry.

The presence of the minuter forms of plant-life must have been familiar to fishermen and voyagers from early times, either as a coating on their nets, as causing discoloration of the sea, or stranded as a scum on the beach. The occurrence of diatoms and other minute forms has also been noted by scientific observers such as Sir Joseph Banks, Sir Joseph Hooker, Dr Gwyn Jeffreys and the various explorers of modern times, *e.g.* those on board the 'Challenger,' as well as the staff of the German Plankton Expedition and the more recent expeditions to the North and South Poles and the International Fisheries Expeditions. The great abundance of diatoms in the Arctic and still more in the Antarctic seas is well known, while in the depths of the Black Sea all else is stated to be absent but bacteria.

Detailed examination of the pelagic life of St Andrews Bay and the offshore waters of the east coast for many years showed the vast abundance and variety of minute plants at all seasons,

from January to December[1]. Their occurrence in the stomachs of many invertebrates and even in some fishes further indicated the important part played by them. The presence of such as *Rhizosolenia* not only coloured the sea, but coated nets with an odoriferous layer. The intimate connection between the two great kingdoms was clearly pointed out as follows:—'It is a remarkable fact that it is primarily to plants in inshore waters that the abundance and variety of animals are in many respects due, especially if estuaries also debouch in the neighbourhood. Thus nowhere are the swarms of Sagittæ, Appendicularians, Crustaceans, and other groups of fish-food more conspicuous than in the midst of a sea teeming with diatoms, Rhizosoleniæ and other algoid structures.'.....'Now this plant-life is specially rich in April and May, just when the larval and very young post-larval fishes appear more abundantly in the inshore waters, so that the cycle is nearly complete, viz., from the inorganic medium—through microscopical plant and larval crustacean—to the post-larval fish[2].' Similar views have been broached by Prof. Hensen of the German Expeditions and Dr George Murray of the British Museum; while Prof. Cleve, of Upsala, was of opinion that even the origin of the coastal currents in certain cases may be traced by their diatoms[3].

Besides, both adult and adolescent marine fishes such as sand-eels devour the green and greyish-green algæ of the Eden, even to the distention of their stomachs in May. Algæ, again, are not uncommon accompaniments of food in other fishes. In many cases the contents of the various tow-nets for instance, by the International Fisheries' Council, are held to be typical without any net having touched the bottom. Thus a tow-net in inshore areas may contain swarms of Appendicularians, Copepods, larval annelids, Cyphonautes, Rotifers, and Bipinnarians amidst a wealth of algoid forms of diverse kinds, yet not a single pelagic mussel may be seen. A bottom-net used at the same time, on the other

[1] *7th Ann. Report, S. F. B.*, 1889, pp. 259—310, 4 Plates.

[2] Lecture, *Royal Instit. of Great Britain*, Friday, February 1, 1889, p. 10.

[3] Dr Petersen, of the Danish Zoological Station, has just issued an interesting addition to our knowledge of this subject—from observations in the Limfjord.

hand, reveals multitudes of young mussels which have just settled on the bottom. A rich store of food might thus be overlooked, and so with anemones, starfishes and other groups of marine animals.

Broadly speaking, therefore, the sea has within its area a vast and ever-present source of nourishment for its teeming animals—a source altogether independent of the increment from fixed marine vegetation on shore or swept into it by rivers. This supply can in no way be affected by the action of man, who is as powerless to modify it as to alter the tides. So long as it remains, one of the most important factors for the safety of the food-fishes is secured[1].

In the ocean are immense numbers of Foraminifera and Radiolarians upon which the lower invertebrates prey both at the surface and the bottom. They in turn feed on diatoms and other simple plants and animals, and thus aid in completing the cycle from plant to fish. The records of the rocks show that many of both groups were as prevalent in the ancient seas as in the modern. In the warmer areas, again, the water teems with the minute phosphorescent *Noctiluca* and *Pyrocystis*.

The Cilioflagellates, such as *Peridinium* and *Ceratium*, occur in great abundance throughout the year. In the warmer months these and the pelagic Infusoria (*e.g. Tintinnus*) are especially conspicuous at the surface. Their multiplication and that of other free and parasitic Infusorians—upon which many simple forms and even fishes, such as sardines, feed—is beyond the sphere of human influence.

Amongst the lower invertebrates we meet with a group which in itself has been the source of a special fishery, viz. the sponges. From time immemorial the Levant and for a less period the Bahamas and Florida have furnished large supplies. Moreover comparatively little care has been taken to propagate them by artificial means, and yet so nicely do all the surroundings fit them to continue the race that, after all these years, no sign of extinction is apparent. The fragments left on the rocks or stones as well as the pelagic larvæ which represent them in the water

[1] Prof. Herdman has recently made interesting observations on the quantities of pelagic fish-food. *Jour. Linn. Soc.*, Vol. xxxiv., 1919, p. 95.

around have sufficed to fill up the gaps caused by the sponge-fishermen just as surely as the gemmules of the fresh water sponges do when the mass dies down in autumn.

The non-commercial kinds of sponge, on the other hand, are free from special pursuit, being only captured by trawls and hooks to be again returned to the sea. The lacerated fragments or their contained eggs and larvæ enable each species to keep up its numbers in all our seas. Storms, moreover, toss many on the beach, but neither the one loss nor the other affects their abundance. Nature persistently carries out her measures of economy from age to age, and no more conspicuous example of this exists than the wide-spread disintegration of limestone rocks and the densest shells by the ceaseless borings of a marine sponge (*Cliona*).

In no group are the resources of the sea in regard to recuperation more prominently exhibited than in the hydroid zoophytes, jelly-fishes, anemones and corals. The hardihood of the common freshwater Hydra, so graphically told by Abraham Trembley, the old naturalist of Geneva, is characteristic of the majority of the race. The immense profusion of such zoophytes as *Obelia* in inshore waters and the rapidity of their growth show the ever ready resources of nature in restoring losses and spreading useful forms on every suitable site. Though it were possible in a given area to remove every vestige of such a form from the sea-bottom, a single summer tide would carry a sufficiency of little, ripe, jelly-fishes (*Hydromedusæ*) to repeople it. The countless swarms of these graceful and beautiful glassy creatures, which stretch for miles round our shores and far beyond into the open ocean, is one of the most striking features in marine life. From the eggs of these swimming jelly-fishes larvæ arise which by-and-by settle on rocks, stones, salmon stake-nets and other zoophytes, indeed, upon everything that affords a suitable hold, and rapidly grow into the plant-like original with which the cycle commenced. In their pelagic condition they are for the most part unaffected by any mode of fishing, though they are often beached in multitudes by the tide. Nature herself in another instance ordains an annual check to growth on the mussels of the Eden, for the dense and graceful tufts—heavily laden with young mussels—are swept