branch of the fauna of Venezuela that appears to have been pretty thoroughly worked at. Herr Anton Goering—the German naturalist, whose name has been already mentioned in connection with the ascent of the Silla of Caracas—sent all his collections of birds to this country, where they were examined and reported upon by two competent naturalists, who have devoted special attention to the neotropical avifauna. The results are given in the series of papers read before the Zoological Society of London, of which the titles stand last in our list of the subjects of this notice.

Mr. Goering's principal discoveries in the class of birds were made in the Andes of Merida, where some splendid novelties were obtained. And in this part of Venezuela, if we mistake not, there remains most to be done as regards both the fauna and the flora of the republic.

THE FISHERIES OF BRITISH NORTH AMERICA[1]

II.

THE careful inquiries that have been recently carried on by various able investigators in regard to the habits of our chief food-fishes—the Cod, the Herring, and the Mackerel—have now finally disposed of a large accumulation of popular fallacies on the subject of their migrations. On the European side Dr. G. O. Sars has added most to our scientific knowledge of the subject; and on the American, the United States Fisheries' Commissioner, Prof. Spencer Baird, and Mr. Hind, of the Halifax Fishery Commission, whose reports furnish a most valuable body of information as to the New England and Dominion fisheries.

It may now be affirmed with certainty that the notion of the long and distant migrations of these food-fishes is a complete mistake: the real facts being that they never range to any great distance from their ordinary *habitats;* that their migrations, which have reference to food on the one hand and to the deposit of spawn on the other, are simply from deep to coastal waters, and back again; and that these migrations are chiefly dominated by temperature.

Commencing with the *Cod,* we are informed by Mr. Hind that the total average weight caught in North American waters is about 185,000 tons, representing from 150 to 175 *millions* of fish, or between three and four times the produce of the whole Norwegian cod-fishery. Of this, the portion caught in the waters of the United States is only about one-fifth. "Winter cod" are taken on the southern coast of Newfoundland through the whole winter, while "summer cod" are captured through the summer months on the north-east shores of Newfoundland, the entire shore of the Gulf of St. Lawrence, and along the Labrador coast as far north as the Moravian missionary stations, Nain and Okak (57½° N. lat.).

It seems now well established that the great body of cod-fish inhabiting the waters of the long North American seaboard is divided into numerous separate "schools," which vary in their habits according to the localities they respectively frequent, each keeping (for the most part, at least) within its own limited range. There is no specific or even varietal difference between the "winter" and "summer" cod; their movements towards the coast from the neighbouring deeps, in which they spend the remainder of the year, being determined by the climatic changes which make the northern shores afford the temperature most congenial to the species in the summer months and the southern in the winter.

The food which lures the cod towards the shore at stated periods varies with the locality and season, being for the most part the capelin in the colder seas and the herring in the warmer; and hence the movements of these fish exert an important influence over those of the cod. At other times the chief food of the cod consists of the Invertebrates of the sea-bottom; and according to the predominance of any particular species will be its share in their maintenance. Thus in some places the cod feeds chiefly (as is shown by examination of the contents of the stomach) upon bivalve or univalve Mollusks; in others upon crabs, shrimps, and yet smaller Crustaceans; in others upon sand-stars, brittle-stars, holothurians, and other Echinoderms. The resort of cod to "banks" seems essentially determined by the food they find there; this, again, being dominated by temperature,—for, as already pointed out, the water on these banks is colder than water at the same depths elsewhere: many sub-arctic species of shell-fish, &c., which serve as food to the cod, thrive there far south of their ordinary habitats (as has been observed by Dr. J. Gwyn Jeffreys on the Dogger Bank); and thus, as Mr. Hind remarks, these banks bear the same relation to the surrounding sea area with regard to certain forms of marine life, as do the oases in the desert to various species of land animals.

An impression has prevailed among fishermen, and even among naturalists, that the Shore cod, or cod generally caught in coastal waters, is specifically different from the Bank cod, which is taken on reefs and banks in comparatively deep water, and often at a considerable distance from land. But it has been conclusively established by the careful observations of the two Profs. Sars (father and son) that no such specific distinction exists, the difference being one partly of age and partly of *habitat.* The two and three-year old cod remain on the Norwegian coast all the year round, and it is usually not until they attain their fourth year that their reproductive organs are sufficiently developed for multiplication. The adult Norwegian cod, according to Sars, retire far from the coast when the spawning season (January to March) is over; and are found during the summer on the slopes of the Polar Deeps. So the cod which frequent the coasts of Labrador through a great part of the year, seem to be immature (though sometimes having their reproductive organs developed); and when they attain their full growth, which occurs in their fourth year, they change their habits, frequenting the outside banks, and only a portion of them visiting the coast during the capelin season.

According to G. O. Sars, the Norwegian cod has no regular spawning ground, but drops its spawn free in the sea at a considerable distance above the bottom. The specific gravity of the ova is slightly below that of sea-water, so that the spawn rises to the surface and floats there, unless the salinity of the surface-layer be lowered either by rain- or by river-water, in which case the ova sink until they reach more saline water. The same is the case with the milt of the male, which seems to be shed at a greater depth than the roe of the female, which is thus impregnated from beneath, the micropyle of the ovum being located at its lowest point. The time required for hatching is about sixteen days, but a further period of fourteen days is required for the absorption of the yolk-bag, up to the completion of which process the young fish has little swimming power.

On the North American coast the spawning of the cod is not confined to a particular season, the process taking place in one locality or another through nearly, if not quite, every month in the year, and being obviously dominated by temperature, for it appears that cod ova find the *coldest* surface-water, provided it be free from ice, the most congenial to their development. Hence, as Mr. Hind justly remarks, the zone of cold water of from twenty-five to thirty miles broad, which extends for hundreds of miles along the Labrador coast, within the line of banks on which icebergs ground, is a most

[1] Continued from p. 172.

valuable possession to us, as supplying the most favourable conditions for the development of the cod ova furnished by the South Labrador schools, and thus feeding the great fishing-grounds further south.

Of late years the salted roe of the cod has become an important article of export, and the preparation of it a considerable industry, the principal use to which it is applied being for bait. Now in so far as this utilisation turns to account what was previously thrown away as offal, it is clearly an advantage; but it now leads to a special search for the gravid fish, which are taken in large quantities in shallow waters by seine nets, and in deep by the "bultow." This practice is very strongly reprobated by the United States Commissioner, who justly remarks that it is "precisely equivalent to killing off all the mature hens in a farm-yard before they have laid their eggs, and then expecting to have the stock continued indefinitely." "As well," he continues, "might the farmer expect to keep up his supply of wheat year by year while he consumed all his grain, reserving none for seed, and without the possibility of obtaining it from any other source." It is obvious from what has been already stated that the fisheries of New England must be much more injured by such a practice than those of the Dominion, the recruiting-ground of the former being far smaller in proportion; and it is also clear that the concession to the United States fishermen of the right to carry on this industry in British American waters is a very valuable one, and that, if made at all it should be placed under conditions which may prevent its being used to the detriment of our own fisheries.

The habits of the *herring* are in many respects different from those of the cod; for while the latter is essentially a bottom-feeding fish, the former is an essentially pelagian fish, feeding and swimming either at the surface or at any depth at which it finds its best supply of food. This consists sometimes of smaller fishes—sometimes the young of its own kind, but generally speaking of more minute animals, especially Entomostraca and Radiolaria, of which small reddish-brown aggregations, known to Norwegian fishermen as *aat*, are often found floating in the waters frequented by the herring. (I have myself met with these in considerable quantity near the Shetlands.)

The old notion of the annual migration of the herring from polar to southern waters has been long since abandoned, in favour of that which recognises in its movements an instinctive direction towards shallower waters at the spawning season. The eggs do not float, like those of the cod; but sinking in virtue of their greater specific gravity, attach themselves by their viscid envelopes either to the bottom or to anything else with which they come in contact. Ropes drawn through herring-spawn, or merely lying where it is deposited, become so thickly coated with it as to resemble large cables; and nets let down upon the spawning-grounds become so thickly covered, that in cleansing them the decks of the fishing-vessels are often ankle-deep in spawn. This spawn is very attractive to cod, which are thus lured towards the shore by the abundance of bottom-food left by the spawning "schools" of herring, as well as by the opportunity of preying on the schools themselves.

The productiveness of the herring fishery of the British North American coasts has been rapidly augmenting of late years, and seems likely to undergo a yet larger increase; for while it has hitherto been prosecuted only when the fish approach the coast at the spawning season, the knowledge now acquired of its habits will guide the fishermen where to look for it at other parts of the year, and how to take it at different depths. The limit set by temperature to the southern range of the herring has been already adverted to; and the admission of United States fishermen to British American fishing grounds is likely to become an even greater boon to them, in allowing them to prosecute a winter herring fishery along the coasts of Nova Scotia and Newfoundland, than it is in enabling them to participate in the cod-fishery. "The fluctuations in North American waters," says Mr. Hind, "are small in extent compared with those astonishing changes which take place in Europe, sometimes causing the ruin of large commercial and fishing communities, and leading to general distress. But the permanency of the herring schools in British American seas, the comparatively small size of the schools, and their uniform extent of distribution over an immense extent of coast-line, give them a direct and individual value to our fisheries, greater than is enjoyed even in Norway."

The spawning of the herring on British American coasts takes place partly in May and June (this being known as the "spring spawning"), and partly in August and September (the "autumn spawning"). The spring and autumn "schools" appear to be quite different; the period being determined in each case by the temperature of the waters frequented by the school. The spring spawning takes place with great regularity on the breaking up of the ice. The young when hatched school together, rarely going out to sea as far as their progenitors, and wintering by themselves apart from the older fish; not being found in any numbers in the deep bays of the coast of Newfoundland, Nova Scotia, and the northern part of Maine, where the old herrings winter. It seems probable that they do not begin to spawn until they have attained their third or fourth year. The depth at which the "spawning grounds" lie varies considerably—on the Norway coast, according to Boeck, from 10 to 150 fathoms. And there is good reason to believe that the occasional abandonment of old spawning grounds is usually due to a change of temperature, and that the fish is to be found at no great distance, probably in deeper waters.

"It is an important result of scientific inquiry," says Mr. Hind, "to ascertain the extent of the movements of a class of animals which have suddenly disappeared from accustomed haunts, and thrown into hopeless confusion an enormous industry upon which hundreds of thousands are dependent for their daily bread. But what immediate relief does it afford, if the discovery establishes the fact that the small downward movement into deeper water, or outward movement into less accessible wintering or spawning grounds, has placed them within reach of fishermen provided with the requisite means of capturing them?" In adapting themselves to such new requirements, he considers that the United States fishermen show more energy than those of New Brunswick; but if the latter allow themselves to be beaten in this winter fishing, in spite of the advantages given by nearer proximity to the fishing-grounds, it is of course their own fault.

The Norwegian herring fishery has of late suffered such a decline, while that of the North American coast has been improving, that out of the million of barrels, to which the catch of the latter is said to amount, no inconsiderable amount is now carried to Sweden in United States vessels. Another source of profit in the capture of the herring is the manufacture of an oil pressed from the bodies of the fish, and the use of the residual "scrap" as manure, under the name of fish-guano. And a vast number of freshly-caught herrings are used as bait in the cod and halibut fisheries; the United States fishermen resorting for this purpose to the Nova Scotia and New Brunswick fishing-grounds, as they find a more profitable market at home for the herrings which they catch off the New England coast. There is reason to fear that, unless due attention is given to the preservation of the spawning grounds, the New Brunswick herring-fishery will decline as that of New England has done; so that the activity of the United States fishermen will not only greatly injure British interests, but will in time come to defeat

their own, if it be not placed under provident restraint. Not only the fishermen of the United States, but those of France also, are supplied with cod-bait from the Newfoundland herring-grounds; and from recent arrangements for storing the bait-fish in ice, the capture of herrings for this purpose is being carried on with increased vigour. "So urgent is the demand for bait, and so entirely dependent are the cod and halibut fisheries upon a sufficient supply, that the fisheries may be said to be altogether dependent upon its being available, either naturally or stored near at hand, in a fresh and suitable condition." "The importance of these facilities for procuring bait only stands out in its true relief, when compared with what would be the condition of affairs if the fishermen of the United States did not enjoy a sufficient supply."

The *Capelin* and *Launce*, also, though of comparatively little value as human food, are of great importance as bait-fishes; the former supplying the cod fisheries of Labrador (where they sometimes abound to such a degree that at the spawning season their shoals are often stranded along the shore), and coming south as far as the Grand Banks; whilst the latter often visit the Banks in such enormous numbers as to give to the sea quite a glittering aspect. The resort of capelin to the Newfoundland fishing-grounds is less regular than that of herring, and it has been found necessary, in order to prevent the destruction of this most important attraction to the cod, to prohibit the use of capelin as manure.

The *Mackerel* is another very important food-fish, which, though an inhabitant of the United States coast much further south than the herring, is especially abundant in northern waters, and has always formed an important component of the produce of the Dominion fisheries, the value of the catch in some seasons exceeding that even of the cod. The supposed migrations of the mackerel from warm southern waters to cooler seas during the summer months, like the mythical wanderings of the herring to polar seas during the winter season, or the equally fanciful migrations of the cod to spawning-grounds on the Norwegian coast, have disappeared before the test of rigid inquiry; the fact being that different schools of mackerel inhabit different parts of the western shore of the Atlantic, from Greenland to Cape Hatteras; wintering in deeper water, and approaching the shore in the spawning season. The time of this approach varies with the temperature of the locality, the fish making their appearance earliest in southern latitudes, and progressively later in the spring and summer in proportion as the latitude is higher and the temperature of the sea lower. The spawn is not deposited on the bottom like that of the herring, but floats on the surface like that of the cod; and the young, when hatched, seems to pass the earlier part of its life in coastal waters. Though the schools of mackerel wander a good deal in the summer months, their wanderings do not appear usually to extend far from their birthplace, and seem mainly to have reference to food-supply, which consists of small fish-fry, entomostraca, and other inhabitants of surface-waters, the relative abundance of which is greatly determined by prevalent winds, while the stratum in which they swim is mainly determined by temperature.

For this and other reasons not yet fully known, the fluctuations in the productiveness of the Mackerel fishery are much greater than those of the Cod and Herring fisheries, especially on the New England coast; and thus the unrestricted admission of United States fishermen to the Dominion waters is a privilege of great value, of which they have largely availed themselves. Mackerel-catching is a special industry, and requires sea-going vessels. The boat-equipment common throughout British-American waters is wholly unsuited to the pursuit of the mackerel, immense schools of which are frequently left unmolested in the Gulf and on the coasts of Newfoundland, in consequence of the fishermen being unprovided with suitable vessels and fishing-gear.[1] Hence the greater part of the mackerel fishery in these waters has hitherto been carried on by United States fishermen; but there is, of course, no reason, save a want of enterprise, why those of the Dominion should not prosecute it with equal success.

From all this it is clear that if the United States fishermen were limited to their own waters, they would speedily exhaust the supplies of the "commercial fish" required not merely for the supply of food to a vast population, but for the supply of bait, fish-oil, and fish-guano—together constituting a drain which far exceeds the natural resources of the limited area along the United States coast inhabited by the cod and other deep-sea fish, as is fully admitted by Prof. Spencer Baird, the United States Commissioner. And thus the free admission of United States fishermen to the fisheries of the Dominion, which are not only unexhausted but apparently inexhaustible (if only placed under reasonable restrictions), is a privilege of enormous value, which should be met on the other side in a spirit of fair reciprocity.

How far this spirit has been exhibited on the part of the Legislature of the United States—which, after agreeing to an arbitration for the settlement of the amount to be paid in compensation, is now raising technical objections to the award, and protesting strongly against its justice,—is not a matter for our consideration; but we cannot conclude without adverting to one point which seems to have received insufficient attention.

While the coastal waters of the United States are in great measure unfitted by temperature for the maintenance of the "commercial" fishes, they are peculiarly adapted for the natural growth and artificial production of different species of shell-fish; some of which are chiefly useful as bait, whilst the Oyster not only supplies the wants of American consumers, but has become a large article of export. The Oyster-industry in the United States now far exceeds in value the aggregate of the deep-sea fisheries; its head-quarters being Chesapeake Bay, "a magnificent basin in which Providence seems to have accumulated every necessary condition for forming an admirable locality for the fishery," so that the oysters inhabiting it do not need culture, but are at once fit for the market. The transport of these oysters to the Northern and Eastern States employs quite a fleet of schooners; and the amount of oyster-shells calcined for lime is almost incredible, the profit derived from the shells at Baltimore alone amounting in 1857 to more than 120,000 dollars.

Now the Treaty of Washington having limited the taking of shell-fish to the citizens of the nationality in which they are found, British American fishermen are completely excluded from the Oyster-industry of the United States, without possessing any corresponding advantage; for the temperature and other conditions of the Dominion coast are just as *un*favourable to the growth of oysters and other esculent shell-fish, as those of the United States coast are favourable; so that, as its produce has no commercial value, "the reciprocity is all on one side."

The different fisheries of the United States coast have been long pursued with the ability and energy which distinguish the American people; but it has been clearly pointed out by the officers employed both by the United States Government and by the several States' Governments, that a decline in the productiveness of the fisheries has of late been going on along the greater part of the coast, and that this decline is due to excessive capture, especially of spawning fish. Through the obstruction and

[1] It is worth notice that the abundance of mackerel on the north-east coast of Newfoundland was for many years so great, that the fish were not only used for manure, but gave such trouble to the fishermen engaged in the cod and herring fishery, that their subsequent diminution was attributed by the fishermen to their having been "cursed off" the coast.

pollution of the New England rivers, the lumberer and manufacturer have ruined the cod-fishery of that locality by destroying the anadromous fishes which attracted the cod thither; so that thus the "fish oil" and "fish guano" manufacturers, who are now enriching themselves, not only at the expense of the herring and menhaden, but of the other species which depend on these for food, will speedily, if unchecked, increase the depletion of the northern waters of the United States; thus increasing the value of the concession made by the Treaty of Washington, and rendering it still more important that laws should not only be made, but enforced, for the prevention of a similar depletion of the (at present) highly productive fishing-grounds of the Dominion.

WILLIAM B. CARPENTER

THE GEOLOGY OF LONDON[1]

ALTHOUGH the British Government have undertaken the geological survey of the country, yet the valuable results obtained by this survey are unfortunately allowed to remain almost unknown to the general public. A complete set of the publications of the geological survey costs, we believe, something like 130*l.*, and is, of course, quite out of the reach of all but great libraries and wealthy public institutions, and no authorised reductions of the maps have as yet been published. It is much to be regretted, too, that the illiberal parsimony displayed in some branches of our public service is most conspicuous of all in that scientific department of it, where its effects prove most injurious. While the publications of the American geological surveys are distributed in foreign countries with an open-handed liberality worthy of a great government, and the courtesy of the chiefs of those surveys, Dr. Hayden and Mr. Clarence King, is well known to everyone—it is notorious that the directors of our own survey are placed in the painful position of having to refuse to acknowledge the just claims of the largest and most important scientific institutions of their own and other countries. The directors of our national surveys are the more to be pitied, inasmuch as the position of grudging parsimony in which they are placed contrasts so strikingly with that course of wise and judicious liberality in making known the results of their labours which the officers of the scientific departments of the United States and some other countries are permitted to pursue.

Another matter calling for serious consideration on the part of those who manage the publication of the results of these national surveys, is the exorbitant prices so often charged for the maps and memoirs. We know not whether it be the result of mismanagement or something worse, but it is a fact that it would seem to cost this Government department three or four times as much to produce a map or memoir as a private firm would require to accomplish the same work. Surely these publications not being handicapped with the charges of authorship, ought to be alike marvels of cheapness and models of excellence, yet how very different is the fact! For an unmounted one-inch map of the district around London the public is charged thirty shillings; for very moderate-sized volumes printed on inferior paper and having the general aspect of mean blue-books put into cloth covers, the sum demanded is two pounds; and recently the geological survey has surpassed even itself by issuing a small paper-covered pamphlet at the price of seventeen shillings!

None suffer so much from the effects of this unwise parsimony and obvious mismanagement as the officers of the survey itself. Those among their number who are engaged in active scientific work see the results of their labours, after long delays and many vexations, placed before the public in an almost inaccessible form; and they are too often disappointed and discouraged by finding that they do not receive the credit which their persevering labours so well deserve. Possibly, as has frequently happened, an amateur observer working independently, and untrammelled by the chains of officialism, is able to forestall their results, by publishing in a scientific journal the most important of their conclusions. Have not the directors of these surveys yet learnt that the day is gone by, when scientific writings can with impunity be delayed for years in the press?

Fortunately the evils to which we have directed attention in the foregoing paragraphs have a tendency to work their own cure. Thus, though the English Government have not followed the wise example of Austria in publishing chromo-lithographed reductions of the larger maps, the director-general and the directors of the branch surveys have produced privately useful maps on a reduced scale of the areas of which they respectively have charge. Objectionable as it may seem in principle that Government officials should issue as private speculations these results of their labours, it is certainly better that they should be allowed so to do, than that the public should be altogether deprived of such important publications.

The map of which the appearance has prompted the foregoing remarks, is another example of private enterprise being allowed to take in hand what we might fairly expect to be accomplished by a national institution. At the Loan Exhibition of Scientific Apparatus, in 1876, a MS. map of the geology of the district around London, drawn on the scale of six inches to the mile, attracted much attention. Since that time this map, with a well-constructed model of the same area, has formed one of the attractions of the admirable museum at Jermyn Street. In this instance the wise course was adopted of publishing a cheap "Guide to the Geology of London," which was drawn up by Mr. Whitaker, one of the most active and efficient officers of the survey, and a geologist whose researches are well known to scientific men beyond its limits. We believe that this excellent little book has had the large circulation it so well deserves; and it is certainly much better calculated to attract the attention of the general public to the important work that is being carried on by the Geological Survey than some of the more ponderous volumes, of which only a few copies are sold at very high prices in each year.

But valuable as the information on this six-inch map clearly was to a large section of the public, its information has been allowed to remain unpublished, and now Mr. Stanford has had to step in to supply the deficiency. Taking advantage of his excellent and well-known library map of London, and securing the services of Mr. James B. Jordan, who has had so much experience in work of this character, he has issued the geological information in question in a very convenient form. The map embraces all the area from Finchley on the north to Beckenham on the south, and from Blackheath on the east to Shepherd's Bush on the west. The subdivisions of the superficial deposits are not so numerous as might possibly have been desired on a map of this large scale, and the work shows too evident traces of having been compiled from a variety of different sources, some of the areas having been carefully surveyed on the six-inch scale, while others are only enlargements of the one-inch map. Nevertheless, with all these drawbacks the map furnishes information not to be obtained from any other published source, and it will supply a want that was beginning to be extensively felt among the ever-growing population of the metropolis.

The colours of the map are exceedingly well chosen and tastefully combined. Until it is superseded by an authoritative Government publication on the same scale, it is sure to have an extensive circulation.

[1] Stanford's Geological Map of London and its Suburbs. The Geology compiled from the Maps and other Works of the Geological Survey of England and Wales by James B. Jordan. Size, 76 inches by 65. Scale, 6 inches to a mile. (London: Edward Stanford, 1878.)