Hjort's Hydrographic-Biological Studies of the Norwegian Fisheries: a Review.

By

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SCANDINAVIA has been for a number of years past the centre of interest in hydrographic inquiries. The waters of the Baltic, Skagerack, and Cattegat, have been thoroughly investigated by Swedish men of science; the complicated currents of those seas and their periodic alterations have been determined and explained; and a relation has been found to exist between the movements of herring and mackerel and the periodic changes in the character of the water which bathes the Swedish shores. The brilliant results attained by the Swedish hydrographers have been fully described by Prof. Otto Pettersson in the tenth volume of the *Scottish Geographical Magazine* (1894), and a critical summary of these results is included in Cunningham's paper on the "Physical and Biological Conditions of the North Sea," published in this journal last year. (Vol. iv., 1896, p. 233.)

The fruitfulness of Pettersson's methods has, however, led other countries to co-operate with the Swedish hydrographers in extending the area of investigation, and in 1893 a series of investigations was carried out simultaneously in different parts of the North Sea by Swedish, German, Danish, British, and Norwegian vessels. The investigations on the part of our country were undertaken by the Fishery Board for Scotland, and were carried out by Dickson in H.M.S. *Jackal*. His results were published in the *Twelfth Report of the Fishery Board for Scotland*, and a further account of their bearings on the fishery problems appeared in *Natural Science* for January, 1895.

The Norwegian investigations were entrusted by the Norwegian Government to Dr. Johan Hjort, Stipendiate of State Fisheries, and his results are contained in the volume of 150 pages before us,* published

* *Hydrographic-Biological Studies of the Norwegian Fisheries*, by Dr. JOHAN HJORT. (*Videnskabsselskabets Skrifter*. I. Math. Naturv. Klasse. 1895. No. 9.) Christiania. 1896.

in the Norwegian language in 1895, and in English in 1896. In the present article I propose to give an account of Hjort's investigations, since the main problems which they were designed to elucidate concern the fisheries of the British Isles almost as closely as they concern the fisheries of Norway.

Hjort's enquiries may conveniently be described under three heads: (1) Hydrography, (2) Plankton (floating fauna and flora), and (3) Fisheries.

These will be discussed in the order mentioned.

I. Hydrography.

Hjort's investigations were limited to the waters bathing the shores of Norway from the Christiania fjord to the Lofoten Islands. The bulk of his work, moreover, was deliberately confined to the region of the West Coast Spring Herring Fishery, *i.e.*, the immediate neighbourhood of the mouth of the Hardanger fjord, in order that a complete knowledge might be obtained at this one spot of the periodical changes in the character of the water throughout the year.

His methods consisted in the analysis of a great number of samples of water obtained in many localities at various depths, the temperature of the different samples having been registered at the time of collection. He was successful in enlisting the interest and co-operation of a number of navigating and fishery officers, and the Norwegian Government placed a suitable steamship, H.N.M.S. *Heimdal*, at his disposal.

It will be remembered that Pettersson showed that the waters of the Skagerack and Cattegat consist of two principal layers, having different salinity and different temperature relations—a layer of light water (*i.e.*, of little salinity) on the surface, and a layer of dense water below. These two principal layers are separated by an intermediate layer of water, whose character, in regard to salinity and temperature, is intermediate between those of the principal layers.

The surface layer is Baltic water, the bottom layer is North Sea water, and the intermediate layer, which crops up at the surface over the shallow banks of Jutland and the west coast of Norway, is termed by Pettersson "bank water" ("coast water" of Cunningham).

The depth of the surface layer at different seasons depends on the amount of fresh water liberated from the Baltic Sea, and ultimately derived from the rivers which flow into it. This amount naturally increases enormously in the spring and summer (April to September), owing to rainfall and the thawing of ice and snow, and decreases in autumn and winter (October to March), owing to the locking up of the rivers by frost.

In spring and summer the Baltic water flows out over the surface of the Cattegat and Skagerack and along the west coast of Norway like a broad, deep river, at a rate of twenty miles daily. It is then of a high temperature, being warmed by the sun.

In autumn and winter the volume of outflowing Baltic water is greatly reduced, and from obvious causes it becomes ice-cold.

The difference in density between the Baltic water and the water in the North Sea basin inevitably results in perpetual efforts of the denser water to fill the Baltic basin; but after it has gained admittance as a bottom current its density becomes reduced by mixture with the fresh water of the Baltic, it rises towards the surface, and is swept out again with the Baltic stream. The varying force of the Baltic current necessarily induces variations in the amount and strength of the inflowing bottom current. The character of the inflowing water also depends on the season and the weather: in summer it is normal North Sea water which enters the Skagerack; in autumn and winter "bank water" of less salinity from the western shores of Jutland and Norway takes its place.

It only remains to add that the outflowing Baltic current, after rounding the Naze, flows northwards along the Norwegian coast. Here it is well known to mariners, and may attain the high velocity of twenty miles a day. (Mohn, 1887, p. 169.)

It might well be imagined that variations in a current of such magnitude would exercise a considerable influence upon the state of the sea water off the west coast of Norway, and Hjort's enquiries have furnished a striking confirmation of this expectation. This will be clear from the statements made in the following sections:—

1. *Seasonal Contrasts.*

The seasonal contrasts in regard to hydrographic conditions off the west coast of Norway are seen from Hjort's account to be essentially similar to those recognized by Pettersson in the Skagerack. The great arbiter of cold and heat, and the principal agent in the reduction of the salinity of the water, is the same in both cases, viz., the Baltic current, although the salinity of this current is not so low off the Norwegian coast as in the east part of the Skagerack. This current, wide, thick, and hot in summer, is, as a rule, narrow, thin, and cold in winter.

In certain winters, generally accompanied by south-west gales (*e.g.*, that of 1893–4), the Baltic current is dammed up in the Cattegat, and the shore along the whole west coast is then washed with a thick layer of bank water of high salinity (33 per thousand and over) from the surface down to a depth of fifty or sixty mètres, beneath which is a thick layer

It is consequently to be inferred that the smaller class of spring herring (250 mm.) represents simply the third class of fjord herring (five-point herring) after an additional half-year's growth. Some of the spring herrings, however, only measure 200–220 mm., and it is therefore possible that these fishes constitute an intermediate "yearly class," in which case the spring herring measuring 250 mm. would be four, instead of three, years old. In any event, the smaller class of spring herring is three or four years old, and with the larger class of spring herring, *has moved in from the sea to shore.*

Thus the life-history of the ocean herring may be summarised as follows. In its young condition the herring inhabits the inshore waters of the fjords until it attains a length of about 8 ins. ($2\frac{3}{4}$ years old), when it gradually moves out to sea and into deep water, gradually assuming the habits of the ocean herring, of which it forms the youngest yearly class. The young herring are clearly much more independent of changes in the coastal waters than the full-grown fish, since they live in the fjords during all seasons of the year.

Readers of Hjort's interesting contribution to fishery literature will be spared some trouble by noting the following errata, which have clearly escaped the author's attention:

Text, p. 25, seven lines from bottom—for 31·44 read 31·34 (cf. Hydrographical tables, p. 25, and Plate I., fig. 4).

Text, p. 47, station 170—for 34·51 read 33·51 (cf. Hydrographical tables, p. 43).

Hydrographical tables, p. 13—for Plate II. read Plate III.

Chart I. The meridians on this chart are based on Christiania=0, instead of Greenwich. The longitude of particular stations, however, seems to be always based on the system generally adopted.

Chart II. The parallel of latitude marked 60° should be 59° 30′.

An Account of the Scientific Work of the Northumberland Sea Fisheries Committee.

By

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JUST as a small marine laboratory is being fitted up at Cullercoats, it may be desirable to present to a wider audience a short account of the scientific work already done—work which has, in fact, given origin to the building now almost ready for occupation. As regards the laboratory, a word may be said. It is small, but it will be provided with a tank-room and the essential requirements for carrying on, at any rate, biological investigations. The tanks are made of wood, and will be supplied by gravitation in succession. At the same time a series of glass cylinders can be added in any number, and supplied with sea water in a similar manner. The workroom is very cheery, well lighted and well ventilated, and will accommodate six or even more workers. We are indebted for this most desirable adjunct to the biological department of the College to the Vice-Chairman of the Committee, who has already done so much for local fishery questions. The laboratory will, we hope, not only help in the development of our biological work, but form a centre for enquiry, and thus take a share in the general work of investigation now going on in this country.

It owes its inception, in fact, to the contributions to this work already made by the Committee. The trawling excursions conducted by Mr. Dent were begun in 1892, and have been continued in successive years since. Mr. Dent can remember when he could get as many as ten fine turbot with a harpoon any night on Blyth Beach (1860-65); at which period, also, he could almost fill a boat with the fish caught in a small drift-net. He witnessed the depletion of these and other bays which occurred after the steam-trawlers commenced to fish in the district (1877). He has seen the consequent

great development of North Shields, and the decline of the ordinary fisheries in the smaller villages and towns.

The three-mile restriction was adopted in 1891, and with the view of ascertaining how far this was to be valuable in restoring the fish to the bays along the coast, Mr. Dent kindly placed one of his steamers at the disposal of the Committee, and personally superintended the expeditions. The trawl used is an ordinary one of twenty-two feet beam, and a day of eight to nine hours is devoted to each bay.

The results have previously been published in yearly tables for the information of the Committee, but it will be more valuable for our present purpose to give the results for each bay. They are interesting in that these bays lie side by side, or, at any rate, within a district of forty miles; they are near to the stations of the similar but naturally more elaborate Scottish experiments, and it seems, from Dr. Fulton's investigations on currents, that we should get our supplies from the spawning grounds of the north. There is no necessity, however, of dwelling upon the results. A glance over each of the following tables shows only too plainly that the bye-law has made little improvement in the numbers of the mature fish. It ought to have been stated that the gurnards were not counted in the first two years. Blyth Bay does show an increase in all kinds, practically. Cambois Bay shows an improvement also as regards turbot, soles, dabs, and gurnards, but the plaice have decreased, though they seem again to be improving in numbers. It would be hard to point to any change occurring in regard to the fish of Druridge Bay. The numbers remain very steady for each year. The increase in the plaice of Alnmouth Bay is very marked. Soles are also increasing. Dabs scarcely show any change. In Skate Roads turbot and soles seem to give better returns, but plaice have decreased. It will be noted that flounders are not recorded for 1895, but it is highly probable that a few occurred and were overlooked, for they are very characteristic of this bay.

The undersized fish were taken particular note of at last year's excursions. By this term is meant such fish as were caught in the trawl and too small to be retained.* At Alnmouth Bay, on the 23rd July, they were roughly counted after the first haul before being returned to the sea. There were some 20 flounders of 6 in. or less; some 25 plaice of 7 in. or less; and 12 gurnards 8 in. or less. It was calculated that quite 100 immature fish were returned to the sea at each haul. It is the custom at these excursions to return the fish which are not

* It may be a rough classification, this, into mature or saleable, and immature or undersized; but in our anxiety to return the small fish as quickly as possible we do not as a rule make measurements, or even always count them.

retained as quickly as possible, and in every case it is noted that the flat fish swim away at once, evidently little the worse for being dragged along with the trawl for often two or even three hours, their visit to the deck of the steamer, and being swept overboard.

Druridge Bay possesses many young dabs and plaice. Skate Roads is rich in young flounders and plaice, and small turbot and brill are got as well. Cambois and Blyth Bays have principally immature dabs, but soles, flounders, and gurnards occur also in this category.

It is quite evident, then, that the restriction is useful in the protection it affords to valuable fish in the immature condition. But there is a curious dissimilarity often in the proportions of young and mature, or, let us say, saleable fish. The latter give us variable returns, sometimes slightly increasing, sometimes slightly decreasing, from year to year. There is no doubt at all that the in-shore trawling of the first few years did make such severe inroads as to be quite apparent. Allowing for seasonal variation in the numbers, there has not been such a return of the mature or large fish as to justify us in saying that the bye-law in that respect was tending to much good. If we now compare the rough statistics we have for Alnmouth Bay in regard to the immature fish with that part of the table referring to 1896, and assuming that the trawl was down five times at each excursion, the immature flounders would have been, say, 100. We only got three saleable. The immature dabs would be, say, 150. We got about half that number large enough to keep. The immature plaice would be 125, which is below the number of matured forms retained, and this in a bay showing an increase in the saleable plaice. I cannot speak as to the immature fish in previous years; but these figures, which could be repeated for the other bays, show only too well that a large destruction of fish occurs somewhere before they become mature. That this occurs when they go out to spawn seems from the collateral evidence of other experiments only too likely. Either this is the case or many of them depart after their in-shore early life and never return. But this does not explain the practical non-increase in these and other similar territorial waters. These facts only add to the evidence in regard to the destruction of the spawners outside the limits.

The plaice last year varied from 12 to 16 or 17 ins. in total length (one example measured 19¾ by 11½ ins., fins included), and were feeding principally on *Donax trunculus*, which is extremely common in these bays. *Tellina tenuis* and *Venus gallina* also occurred in some of the stomachs examined. The dabs measured 9 to 13 ins. in length, and were feeding mainly on *Portunus holsatus*, and sometimes old and fresh shells of various mollusca were found in the stomach as well. The soles were got from 12 to 20 ins., and sandeels were found most often in the stomachs.

Turbots also varied from 12 to 20 ins., and were found to feed on small whitings, the lesser weever, and the sandeel. Brill of 14½ and 20½ ins. were feeding on whitings. Flounders (12 to 18 ins.) had *Donax trunculus*, sandeels, *Mactra stultorum*, *Tellina tenuis*, *Portunus holsatus* as the forms found in the stomachs of a few examples. The common gurnard of 11 to 16 ins. was feeding on sandeels, whitings, *Portunus holsatus*, etc. Other forms were investigated, and full details of measurements and contents of stomachs are given in last year's report. The more important "other fish," etc., are also referred to.

The surface nets gave us two kind of eggs—those of the Lesser Weever (*Trachinus vipera*) and an unknown egg not differing from McIntosh and Prince's "F" form.

Mr. Gregg Wilson, of Edinburgh University, while in the district, made investigations into the condition of the crab, lobster, and mussel fisheries. He found evidence which led him to suppose that crabs spawn during November, December, and January; that females were not less than 6 in. when mature, that males were mature at 5 in. Along with a close time, which is, however, commonly naturally given during these months, he recommended the raising of the size-limit to 5 in. He recommended also a close time for lobsters during June and July, on the assumption that in these months most berried hens were found. The sale of the berried hen, it is expected, will shortly, however, be prohibited in the district.

A member of the Committee, Mr. William King, who has had much experience in mussel cultivation, contributed an interesting paper on that subject. A list of the papers published for the information of the Committee is appended.

We have to remember also the rich inheritance of local zoological work we have from such eminent naturalists as Dr. Johnston, Joshua Alder, Albany Hancock, Dr. G. S. Brady, Dr. H. B. Brady, the Rev. Canon Norman, R. Howse, and others.

List of Papers Published by the Committee.

1. 1891. William King—"Mussels and Mussel Culture."
2. 1893. Gregg Wilson, M.A., B.Sc.—"Report on the Crab, Lobster, and Mussel Fisheries of Northumberland."
3. 1895. C. Williams—"Report of a Visit of the Northumberland Sea Fisheries Committee to the Marine Hatchery at Dunbar."
4. 1895. Gregg Wilson, B.Sc., Ph.D.—"Further Report on the Crab Fishery."
5. 1895. John Dent, J.P.—"Records of Scientific Trawling Operations conducted off the Northumberland Coast (1892-95).
6. 1896. Alexander Meek, B.Sc., F.Z.S.—"Report on the Scientific Results of the Trawling Expeditions carried on by the Northumberland Sea Fisheries Committee during the Summer of 1896."

Tables showing the number of Fish captured in each Bay.

(1) Blyth Bay. 2–5 Fathoms.

Year.	Date.	Turbot.	Brill.	Sole.	Plaice.	Dab.	Flounder.	Haddock.	Whiting.	Gurnard.	Skate.	Midday surface temp., F.	Sea.	Wind.
1892	Aug. 1	—	—	1	88	40	—	—	—	—	—	—	rough	N.E.
	,, 15	—	—	—	20	12	—	—	—	—	—	—	smooth	W.S.W.
	Sept. 20	2	—	3	60	41	—	—	—	—	—	—	rough	E.N.E.
	Average	·5	—	1·5	56	31	—	—	—	—	—	—		
1893	Aug. 2	3	—	56	59	23	—	—	—	—	—	55	smooth	W.N.W.
	Sept. 13	6	—	17	37	19	—	—	—	—	—	56	rough	W.S.W.
	Average	4·5	—	38·5	48	21	—	—	—	—	—	55·5		
1894	July 27	2	—	43	67	23	2	5	—	41	1	52	smooth	N.E.
1895	July 31	1	—	12	64	32	—	4	—	25	—	53·5	smooth	calm.
	Aug. 15	4	—	20	58	95	—	7	—	40	—	54	smooth	calm.
	Average	2·5	—	16	61	63·5	—	5·5	—	32·5	—	53·75		
1896	June 18	7	—	5	85	44	—	—	—	46	—	53	smooth	W.N.W.
	Aug. 26	2	—	36	63	78	2	—	—	20	1	55	smooth	E.
	Average	4·5	—	20·5	74	61	1	—	—	33	·5	54		

(2) Cambois Bay. Depth 3–7 Fathoms.

Year.	Date.	Turbot.	Brill.	Sole.	Plaice.	Dab.	Flounder.	Haddock.	Whiting.	Gurnard.	Skate.	Midday surface temp., F.	Sea.	Wind.
1892	Aug. 11	—	—	—	80	44	—	—	—	—	—	—	smooth	S.W.
	Sept. 13	3	—	7	120	80	—	—	—	—	—	—	smooth	W.
	,, 15	2	—	8	81	47	—	—	—	—	—	—	smooth	W.S.W.
	Average	1·7	—	5	93·7	57	—	—	—	—	—	—		
1893	July 15	2	—	3	50	12	—	—	—	—	—	54	strong... N E sea...	calm. W.
	Aug. 7	4	—	16	60	51	—	—	—	—	—	55	smooth	
	Average	3	—	9 5	55	31·5	—	—	—	—	—	54·5		
1894	Aug. 17	1	—	20	18	11	4	20	—	17	—	53	strong...	N.
	Sept. 13	1	—	59	30	18	—	22	—	6	—	53	surf	N.E.
	Average	1	—	39·5	24	14·5	2	21	—	11·5	—	53		
1895	July 4	3	—	4	37	13	—	—	—	7	—	52·5	rough	N.E.
	Sept. 5	3	—	4	71	33	—	7	—	85	1	54	smooth	W.
	Average	3	—	4	54	23	—	3·5	—	46	·5	53·25		
1896	Aug. 12	8	—	24	76	81	—	—	—	100	—	55	smooth	W.

(3) Druridge Bay. 2-3 Fathoms.

Year.	Date.	Turbot.	Brill.	Sole.	Plaice.	Dab.	Flounder.	Haddock.	Whiting.	Gurnard.	Skate.	Midday surface temp., F.	Sea.	Wind.
1892	Sept. 16.	—	1	13	140	70	—	—	—	—	—	—	smooth	S.W.
1893	Aug. 31.	9	—	24	87	67	—	—	—	—	4	56	smooth	N.E.
	Sept. 8.	7	—	28	73	39	—	—	—	—	—	56	smooth	N.N.E.
	Average.	8	—	26	80	53	—	—	—	—	2	56		
1894	July 4.	27	—	5	146	54	3	7	—	—	3	54	smooth	W.
	Aug. 22.	7	—	36	50	40	2	24	—	120	—	55	smooth	N.E.
	Average.	17	—	20·5	98	47	2·5	15·5	—	60	1·5	54·5		
1895	June 20.	5	—	6	120	15	2	—	—	13	2	52	rough	N.E.
	July 11.	5	—	12	116	60	—	—	—	35	1	52·5	smooth	W.
	Aug. 22.	2	—	11	132	70	—	2	—	120	1	55	smooth	calm.
	Average.	4	—	10	123	73	·5	·5	—	63	1·5	53		
1896	July 9.	9	—	35	160	68	—	—	—	83	3	54	smooth	S.W.
	,, 29.	8	—	8	157	68	1	—	—	143	—	55	rough	E.
	Sept. 8.	13	—	26	104	123	1	—	—	124	1	56	smooth	E.
	Average.	10	—	23	140·5	86·5	·5	—	—	117	1·5	55		

(4) Alnmouth Bay. Depth 2-3 Fathoms.

Year.	Date.	Turbot.	Brill.	Sole.	Plaice.	Dab.	Flounder.	Haddock.	Whiting.	Gurnard.	Skate.	Midday surface temp., F.	Sea.	Wind.
1893	July 25.	9	—	8	116	100	—	—	—	—	4	54	smooth	N.W.
	Aug. 22.	3	—	11	75	49	—	—	—	—	1	55	smooth	S.S.W.
	Average.	6	—	9·5	95·5	74 5	—	—	—	—	2·5	54·5		
1894	July 11.	17	—	5	131	63	14	2	—	49	3	52	smooth	N.E.
	,, 31.	8	—	18	60	51	4	12	—	17	3	54	smooth	calm.
	Aug. 29.	14	—	8	65	35	7	15	—	85	2	55·5	smooth	W.
	Average.	13	—	10·5	85·5	50	8·5	10	—	50 5	3	54		
1895	July 25.	7	—	4	118	82	—	10	—	24	—	52	smooth	N.E.
	Aug. 29.	3	—	7	101	46	—	103	—	65	1	54	moderate	W.
	Average.	5	—	5·5	109·5	64	—	56·5	—	44·5	·5	53		
1896	July 23.	13	—	30	202	117	3	2	1	29	1	55	smooth	W.
	Aug. 19.	9	1	9	154	44	3	—	—	46	—	55	smooth	N.
	Average.	11	·5	19·5	178	80·5	3	1	·5	37·5	·5	55		

(5) SKATE ROADS (BUDLE BAY). $2\frac{1}{2}$–4 FATHOMS.

Year.	Date.	Turbot.	Brill.	Sole.	Plaice.	Dab.	Flounder.	Haddock.	Whiting.	Gurnard.	Skate.	Midday surface temp., F.	Sea.	Wind.
1894	June 27	28	—	1	371	22	19	—	—	—	4	54	smooth	N.E.
	Aug. 6	18	—	1	90	30	9	—	—	81	3	54	smooth	W.S.W.
	Average	23	—	1	230·5	26	14	—	—	40 5	3·5	54		
1895	June 26	4	—	—	120	42	—	6	—	30	—	53	rough	calm.
	Aug. 5	1	—	3	75	13	—	4	—	70	—	53·5	moderate.	N.
	Average	2·5	—	1·5	97·5	27·5	—	5	—	50	—	53·25		
1896	June 24	7	—	5	85	44	—	—	—	46	—	53	smooth	W.N.W.
	Aug. 3	50	1	2	155	10	32	—	—	29	—	55	rough	N.E.
	Average	28·5	·5	3·5	120	27	16	—	—	37·5	—	54		

Gadus Esmarkii, Nilsson, the Norway Pout, an addition to the Fish Fauna of the English South-Western District.

By

Matthias Dunn, of Mevagissey, and Ernest W. L. Holt.

In the summer months, for some years prior to 1887, very large quantities of *Hake* (*Merluccius vulgaris*) had been caught by trawlers beyond the entrance of the Bristol Channel, and landed at Plymouth. Knowing that such masses of hungry creatures would not be found continuously in any given locality without a heavy balance of smaller fish being in their neighbourhood as food for these hakes, I became anxious to know what these smaller fish were, and throughout the summer of 1888 I tried more than once to get at them through our fishermen, but failed.

In July, 1889, I desired my son Howard to visit the Plymouth Barbican, and notice the gutting of the hakes there and tell me the result. His report was that they had been feeding on small whiting (*Gadus merlangus*), and that single hakes had as many as ten whiting in their stomachs. I told him that I doubted if these small fish were whiting, and asked him to send the specimens at once, as I expected them to be the poutassou (*Gadus poutassou*) of Couch. I had recently had specimens of this fish brought me from thirty miles west of the Scilly Isles.

About a week afterwards my son sent me seven of these little ones taken from the stomach of a pollack (*Gadus pollachius*) which had been caught in a trawl forty miles north-west of St. Ives. On giving them my attention, I was surprised to find they were not the poutassou nor any other *Gadus* I was acquainted with.

Hence I forwarded these two specimens to the Plymouth Biological Laboratory for further enquiry and research concerning this new species.

M. D.

The credit of the discovery of the Norway pout in the south-western district, and of its recognition as distinct from any *Gadus* previously recorded in the local fauna, is entirely due to Mr. Dunn. My own share in the matter is confined to the specific identification of the material, a matter of small difficulty, owing to an extensive previous acquaintance with the species on the west coast of Ireland and in the North Sea.

Though the species has been discussed at some length as recently as 1895,* a short recapitulation of its history appears convenient.

Originally discovered by Esmark, in 1844, as an inhabitant of the Norwegian coast, its range was subsequently extended by Lütken to the Faröe Islands.

In 1888 it made its first appearance in British records, being found in comparative abundance by Günther among the fishes collected by Murray on the west coast of Scotland.

It was next recorded by myself, in 1890 and 1891, from the west coast of Ireland, where it occurred, during the Royal Dublin Society's survey, in considerable numbers, a great many of my specimens being found, as was the case with Mr. Dunn's, in the stomachs of larger fishes; and in 1892 I was able to extend its range again, from the examination of stomach contents, to the Great Fisher Bank in the North Sea. It is therefore apparent that, in so far as regards the date of capture, Mr. Dunn's specimens actually represent the second occurrence of the species within the British area.

It is not a shallow-water fish, having hitherto been found, or at any rate recorded, only between 26 and 144 fathoms, a fact which may partially account for its having so generally escaped attention at the hands of naturalists. Fishermen would naturally regard it with unconcern, since it never grows to a marketable size, and bears, moreover, a very close resemblance to a common and, from the market point of view, equally worthless form, *Gadus minutus*.

Probably it may prove to be common enough at suitable depths around our coasts, though it may perhaps not extend into the English Channel or further south, since our continental neighbours, who take a gastronomic interest in even smaller fish, would in such case be likely to have noticed it.

The specimens forwarded by Mr. Dunn to the Laboratory are two in number, and, taken as they were from the stomach of a pollack, are naturally not in the most perfect condition, though quite sufficiently so for identification. One, which is complete, measures $7\frac{1}{4}$ inches in total length, while the original length of the other, which has lost

* Holt and Calderwood, *Sci. Trans. R. Dub. Soc.*, v. 1895, ix. p. 431.

the caudal peduncle, may safely be estimated as over eight inches. They are thus rather large examples.

Dr. Günther has called attention to the existence of two varieties of the species, of which the typical Norwegian forms were found to differ from the Scottish chiefly in the greater attenuation of the body and the greater size of the eye. The same difference was found to exist between the solitary specimen from below the 100 fathoms line and the smaller ones from lesser depths among the Irish survey collections. Without entering into details, it may suffice for the moment to remark that Mr. Dunn's specimens agree with the larger Norwegian and deep-sea Irish type, and not with the smaller Scottish and Irish variety.

E. W. L. H.

Remarks on Dr. Petersen's Report of the Danish Biological Station for 1895.

By

Ernest W. L. Holt.

It may be predicted of a Report by Dr. Petersen that it is sure to contain matter of great interest, both to the ichthyologist and to the student of fishery questions; and the volume for 1895 is assuredly no exception to the rule.

The subject dealt with is the plaice fishery of the Lim fjord, an arm of the sea which pierces the Danish peninsula from Thyboron, on the west coast, to Hals, on the Cattegat. Such a geographical feature is quite without parallel in our comparatively mountainous countries, and may even be said to present difficulties of comprehension to those who have not had an opportunity of visiting Denmark. Indeed, the physical conditions are so different from our own, that it must be at once acknowledged that the mass of information so carefully collated by Petersen cannot be made of direct use in connection with any of our own fisheries. Indirectly, however, the Danish work will be found to be of the highest importance, and well worth the attention of those concerned with British fisheries.

A glance at Petersen's map shows that the Lim fjord consists of "brednungs," or broads, connected with each other by somewhat narrow channels of various lengths. The westernmost (Nissum) broad communicates with the sea (since the beginning of the present century) by means of an inconsiderable opening in the barrier ridge of Hasboöre, while the Liv broad, the easternmost, and by far the largest of the series, is separated from the Cattegat by a long and, for the most part, narrow sound. Previous to the breakdown of the Hasboöre barrier we learn that plaice were only found in the sound last mentioned, viz., that between Hals and Lögstör, and only then, as now, in quite inconsiderable numbers, even in that part. Consequently the fish, which now form the object of a most important

industry, are comparatively new-comers, and belong, not to one of the stunted Baltic races, but, as Petersen incidentally shows, to the largest of the North Sea races, viz., the one familiar to Grimsby fishermen. It is, moreover, most important to note that the plaice of the Lim fjord does not as yet appear to have become a true native, the stock of fish annually taken being merely those which have entered the fjord in the early stages of their career. Petersen evidently holds the conviction that the fish does not breed there at all; but rightly guards himself against an absolute statement to that effect until his evidence shall be more complete. It is equally evident that the contrary opinion is not unknown in the locality; but certainly all that we know in this country about the breeding of the plaice must be taken as evidence of the correctness of Petersen's views on this matter.

To what extent the reproductive activity may be affected by conditions of mere salinity is a question to the solution of which we are not helped by the recorded observations of any writer; and, as it happens, no details of specific gravity, etc., are given in the present Report, though we learn, incidentally, that the salinity, if that be really a desideratum, must be sufficient for the reproduction of the rockling, sprat, and flounder. That these fish will spawn in narrow waters we know from our own experience at home, but except where, as on the west coast of Ireland, the rapid declivity limits the habitable area to a comparatively narrow strip, I cannot call to mind any record of plaice spawning close inshore. In the Lim fjord the fish is limited to an area of 614 square miles, of which only 283 square miles contain three or more fathoms of water; and, as Petersen shows, the Liv and Thisted broads, which comprise about one-half of the whole area, are seldom, if ever, reached at all by plaice under natural conditions.

That a few fish are occasionally found with ripe ovaries is, I think, rightly held by Petersen to be no proof that actual breeding takes place there, since we know, from our experience of aquaria, that fish will yearly develop spawn, but will not shed it until thoroughly acclimatised. Even in the feral condition one occasionally meets with fish in which the ripe ova have remained to decompose within the ovaries, and I can recall at least one instance in which such a condition appeared to be directly due to the creatures having returned too soon, or having never left the estuarine waters.

That the fish are not actually land-locked in the fjord is evident from the fact that they got in there, but very few seem to get out again, for the sufficient reason that the fishermen catch practically all that are marketable; and it is worth while to note that it only takes about twelve days' fishing in each broad to exhaust the annual supply.