

Observations on the Marine Fauna off the East Coast of Scotland.
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DURING the last few years considerable interest has been felt, both by naturalists and fishermen, in the fact that the herring-fisheries along the east coast of Scotland have been carried on much further from the shore than was formerly the case, and this has necessitated the employment of larger and better-found fishing crafts, which, however, in boisterous weather find it difficult or impossible to enter with safety into the existing harbours.

The local fishermen having expressed considerable doubts respecting the accuracy of the charts of the coast, Sir George Balfour, K.C.B., M.P., drew the attention of the Board of Trade to the subject; and H.M. surveying vessel 'Triton' was directed to be sent in July 1882, under Staff-Commander Tizard, to survey off Aberdeenshire, Kincardine, and the north part of Forfar.

Having been invited to join the survey party, I took the opportunity of inquiring locally into the opinion of the fishermen and others, the reason why the herring-fisheries were being carried on further out to sea, and also if the inshore ones were less prolific than they used to be. For it has appeared to me rather remarkable that some who will not admit the possibility of the inshore fisheries being less prolific than formerly, pointing out the generally increased supply from the line fishermen, do not deny that the inshore herring-fisheries are less prolific than they were a few years since, although an augmented herring supply reaches the market.

In the following brief notes I have not thought it necessary to enter fully into points which have been discussed elsewhere, but confined myself as much as possible to such as are still subjects of debate. Questions of fisheries I have more fully detailed, and drawn attention to some subjects on which, I would venture to submit, further information is very desirable.

The Herring-Fishery.—Concerning the investigations of the Commissioners on the "Scotch Herring-Fishery," published in 1878, I have a few observations to make. It is remarked that the herring-fishery on the coast of Scotland as a whole has in-

creased and is increasing, while any further legislation respecting it is deprecated, and that "neither government encouragement nor restrictive legislation has had much effect on its herring fishery. Its progress is marked by constant fluctuations from year to year, but is on the whole a record of continually increasing prosperity from 1809 to the present time." "The prosperity of the Scotch herring fishery is entirely due to the extraordinary development of the fisheries on the Aberdeenshire and Forfarshire coast;" and "if the takes between Fraserburgh and Montrose be deducted, the condition of the other fisheries will be found to be much less satisfactory." "However little effect the enormous mass of netting may have on the stock of herrings, we think it reasonable to conclude that the fish may be scared by these means and deterred or intercepted from entering the narrow waters, and firths, and lochs of Scotland" (p. xxiii). During the last few years, however, the fishing has been conducted further and further out to sea, and the fisheries of the Firths themselves have either decreased or become neglected. Twenty years since (about 1858)* a boat carried twenty-four nets made of hemp, each net forty yards long, with twenty-eight or twenty-nine meshes to the yard, and ten to twelve score deep, or nine hundred and sixty yards of netting, having a catching surface of 3000 square yards; while in 1878, a boat carried fifty to sixty nets made of cotton, each net sixty yards long, with thirty-five meshes to the yard, and eighteen score meshes deep, or 3300 yards of netting having a catching surface of 33,000 square yards.

From the report we may conclude:—(1) that the amount of netting employed has vastly increased of late years, while the size of the mesh has likewise greatly diminished; (2) that generally in Scotland herrings have forsaken the inshore fishing-grounds and gone further out to sea; (3) that it does not appear improbable that increased netting or such being carried on in too indiscriminate a manner may have had something to do with the fish retiring to deeper water; (4) that in the Moray Firth, sprat-fishing increased in 1868, when restrictive enactments were repealed, while the commencement of the decrease of herrings began the same year.

The migrations of the herring have given rise to many speculations, and is a subject that still requires much elucidation.

* Probably five or ten years prior to the date assigned.

Some suppose that this fish is not, strictly speaking, migratory—that is, that it does not travel comparatively far from the locality in which it was hatched, reared, and came to maturity, but simply changes from shallow to deep water, in accordance with temperature and the supply of food—one proof advanced being that certain definite varieties are present in certain waters. Where they conceal themselves is certainly remarkable. Thus along the Devonshire and south-west coast of England, Mr. Dunn observes that should a gale spring up numbers are taken in nets purposely anchored parallel to the shore, while they are meshed on the land side, and this in localities which had been unsuccessfully swept by seines and nets a very short time previously.

That herrings, in common with other species of the herring family, will occasionally disappear from one locality, sometimes reappearing in another, is well known. I have observed it as occurring among the oil-sardines of India (*Clupea longiceps*); and this has taken place in years when the fishing was very little prosecuted. From 1690 to 1709 a very extensive herring fishery existed at Cromarty; about the latter year an immense shoal was driven ashore near the town; the remainder left the vicinity in a single night; and for upwards of half a century no shoals reappeared.

The two main objects of migration would appear to be for the purpose of seeking some locality where spawn may be safely deposited and the species continued, or else a search for food in order to maintain the growth and existence of the individual. But it would seem that fish may seek new ground when that they usually reside on has become unsuited to them from any cause, as absence of food or even their constant capture by incessant netting. If having selected waters further from the shore than formerly, the spawn were deposited and bred there, it does not seem unreasonable to suppose that the progeny would locate themselves where they were reared. In time, perhaps, this new location may be found unsuited, and the shoal may return to the spot they first inhabited, and where possibly a more abundant supply of surface-food may exist.

At Wick, upon the north-east coast of Scotland, the largest race usually arrives with the new year, remaining until about March, and then disappears. The next herrings come in May or June in the shape of a few small ones of little value as food,

although good as bait for other fishes, and which appear to be the forerunners of the summer fish, as they grow better, larger, and fatter as the season advances, until they are in perfection about July and August, spawning about the end of the latter month or early in September, after which they disappear until the succeeding January (Reid, MSS.). If we turn to the Herring Fishery Report of 1878, we are informed that "it is a very remarkable circumstance that the yield of the fishery at Wick began to decline at the very period at which the produce of the Aberdeenshire fisheries began to increase" (lxiii). Here it would be as well to consider whether any change was during this period instituted in the working of the Wick fisheries which might account for the migration of the fish elsewhere. Mitchell, who wrote in 1864, remarked on the herring appearing off Wick, the Moray Firth, and Aberdeenshire in June; but he observed they are at first so small that the nets cannot catch them *, but they begin to be of sufficient size in July (at this time the mesh of the nets was not less than one inch between knot and knot) †.

In the fourteen years from 1849 to 1862, one thousand and three boats were annually employed in fishing at Wick, with an average catch per boat of one hundred and thirty-three barrels. During that period no winter fishing was carried on: it now commenced, and in the fourteen years from 1863 to 1876 eight hundred and eighty-five boats were annually similarly employed, and the average catch per boat was one hundred and eight barrels. The witnesses condemned the decrease which had taken place in the size of the mesh of the nets, and in the change of shooting nets before sunset having become more common; whilst it was noticed that the Wick Chamber of Commerce for some years gave a premium to the fisherman who

* In 1809 an Act of Parliament was passed regulating the mesh of the herring-net at not less than one inch between knot and knot; England and France concluded a convention with these provisions in 1839, which was abrogated in 1862, whilst in 1868 the regulation itself was repealed.

† M. de Caux observes that for the purpose of capturing herrings the mesh of the nets since 1864 has diminished off the Norfolk coast to forty or forty-four to the yard; ten to twenty years ago five sixths of the catch were full fish, but for the last ten years the proportion has not been above two fifths, due to the change in the mesh of the net; these immature herrings will take the salt, but they will not keep.

landed the first herrings of the season: thus fishing has gradually changed from July to the third week in June, the quality being small and mostly only fit for bait. This, it is stated, prematurely disturbs the shoals and injures the future prospect of the fishing*.

As the Wick herring-fisheries from some cause diminished, those at Fraserburgh began to increase in yield. Here the same complaints were made as to the reduced size of the mesh of the nets and the taking of immature fish; but the fishing was said to commence about the middle or 20th of July, the fish being mostly taken further from shore than was formerly the case; while there is now (1878) no winter fishing except for bait. The small fish do not fetch good prices, and are often condemned as unfit for food.

In questions of migrations of fish a very important consideration must be, On what do these fishes live? for animals which afford them sustenance may, or may not, be subject to meteorological influences. Manifold and various has been the reputed diet of the herring, which, so far as I have personally observed, consists of minute entomostraca, annelids, crustacea, ova, and small fishes. Digestion is very rapid, and continued after death; consequently examinations should be instituted on very fresh examples, and the contents at once placed in spirits. The same phenomenon, as regards a false membrane forming around the food, which I observed last year occurred in the pilchard (see 'The Zoologist'), is also perceptible, but to a lesser degree, in the herring. On February 15th this year, I investigated the contents of herrings' stomachs sent to me from Mevagissey in Cornwall, by Mr. Dunn: they were taken about half a mile from land in twelve fathoms of water; they contained the remains of small crustacea &c. On May 12th in one from the same locality I found this organ distended with nineteen sand-launces (*Ammodytes*) up to two and a half inches in length, while the intestines of these small fish were of a bright orange-colour due to the crustacea which they had been consuming. From the same place, between June 10th and 14th, the stomachs of some captured about eight miles from

* The same opinion seems to have found favour at Peterhead, Aberdeen, and Montrose, that the early fishing has a bad effect on the offshore banks, increased by the repeal of the enactments against garvie fishing (see page 85), which occupation commences in November and occasionally lasts until March.

Mevagissey in six fathoms of water had changed to the fry of that excessively rare British goby *Crystallogobius Nilssoni*, the largest of which were one inch and a third long; there were also a few little herrings and sand-launces. During the last winter, off the same place Mr. Dunn observed mackerel midges (*Motella*) in the stomachs of herrings taken about eight miles from shore. Off Aberdeen I found another change, the herrings' stomachs being crammed with entomostraca and shrimps and crabs in the zoea stage; there were also two sand-launces in one herring. In most stomachs I observed some ova, apparently of fish and probably of herrings; but this is only conjecture. Many investigations, constantly carried on at different places throughout the entire herring-season, would be necessary to decide upon what this fish subsists, and whether its food exercises any influence upon the quality of its flesh. That the herring entirely ceases feeding during the time it is in full roe I satisfied myself is an error, or at any rate does not apply to the fish I examined at Aberdeen.

The breeding of this fish, or rather the period at which such occurs, is subject to very great diversity. At Wick this year (1882), early in January there were herrings full of roe; while they again spawn there in August and September. The same has been observed in the Moray Firth.

Respecting the capture of the herrings off the east coast of Scotland, it is evident that the great bulk of the fishing is carried on much further out to sea than it was a few years since. Still it does not seem at all proved that the inshore fishing has been neglected; but the probabilities are that the fish are no longer there in sufficient numbers to repay the fishermen's labour. It also seems doubtful whether the boats have really gone out so far as one hundred and ten miles herring-fishing, as asserted by some of the local fishermen; for such a distance would necessitate the captures being salted at sea, conveyed in ice, or by a more rapid mode of transit than simply sailing. During the time the 'Triton' was investigating the coast, only twice were fishing-crafts seen about one hundred miles from shore: they may have been line-fishing, or, if netting, may have been coming down the coast, seen fish, and were trying their nets. Forty miles appeared to be about the limit at which we found fleets of fishing-boats at work for herrings. Respecting the mesh of the nets employed, doubtless a difference of opinion exists, and many would like to

see the old law reimposed provided the fishermen of other nations adopted it.

I am indebted to Mr. Graham, of the Scotch Fishery Board, for the figures in the following table.

Scotch Herring-Fishery Returns.

Year.	No. of boats.	Fisher-men.	Barrels of herrings cured ¹ .	Year.	No. of boats.	Fisher-men.	Barrels of herrings cured ¹ .
1825	10,365	44,598	379,234	1854	10,891	40,359	636,562
1826	10,958	47,371	288,495	1855	11,747	41,602	766,703
1827	11,974	47,733	399,778	1856	12,072	42,433	609,988
1828	11,166	47,953	355,979	1857	12,377	43,014	580,814
1829	11,199	48,699	329,557	1858	12,516	43,072	636,124
1830	10,980	48,373	439,370	1859	12,802	43,062	491,487
1831	11,059	49,164	362,661	1860	12,721	42,430	681,193
1832	11,008	48,181	416,964	1861	12,961	42,751	668,828
1833	11,284	49,212	451,531	1862	13,144	43,508	830,904
1834	11,359	49,462	277,317	1863	13,191	43,358	654,816
1835	11,427	49,720	497,615	1864	13,331	43,484	643,650
1836	11,494	50,253	397,829	1865	13,650	44,459	621,763
1837	11,279	50,310	507,775	1866	13,815	45,470	658,147
1838	11,357	50,238	555,560	1867	14,208	46,219	825,589
1839	11,893	50,037	543,945	1868	14,300	46,417	651,434
1840	12,422	53,939	557,262	1869 ⁶	14,406	45,201	675,143
1841	12,476	52,983	667,245	1870	14,935	45,712	853,160
1842	12,405	54,282	623,420	1871	15,513	46,546	825,476
1843 ²	14,067	60,457	665,360	1872	15,232	46,178	773,859
1844 ³	14,266	59,859	526,033	1873	15,095	45,594	939,233
1845	14,649	60,279	532,646	1874	14,847	45,226	1,000,561
1846	15,076	61,224	607,451	1875	14,656	45,082	942,980
1847	15,279	61,257	562,743	1876	14,547	45,263	598,197
1848	15,062	60,346	644,368	1877	14,623	45,890	847,719
1849 ⁴	14,962	59,792	770,698	1878	14,431	46,529	905,768
1850 ⁵	10,480	40,362	544,009	1879	14,457	46,502	841,796
1851	10,914	40,938	594,031	1880	14,751	47,131	1,473,600
1852	11,010	41,187	498,787	1881	14,809	48,121	1,111,155
1853	10,974	41,045	778,045				

¹ Fractions of barrels are omitted, unless exceeding $\frac{1}{2}$, when they are given as 1 barrel.

² Returns were from April 5th till the following April, up to 1843.

³ Returns for 1844 ended January 5th, 1845, and so continued until 1851.

⁴ Returns up to this year include those of N.E. of England.

⁵ Returns from 1850 to 1868 include those of the Isle of Man.

⁶ Returns from 1869 refer to Scotland only.

The foregoing table demonstrates a steady annual increase in the capture of the herrings from the commencement of this century until the present period. Everything is deemed as denoting prosperity; and should an occasional storm sweep the

coast and numbers of fishermen be engulfed, such we are given to understand is an unavoidable accident, incidental to marine fisheries and incapable of remedy.

Before, however, we accept this summary method of disposing of the subject, some questions must force themselves on our notice. First of all, we are led to inquire what proportion of persons are now engaged in this occupation to the numbers that were so employed at the commencement of the present century? Do we find the augmented takes due to increased facilities of capture, larger ventures in fisheries, or simply owing to the fish being more abundant?

Mr. Graham* observes that 1825 is the earliest date in which confidence can be placed; and I find that the number of barrels of cured herrings have gradually augmented from 379 thousand cured in Scotland and the N.E. coast of England, until they have reached to upwards of a million during the last two years, while the fishermen and boys have increased by almost 4000. The proportion of the number of fishermen to barrels of herrings cured has averaged as follows:—

5 years 1825 to 1830, 1 fisherman to 8 barrels of herrings.					
5	„	1830 „ 1835,	„	8	„
5	„	1835 „ 1840,	„	9	„
5	„	1840 „ 1845,	„	10	„
4	„	1845 „ 1849,	„	9	„
5	„	1849 „ 1854,	„	14	„
5	„	1854 „ 1859,	„	15	„
4	„	1859 „ 1863,	„	15	„
6	„	1863 „ 1869,	„	15	„
2	„	1869 „ 1871,	„	17	„
5	„	1871 „ 1876,	„	19	„
5	„	1876 „ 1881,	„	22	„

But when we inquire into the gear employed, we are told that cotton nets with a fivefold increased catching-surface came into use some time about 1853(?), and have superseded the hempen ones. But the amount captured does not appear to have kept pace with these increased killing powers; for if so, the fishermen, who from 1825 to 1850 using hemp nets obtained from 8 to 10 barrels per man, should now, had the proportions continued equal, be capturing from 40 to 50 barrels instead of about 22.

* The whole of the fishermen and boys engaged in sea-fisheries are included; but as the proportion employed in the various branches continues about the same, the fluctuations would be of probably slight amount.

I would also briefly allude to another point, which is:—If herrings have, due to changes in our fishery laws, been unduly interfered with, so that the shoals are now further out to sea than was formerly the case, thus necessitating the employment of larger boats, has such occasioned, or been instrumental in occasioning, an increased loss of fishermen's lives?

That going further out in order to find and capture these fish is a necessity is now admitted, while the harbour accommodation remains unchanged: thus the larger boats now employed are unable to enter during storms, and a considerable sacrifice of life is the result.

If it had not been for the increased facilities of transit due to our railways, the cost of these fish must have risen. If the present migrations of the fish continue and they go still further off our coasts, steamers will be necessary to bring the fish in good condition on shore, or they must be salted on board. It is also questionable whether, the herrings being further out, this may not have been one reason why the haddock and inshore fisheries are likewise receding from the shore.

An important zoological question here arises, which may be briefly disposed of as follows.

It would appear from the Commissioners' report that young herrings along the east coast of Scotland were first permitted to be captured in small-meshed, sprat- or garvie-nets in 1868—the true garvie being the sprat (*Clupea sprattus*), and the young herring or whitebait belonging to *C. harengus*. Some of the witnesses averred that when the garvies are scarce many young herrings are sent away with them, while it is impossible to take garvies without taking the young herring. One witness (p. 14) asserted that he had purchased thirty barrels of garvies in one day, and found they were all young herrings. My only personal experience consists of some garvies from the north-east coast, most of which were undoubtedly young herrings. They were about three inches each in length, requiring 288 to weigh a pound, or 645,120 to the ton. In the report already referred to, we are told that 800,000,000 of herrings must be annually taken by Scotch fishermen alone, or equal to a little over 1240 tons of garvies, or young herrings, such as I have described; whilst from Inverness we are informed that in three years ending 1876–77 the Highland railway carried on an average 267 tons of garvies annually to London.

One argument, adduced in order to disprove that the destruction of fry inshore can do injury, has been that numbers of the young fish in our sandy bays and inshore grounds are possibly the offspring from some of the floating spawn shed at sea, and that it seems most likely that all the ova produced by those fishes which actually spawn in these bays are either washed ashore or drifted away. Such a conclusion is opposed to what may be seen at any time along our shores, where these minute fishes are destroyed by millions in small-meshed nets.

I would suggest, as worthy of consideration, a minute investigation of how these garvie-fisheries are carried on, and that such an examination should last through at least the whole of the month of October and until the end of January: the proportion of herrings captured to sprats, and what becomes of the captures, should be thoroughly elucidated. It would also be very desirable that such an inquiry should extend to the question of whether or not the cessation of the inshore herring-fisheries has been coincident with the extension of the garvie-fisheries.

There are it appears two chief periods when herrings appear off the east coast of Scotland, while the winter, the June, and the garvie-fisheries are partially or wholly new industries. Whether they have or have not any bearing on the cessation of the inshore herring-fisheries, I have not sufficient evidence to adduce. Still it is by no means impossible that some fishes, especially such as are gregarious, mostly return to the place where they were reared. If, therefore, from any cause the inshore race of herrings were being unduly destroyed, it does not seem an unwarrantable conclusion to draw, that such may have something to do with the deep-sea race being now the most common along the east coast of Scotland.

Dredging Operations, &c.—On June 30 we steamed from Montrose; and I must be allowed to express my thanks to Captain Tizard and the officers of H.M.S. 'Triton' for the assistance they afforded me; also to Professor Jeffrey Bell for having kindly identified the Echinodermata, to Mr. Ridley for having done the same for the Zoophytes and Sponges* (see Reports, p. 102 and p. 105), and to Mr. J. Marshall for identifying the shells.

* Dr. Malm, of Gothenburg, has kindly promised to describe the Entomostraca and also the Annelids at a future date.

At about ten miles from land, by means of a tow-net I obtained my first examples of Entomostraca.

July 1st, the tow-net yielded the same result as yesterday, but in a larger amount. From 5 A.M. and until 7 A.M. the dredge was used, having been put down in lat. $56^{\circ} 40'$ N. by $0^{\circ} 47'$ E. long., in fifty-three fathoms water having a surface-temperature of 55° , and $48\frac{1}{2}^{\circ}$ at the bottom, which was muddy or fine sand, in which Mr. C. L. Jackson was unable to detect organic matter. A swab had been attached to either end of the dredge, by which means many sea-urchins and starfishes were secured. The result hardly showed that good feeding-ground existed at this spot. There were no fish; and among the Crustacea were three examples of *Hyas coarctatus*, and five hermit crabs (*Pagurus Bernhardus*), which inhabited dead whelks or other univalve shells. There were many of the common heart urchin and two of the fiddle heart urchin, *Brissus lyrifer*, Forbes (*Brissopsis lyrifera*, Agass.).

The Mollusca were *Mytilus phaseolinus*, Phil., *Modiolaria nigra*, Gray, several being alive as well as some of *Nucula nucleus*, Linn., *Leda minuta*, Müll., *Lucina borealis*, Linn., *Venus ovata*, *Cardium fasciatum*, Mont., *Cyprina islandica*, Linn., *Astarte sulcata*, Da Costa, *Astarte compressa*, Mont., *Dentalium entalis*, and *Psammobia ferroënsis*. There were likewise some live examples of *Venus ovata*, *Natica grælandica*, *Astarte compressa*, *Dentalium entalis*, Linn., *Puncturella noachina*, Linn., *Trochus alabastrum*, Bech., *Turritella terebra*, Linn., *Trophon clathratus*, Linn.

A single example of sea-mouse (*Aphrodite aculeata*), and a few living Annelids, some corallines, &c.

Dredge no. 2 was down from 5 P.M. until 7 P.M. It was put overboard in lat. $56^{\circ} 54'$ N. and long. $0^{\circ} 33'$ W., in forty-two fathoms water having a surface-temperature of 54° , and $49\frac{1}{2}^{\circ}$ at the bottom, which was sandy and shelly. Swabs were not attached to the dredge on this occasion. The results were, comparatively speaking, somewhat larger. Fish were absent; four crabs (*Hyas coarctatus*) and more than a dozen hermit crabs; eight examples of *Hippolyte spinus*, which were bright red when first observed; three examples of a shrimp (*Crangon Allmanni*, Kinahan). Polyzoa and sponges were in large numbers; and the form popularly termed the potato sponge gave six very interesting specimens. At first sight it appeared as if a hermit crab were living inside a sponge, which possessed a smooth orifice for the crab's benefit;

but on further examples being examined, a portion of the lower surface in one or two was seen to be smooth, uncovered with sponge, and showed a shelly structure. On cutting one across it was found that the crab had originally obtained possession of a *Fusus gracilis* or *F. propinquus*: this had become coated with sponge except in that portion where constant friction, due to the movement of the crab, prevented the sponge from obtaining a hold. The substance of the shell itself had become soft.

The Mollusca consisted mostly of dead shells of *Lucina borealis*, Linn., *Cyprina islandica*, Linn., *Venus striatus*, *Solen pellucidus*, Penn., *Aporrhais pes-pelecani*, Linn., *Tectura testudinalis*, Müll., *Fusus islandicus*, Chemn., *Buccinum undatum*, and *Natica grœnlandica*.

July 2nd, the tow-net yielded but small returns; the day was foggy. At 1 P.M., when about three miles from shore, and in twenty fathoms of water, one of the cod fishes locally called a saithe (*Gadus virens*), weighing about 12 lb., was captured by a hand-line baited with salt junk. In its stomach I found one sand-launce (*Ammodytes*), five small haddocks, as well as a large pebble.

Dredge no. 3 was put down at 9.15 A.M., at about ten miles off Aberdeen, in lat. 57° 8' N. and long. 1° 44' W., in thirty-eight fathoms water, the surface-temperature being 56°, and 49° at the bottom, which consisted of mud or fine sand. There were no fish in the dredge, but more crabs than in the two preceding trials; there were nearly fifty purple heart-urchins.

The stalk-eyed Crustacea consisted of:—2 *Inachus dorsetensis*; 8 *Hyas coarctatus*, two of which had numerous ova; a small *Portunus marmoreus*; *Carcinus mœnas*; 14 *Pagurus Bernhardus*, Linn.; 2 *P. Prideauxii*, Leach; 1 small *Galathea squamifera*, Mont.; 8 *Crangon Allmanni*; 4 *Hippolyte spinus*, Sow.; 4 *H. Thompsoni*; 1 *Caridina varians*, Leach; 1 *Pandalus annulicornis*, Leach; 2 *Palæmon serratus*, Penn.; and 3 *Mysis vulgaris*.

The following Mollusca were obtained:—*Anomia ephippium*; *Pecten tigrinus*, Müll.; *P. opercularis*, Linn.; *P. similis*, Laskey; *Nucula nucleus*, L.; *Leda minuta*, Müll.; *Lucina borealis*, L.; *Cardium fasciatum*, Mont.; *Cyprina islandica*, L.; *Astarte compressa*, Mont.; *A. sulcata*; *Venus ovata*, Penn.; *V. striatus* L.; *Montacuta substriata*; *Psammobia ferroënsis*, Chemn.; *Mactra elliptica*, Brown; *Thracia papyracea*, Poli; *Solen pellucidus*, Penn.; *Dentalium*

entalis, L.; *Turritella terebra*, L.; *Natica grænlandica*; *Fusus islandicus*, Chemn.; *Pleurotoma turricula*, Mont. That evening we anchored at Aberdeen.

July 5th, at 1.30 P.M. left Aberdeen, and at 9 P.M., when about twenty miles off Peterhead, took a mackerel midge, the young of the three-bearded rockling, in a tow-net; and I subsequently captured about half a dozen more, at distances varying from twenty to fifty miles from land. Finding these young forms almost invariably so far from land, would seem to point to the probability of the eggs, like those of the cod, being extruded some distance from the shore and floating until hatched. Mr. Sim tells me that near Aberdeen he has captured these fishes in rock-pools. As I have already remarked, they have been observed forming the food of herrings off the south-west coast of England. The evening was mild, and many large jelly-fishes were floating along past the vessel; but only a few gulls, gannets, and guillemots were seen.

July 6. Dredge no. 4 was down at 11.40 A.M., remaining until 1 P.M.; it was put overboard in lat. $57^{\circ} 36' N.$ and $0^{\circ} 47' E.$ long., in fifty-eight fathoms water having a surface-temperature of 55° , and 49° at the bottom, which consisted of fine sand. Three flatfishes (*Hippoglossoides limandoides*), the smallest being seven tenths of an inch in length, were secured, some crabs and sea-urchins. Starfishes and shells were similar to those obtained at the preceding dredge, showing a great absence among the latter of living forms; also a fair number of annelids. Corals were more abundant, and Polyzoa numerous.

The stalk-eyed Crustacea consisted of:—1 *Inachus dorsettensis*; 1 *Portunus pusillus*; 6 *Hyas coarctatus*; 10 *Galathea squamifera*, some of which were very small; 3 *Pagurus Bernhardus*; 13 *P. Prideauxii*, some of these being with ova; 2 *Hippolyte Thompsonii* also with ova; 2 *Crangon Allmanni*; 1 *Pandalus annulicornis* also with ova.

Among the Mollusca were:—*Anomia ephippium*, L.; *Pecten tigrinus*, Müll.; *Leda minuta*, Müll.; *Lucina flexuosa*, Forb. and Han.; *Cardium pygmæum*, Don.; *C. echinatum*; *Astarte sulcata*, Müll.; *A. compressa*, Mont.; *A. scotica*, Mat. and Rack.; *Venus striatum*, Humph.; *V. ovata*, Penn.; *Tapes pullastra*, Mont.; *Tellina balthica*, L.; *Saxicava rugosa*, L.; *Dentalium entalis*, L.; *Trochus alabastrum*, Bech.; numerous *Turritella terebra*, L.; *Scalaria Trevelyana*, Leach; *Fusus islandicus*. At 3.30 P.M. the lead, being

brought up from $46\frac{1}{2}$ fathoms, had the valve of a *Venus striata* attached to it.

Dredge no. 5 was down at 5.20 P.M., remaining an hour. It was put overboard in lat. $57^{\circ} 27' N.$ by long. $1^{\circ} 15' E.$, in forty-eight fathoms water having a surface-temperature of 56° , and 47° at the bottom, which consisted of fine sand. A large medusa came up in the dredge—another proof how fallacious conclusions would be drawn if it were considered that all which came to the surface in an open dredge must necessarily have been obtained from the bed of the sea. Many fine jellyfishes were to be seen around the vessel; the medusæ were said by the fishermen to have been in considerable quantities at sea, off Montrose, during the preceding three weeks; they do not believe that fish eat them, but that they interfere with fishing. There were no fish, a few crabs, hermit crabs, galatheas, and shrimps, and only one live species of sea-urchin, the common heart-shaped form, of which twenty-six came up in the dredge or entangled in the swab. There were few starfishes or shells, not many annelids, some Polyzoa, sponges, &c.

July 7th. After having been rolling all night, a smart shower of rain occurred about 7.30 A.M., subsequent to which the sea went down. At 9.15 A.M., when about twenty miles from land, twenty-five herring-boats were to be seen, most of which appeared to be fishing. I obtained two more mackerel midges in the tow-net, over fifty-nine fathoms water.

Dredge no. 6 was down at 9.40 A.M., remaining until 11 A.M.; it was put overboard in lat. $57^{\circ} 25' N.$, and $1^{\circ} 18' W.$ long., in sixty fathoms water having a surface-temperature of 58° , and $49\frac{1}{2}^{\circ}$ at the bottom, which consisted of fine sand. Swabs were attached to the dredge. It contained no fish, some crabs, *Hyas*, hermit crabs, 2 *Hippolyte spinus*, about thirty of the common heart-urchin, upwards of a dozen starfishes belonging principally to three species, many dead but few living shells, some annelids and Polyzoa.

The Mollusca consisted of *Lucina borealis*, L., *Venus ovata*, Penn., *V. striata*, H., *Macra elliptica*, L., *Scrobicularia prismatica*, Mont., *Psammobia ferroënsis*, *Dentalium entalis*, L., *Fusus islandicus*, and *F. propinquus*.

At 1 o'clock, just as the course of the vessel was being changed, and when only a few miles from shore, we passed a large number of saithe fish, which were dashing about as if into

a shoal of herrings ; gulls were likewise assisting. At 5 P.M. we arrived at Aberdeen.

July 10th, left Aberdeen at 4 A.M., and when about ten miles from port captured some very young crabs and shrimps in the tow-net, and when about twelve miles from land a mackerel midge ; but up to 8.30 A.M. had only secured one small entomostrakon in eight trials of the net. At 9.15 A.M., when at about twenty miles from shore, and while we were stopping for soundings, I took, in a tow-net at about a foot below the surface, a few entomostraca and a mass having somewhat the appearance of a portion of a jellyfish ; but on placing it in spirit it likewise proved to be composed of minute entomostraca. At 10.30 A.M., when about twenty-five miles from shore, an embryo crab was secured.

Dredge no. 7 was put down at noon for an hour in lat. $57^{\circ} 17'$ N., and long. $0^{\circ} 56'$ W., in forty-three fathoms water having a surface-temperature of 55° , and 54° at the bottom, which consisted of sand and shell, and which was richer than that of No. 1, "consisting of fine sand, a good many pebbles, and fragments of shells. These last were very much worn, and probably never lived where found, but had been washed there. I judge thus because I cannot find a single one in good condition. There were also a few spines of Echini, and two or three common forms of Foraminifera ; but the spines look also much worn, as do also the Foraminifera" (C. L. Jackson). No fish were taken. There were large numbers of the purple heart-urchin, not quite so many of the other forms ; several small but no large starfishes ; a few live and many dead shells, and some annelids. Sponges were rather numerous ; several were the potato sponge, containing hermit crabs, as observed upon previously ; and three beautiful examples of the amphipod *Dexamine spinosa*. One jellyfish came up in the dredge.

The stalk-eyed Crustacea consisted of 1 *Stenorhynchus tenuirostris*, 1 *Ebalia Cranchii* (male), 3 small *Galathea*, 2 *Caridina varians* and several young, 1 *Hippolyte spinus*, 2 *H. Thompsoni*, 1 *H. Cranchii*, 3 *Crangon Allmanni*, 1 *Pandalus annulicornis*, and 8 hermit crabs of the two forms previously adverted to.

Among the Mollusca were examples of *Anomia ephippium*, L., *Pecten tigrinus*, Mont., *P. opercularis*, L., *Mytilus phaseolus*, L., *Nucula nucleus*, L., *N. nitida*, S., *Lucina borealis*, L., *L. flexuosa*, Forb. & Han., *Cardium fasciatum*, Mont., *C. echinatum*, L., *C.*

minimum, Phil., *Cyprina islandica*, L., *Astarte compressa*, Mont., *A. sulcata*, *Venus ovata*, Penn., *V. striata*, L., *V. lineata*, *Tapes virgineus*, Linn., *Lucinopsis undata*, Penn., *Tellina balthica*, L., *Macra elliptica*, Brown, *Scrobicularia prismatica*, Mont., *Thracia papyracea*, Poli, *Chiton cinereus*, L., *Solen pellucidus*, *Dentalium entalis*, L., *Trochus millegranus*, *Trochus tumidus*, Mont., *Turritella terebra*, L., *Natica montagui*, Forb., *N. catena*, Da Costa, *Eulima polita*, Linn., *Aporrhais pes-pelecani*, L., *Trichotropis borealis*, Brod. and Sow., *Buccinum undatum*, L., *Trophon clathratus*, L., *T. barvicensis*, Johnst., *Fusus Turtoni*, Bean, *F. propinquus*, Ald., *F. gracilis*, *Defrancia linearis*, Mont., *Pleurotoma turricula*, Mont., *Cypræa europæa*, Mont., and *Cylichna cylindracea*, Penn.

At 12.30 P.M., two saithe fishes, averaging about ten pounds each, were taken by hand-lines. One had no food inside it, but an old whiting-hook in its gullet. At 3 P.M. a mackerel midge was taken in the tow-net. The sea being dead calm, many jellyfishes were seen near whenever we stopped for the purpose of taking soundings. About one o'clock a third saithe was taken by a hand-line: its stomach was also destitute of food; but a strong spine was observed to have entirely pierced the stomach from the inside, and appeared to have belonged to a large grey mullet that had been swallowed.

Trawl no. 1 was down from 5.40 to 7 P.M., in lat. $57^{\circ} 17' N.$ and $0^{\circ} 10' W.$ long., in forty fathoms water having a surface-temperature of 58° , and 51° at the bottom, which was shelly. Only six purple heart urchins, one *Turritella terebra* containing a hermit crab, and three potato sponges, all containing similar crabs, were obtained.

July 11th, trawl no. 2 was down from 5 A.M. to 7 A.M. in lat. $57^{\circ} 6' N.$ by $1^{\circ} 6' E.$ long., in forty-seven fathoms water having a surface-temperature of 58° , and 49° at the bottom, which was sandy and shelly. One small sole, *Hippoglossoides*, was taken, twelve purple heart urchins, eight common heart urchins, two starfishes, and some sponges.

At 6.30 P.M. a porpoise was near the vessel, and a little later several more. At 8.30 A.M. two fishing-crafts were seen, apparently at work. The sea was very smooth during the day, and large number of jellyfishes were about. At 4.15 P.M., when about fifty-five miles from land, eight fishing-boats were in sight. Between 3 P.M. and 4 P.M. very large quantities of *Entomostraca* were taken in the tow-net.

Trawl no. 3 was put down from 5 P.M. to 6 P.M., in lat. $57^{\circ} 7'$ N. and long. $0^{\circ} 37'$ W., in forty fathoms water having a surface-temperature of 59° , and 32° at the bottom, which was sandy and shelly. There were taken one pogge (*Agonus cataphractus*), four soles (*Hippoglossoides*). One hundred and seventy-five purple heart urchins, some being of a large size; a few other urchins. Annelids were numerous, as also were the sea-anemones (*Actiniæ*), sponges, corals, and Polyzoa generally.

Of stalk-eyed Crustacea there were 4 *Hyas coarctatus*, 2 *Portunus pusillus*, 9 *Pagurus Bernhardus*, 2 *P. Prideauxii*, 4 *Galathea squamifera*, 2 *Hippolyte Thompsoni*.

Of Mollusca examples were taken of *Pecten tigrinus*, *P. opercularis*, *Lucina flexuosa*, *Cardium fasciatum*, *C. echinatum*, *Mytilus modiolus*, *Cyprina islandica*, *Mactra elliptica*, *Venus casina*, *V. striata*, *Saxicava arctica*, *Trochus tumidus*, *Natica catena*, *Fusus gracilis*, *F. propinquus*, and *Defrancia linearis*. Several fine whelks (*Buccinum undatum*) were also secured, and the mollusks used as bait. Some sea-anemones were found adhering to valves of *Cyprina islandica*, *Mytilus modiolus*, *Cardium echinatum*, and *Mactra elliptica*.

At 6 P.M. a shoal of mackerel midges came close to the vessel, and one was obtained in the tow-net. At about 8 P.M., when probably fifty miles from shore, many herring-boats were passed fishing. At 9 P.M. another shoal of mackerel midges passed the vessel, playing round a piece of sea-weed.

July 12th. When about four miles from shore, some young crabs and shrimps were taken in the tow-net; and at 10.30 we arrived at Aberdeen, where the herring-fishery had not yet commenced, although boats were almost daily going out herring-fishing, and returning with more or less good cargoes, some consisting of fine full fish, others of matties.

Nature of Ground traversed and Temperatures &c.—It has almost invariably been observed that waters which do not exceed a hundred fathoms in depth, termed by some naturalists the littoral zone, usually contain a large amount of life. It did not seem to me that the portion of the North Sea over which we steamed, and where we tried the dredge and the trawl, was so rich as localities I have examined elsewhere.

The nature of the ground we traversed in the 'Triton,' Captain Tizard observes, was fairly well defined, as we found a considerable area (nearly 1500 square miles) of sand and shells

with gravel or small stones between the parallels of $56^{\circ} 55'$ and $57^{\circ} 30'$ at a distance of 25 to 65 miles from the shore; while around this area, except close to the coast, the bottom consists for the most part of a fine sand, approximating in some cases to hard mud.

The temperature at the bottom showed a slight decrease as the distance from the shore increased (irrespective of depth), as within twenty miles from the shore it varied from 48° to 53° in depths of from 28 to 55 fathoms, while at 100 miles from shore the range was from $46^{\circ} 5'$ to 50° in depths of from 46 to 56 fathoms.

In the observations taken on board the 'Triton,' and kindly furnished by Captain Tizard, the following results were observed as regards temperature:—

		Air.	Water-surface.			
June 30th.	4 a.m.	49.8				
	8 a.m.	55.5				
	Noon.	2.8	53.0	50	at 47 fathoms.	
	4 p.m.	53.5	52.2	49	" 47	"
	8 p.m.	53.5	53.7	49	" 49	"
	Midnight.	53.5	54.2	49	" 41	"
July 1st.	4 a.m.	53.0	54.0	48.5	" 45	"
	8 a.m.	56.5	54.7	48.5	" 48	"
	Noon.	62.0	56.3	49.0	" 48	"
	4 p.m.	55.5	56.2	49.0	" 38	"
	8 p.m.	52.5	54.0	49.5	" 40	"
	Midnight.	51.0	53.0	48.0	" 35	"
,, 2nd.	4 a.m.	51.0	53.0			
	8 a.m.	51.5	53.0			
	Noon.	52.5	53.0			
,, 5th.	8 p.m.	53.0	52.0	51.0	" 55	"
	Midnight.	54.2	54.5	51.0	" 57	"
,, 6th.	4 a.m.	54.0	55.0	49.0	" 56	"
	8 a.m.	56.2	55.0	49.0	" 51	"
	Noon.	61.0	55.0	49.0	" 56	"
	4 p.m.	58.0	56.0	49.0	" 47	"
	8 p.m.	56.2	55.5	48.0	" 50	"
	Midnight.	55.0	55.0	43.0	" 44	"
,, 7th.	4 a.m.	54.5	54.7	49.5	" 49	"
	8 a.m.	54.8	54.0	51.5	" 37	"
	Noon.	54.0	51.0	50.5	" 42	"
,, 10th.	8 a.m.	54.8	53.7	51.5	" 43	"
	Noon.	56.0	55.0	54.0	" 42	"
	4 p.m.	60.0	57.0	53.5	" 41	"
	8 p.m.	59.5	58.0	51.0	" 43	"
	Midnight.	57.0	58.0	49.0	" 47	"
	4 a.m.	57.5	57.5	50.0	" 45	"
,, 11th.	8 a.m.	59.0	58.0	46.5	" 57	"
	Noon.	62.5	60.0	50.5	" 41	"
	4 p.m.	63.5	60.0	49.0	" 45	"
	8 p.m.	59.5	59.0	52.0	" 37	"
	Midnight.	57.0	57.0	52.0	" 49	"
	4 a.m.	56.0	56.5	51.5	" 38.5	"
,, 12th.	8 a.m.	58.0	55.5	52.0	" 51	"

The foregoing table gives the following results :—

No. of obser- vations.	Hour.	Temperature of air.	No. of obser- vations.	Temperature of sea-surface.
7	4 a.m.	53 ⁰ ·5	6	55 ⁰ ·0
8	8 a.m.	55·7	7	55·8
7	Noon.	57·0	7	54·7
5	4 p.m.	58·0	5	56·0
6	8 p.m.	55·6	6	55·5
6	Midnight.	54·5	6	55·1
		55·6		55·3

The subject of mussel-beds and ground bait, which I had intended referring to, I find so comprehensively treated in a paper by Mr. Wilcock, about to be published among the prize essays of the Edinburgh Fisheries Exhibition, that I have omitted an account of this portion of my investigations.

PS.—The Rev. A. Norman having kindly examined* some of the captures made in the ‘Triton,’ has identified them as follows :—From the surface-net—*Anomalocera Petersonii*, Templeton, *Dias longiremis*, Lilljeborg, *Evadne Nordmanni*, Lovén, *Pondon polyphemoides*, Leuckart, and *Acanthometræ*; from the dredge—*Melita obtusata*, Montagu, *Probolium pollexianum*, Bate, *Pherusa fucicola*, Lead., *Calliopijs bidentatus*, Norman, *Eurystheus erythrophthalmus*, Lilljeborg, *Cheirocratus Sundevallii*, Rathke.

Report on the Echinodermata collected by Mr. Francis Day in H.M.S. ‘Triton’ off the Eastern Coast of Scotland in July 1882. By Prof. F. JEFFREY BELL, M.A., F.R.M.S. (Communicated by F. DAY, F.L.S.)

[Read December 21, 1882.]

A SOMEWHAT large collection of Echinodermata was made, *Spatangus purpureus* and *Asterias violacea* being very abundantly represented, as was also *Echinus elegans*, of which a very large number of small (though not one large) specimens were taken; entangled in the spines of many of these last were small egg-cases with unfertilized ova within. The Ophiurids are only six in number; and the single Holothurian is not in a condition for determination.

* Mr. Norman's memorandum was received after my paper had been read.—F. D.



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