REPORT FOR 1895

ON THE

LANCASHIRE SEA-FISHERIES LABORATORY

AT

UNIVERSITY COLLEGE, LIVERPOOL.

DRAWN UP BY

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AND

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REPORT on the Investigations carried on in 1895 in connection with the LANCASHIRE SEA-FISHERIES LABORATORY at University College, Liverpool.

By Professor W. A. HERDMAN, D.Sc., F.R.S., and
Mr. ANDREW SCOTT, Fisheries Assistant.

With Plates I.—V.

INTRODUCTORY.

THE work that can be done in the application of Zoological Science to the local Fishing industries seems spreading and increasing in amount each year; and the work of the past year, as may be seen from this Report, has opened up much fresh ground, and has been carried on not only in Liverpool and at Sea but also partly at Port Erin and to a slighter extent in the neighbourhood of Piel Island, near Barrow; and so has extended over the various parts of our northern district of the Irish Sea. In fact we may be regarded now as having, planned out, if not yet completely established, a system of Fisheries investigations which, although still on a small scale, will be able to cover the ground effectively and to cope adequately with the subject.

The central laboratory at University College, Liverpool, the Marine Biological Station at Port Erin, the steamer at sea, and the new branch laboratory now being fitted up at Piel Island can subdivide the work between them, and so render possible a wider range of observations. The finer microscopic and laboratory work, the comparison of results and the drafting of reports can only be carried on at a place like the Liverpool laboratory where microscopes, microtomes and other laboratory apparatus are available, where there are biological libraries to consult, and where there are other scientific workers to lend their help. The Biological Station at Port Erin affords facilities for practical work on the shore and for observations and experiments on the reproduction and rearing of young marine animals in tanks. Such observations will prepare the way for the proposed Sea-Fish Hatchery for which Port Erin seems pre-eminently fitted. The trawling observations, the examination of the spawning and feeding grounds, and the collection of statistics can only be carried out by the steamer at sea, under the direction of Mr. Dawson, as has been done in the past. Finally, the little laboratory now being fitted up at Piel Island will enable us to examine more systematically the great shell-fish beds of the northern district and to deal with fresh material brought in from that neighbourhood before it is preserved and sent on to the central laboratory at Liverpool.

Section I. of the following report, dealing with the foods of fishes, found by an investigation of the stomach contents, is in continuation of the work of previous years, and has been drawn up by Mr. Scott.

Section II., on the investigation of the tidal and other currents, which might affect the distribution of floating fish eggs and fish food, by means of "drift bottles," is a further account of the observations commenced last year and already discussed in a preliminary manner in the Ninth Annual Report of the Port Erin Biological Station. The results are now given more fully, and certain practical conclusions are drawn from them. I am myself responsible for this section.

A new line of enquiry has been commenced this year by sending Mr. Scott to examine some of the shell-fish beds of the district periodically, and bring back material consisting of shell-fish, of various sizes, and samples of the sea-bottom and sea-water, from which when fully examined in the laboratory a report can be drawn up on the condition of the beds. Section III., dealing with this investigation and giving lists of the organisms found on the beds has been drawn up by Mr. Scott. This can only be regarded as a first instalment of our report on the shell-fish beds, and the work will be continued during the present year. It need scarcely be pointed out that the branch laboratory on Piel Island will be of material assistance to us in examining the beds of the northern part of the district. Mr. Scott in the course of his examination of the mud from these mussel beds and of deposits from other parts of our district—notably the neighbourhood of Port Erin—has come upon a number of minute animals, chiefly Copepoda, not hitherto recognised as living in our district and some of them new to Science. These are described by Mr. Scott in Section IV. and are figured in Plates I. to V.

Section V. contains a preliminary account of the investigations now being carried on, partly in the Liverpool laboratory and partly at Port Erin, by Professor Boyce and myself, upon the conditions under which Oysters live healthily, and upon the supposed connection between oysters and disease—especially typhoid fever. It may be noted that in addition to the enquiry into the subject of the great "Oyster and Typhoid" scare, we have made many observations upon the different kinds of oysters grown or laid down in our neighbourhood, and the effect upon them of different kinds of water.

During last summer, I gave a Course of Free Lectures under the auspices of the Sea-Fisheries Committee and in accordance with the regulations of the University

Extension Scheme. The course was on "Our Edible Sea-Fish and Sea-Fisheries," and the lectures were delivered in the Zoology Theatre of University College on Monday evenings, commencing May 6th. The course was well attended, and the audience expressed much interest in the subject, many of them staying on at the conclusion of each lecture to examine the microscopic and other specimens and to ask questions. These lectures were not intended for, and were not attended by, fishermen *alone*, but were open to the general public; and I am convinced that it is fully as important for the future of Fisheries investigation and improvement and of just legislation in regard to the fisheries, that the general public should have opportunities of learning the truth in regard to the habits and life-histories of food fishes, and the inter-relations of animals in the sea, as it is that the fisherman himself should be instructed in such matters.

In addition to such public lectures, there is another method by which an educated public opinion upon Fishery questions can be formed, and that is by the establishment in each district of a technical museum or collection illustrating the local fisheries, the spawn and other stages in the life-history of the various fishes, their foods, their parasites, their diseases, and so on. Such a collection could now readily be formed, with very slight additional expenditure, at University College, in connection with the Fisheries Laboratory, and would then be available for consultation by fishermen, fishmongers, and all others concerned. It would be of constant use to ourselves, for comparison, in our fishery work; it ought to be of value to Fisheries inspectors and superintendents and to members of Sea-Fisheries Committees both in this neighbourhood and from other parts of the country; and it is the practical evidence that Fisheries experts from abroad especially desire to see when they come for information in regard to our local Fisheries and the conditions under which they are carried on.

Finally, such a technical museum of the Fisheries would naturally be made the scene and the means of object lessons and set demonstrations to the fishermen of the neighbourhood, and would probably be the most effective method of supplying technical instruction to that class of the community.

W. A. HERDMAN.

JANUARY, 1896.

SECTION I.

Examination of Food in Fishes' Stomachs.

(By Mr. Andrew Scott.)

We have continued the examination of the stomachs of the various marine animals whose life-histories we are more intimately concerned with, chiefly from a fisheries point of view, and to which we have been paying considerable attention during the past few years, but as we now know fairly well what forms the chief food supply of these particular animals in our district, we do not deal with this part of the work in such an exhaustive manner as formerly and content ourselves by merely giving a summary of the results, noting any points of special interest connected with them.

During the past twelve months, from the beginning of January to the end of December, 1,540 stomachs of various marine animals from different parts of the district have been examined.

The following are the sources from which the stomachs have been obtained:—

Food fishes up to three inches	487
,, ,, above ,, ,,	493
Other fishes	20
Cockles	210
Mussels	230
Shrimps	100
	1,540

The Food of Young Fishes.

The following summaries give the result of the examination of 487 stomachs of young food fishes, the differences between the year 1895 and the previous years, if any, being stated:—

Plaice (*Pleuronectes platessa*).

167 stomachs of young Plaice were examined, of these 36 were empty and 1 contained indistinguishable animal matter, leaving 130 to be accounted for as having recognisable matter.

Crustacea were found in 65 stomachs, exactly 50 %, and consisted of the remains of Amphipods and Copepods, 51 stomachs contained numbers of the Copepod *Jonesiella hyæna,* a species described by Mr. I. C. Thompson some years ago and which has since been found to enter very largely into the food supply of the young flat fishes.

Annelida were also found in 65 stomachs, 50 %. The stomachs examined last year and referred to in the Third Annual Report, gave a somewhat different result. Crustacea took first place with fully 63 %, Annelida second with 30 %, while 4 % of the stomachs contained Mollusca. So that it is quite clear that Crustacea and Annelida are the chief food supplying agents of the young plaice, and of the two, Crustacea is probably the more important.

Dab (*Pleuronectes limanda*).

272 stomachs of young Dabs were examined, of which 226 were found to contain no food and 11 contained food matter which was not recognisable, leaving only 35 to be accounted for.

Annelida were found in 34 stomachs, or fully 97 %. Echinoderms were found in 1 stomach, representing scarcely 3 %.

In last year's report 65 % of the stomachs of young Dabs examined contained Annelida, and 24 % Crustacea, so that Annelida appears to be by far the most important food supplying agent of the young Dabs, Crustacea occupying second place.

Flounder (*Pleuronectes flesus*).

5 stomachs of young Flounders were examined, of which 3 were empty and 2 contained the remains of Annelida.

Sole (*Solea vulgaris*).

5 young Soles were examined; and the stomachs were found to be empty.

Cod (*Gadus morrhua*).

10 stomachs of young Cod were examined, 7 of which were empty and 3 contained the remains of Crustacea.

Whiting (*Gadus merlangus*).

6 stomachs of young Whiting were examined. all of which were empty.

Sprats (*Clupea spratta*).

21 stomachs of young Sprats were examined, all of which were empty. Last year's report shows that out of 20 Sprats only 2 contained recognisable food, so that we have still to find out what the Sprats feed upon.

Food of Larger Fishes.

Plaice (*Pleuronectes platessa*).

153 stomachs of Plaice were examined, of which 43 were empty and 2 contained indistinguishable animal matter, leaving 108 to be accounted for.

Annelida were found in 68 stomachs, or nearly 63 %.

Mollusca were found in 36 stomachs, fully 33 %, and consisted of *Solen*, *Philine*, *Mactra*, *Cardium* and *Mytilus*. The shell-fish beds are without doubt a good feeding ground for the smaller flat and round fishes, as we frequently find the remains of Cockles and Mussels as well as Annelida in the stomachs of the fish caught in the vicinity of the shell-fish beds, so that the protection and cultivation of the more important shell-fish would be a means of increasing the food supply for the smaller sizes of the valuable food fishes.

Fish were found in 7 stomachs, or about 6½ %, and consisted chiefly of sand eels.

Last year's report showed that Mollusca were the most important food supplying agent of the Plaice, as fully 72 % of the stomachs contained the remains of various shell-fish, Annelida were second 22 % and Crustacea third with 8 %.

Dabs (*Pleuronectes limanda*).

176 stomachs of Dabs were examined, of which 70 were empty and 13 contained unrecognisable animal matter, leaving 93 to be accounted for.

32 stomachs contained Mollusca, or fully 34 %, the Mollusca consisted of the remains of *Buccinum, Cardium, Mactra, Mytilus, Philine* and *Nucula*. Here again we also find the smaller sizes of dabs, such as are caught in the shrimp nets, &c., feeding on the young Cockles and Mussels which they pick up on the shell-fish beds.

24 stomachs contained remains of Annelida, nearly 26 %.

23 stomachs contained remains of Crustacea, or nearly 25 %, and consisted of *Crangon, Pagurus, Portunus* and various Amphipoda.

6 stomachs contained remains of Echinoderms, nearly 7 %, and consisted chiefly of the sand starfish, *Ophioglypha*.

9 stomachs contained remains of fish, nearly 10 %, and were mostly composed of sand eels, but 1 stomach contained a number of fish eggs.

1 stomach contained remains of a Zoophyte.

Last year's report gave Annelida as first with 50 %, then Echinoderms, Mollusca, Crustacea and Zoophytes with 21 %, 20 % and 15 % respectively. In the previous year (1893) Mollusca were found to be the chief food.

Flounders (*Pleuronectes flesus*).

20 stomachs of Flounders were examined 15 of which were empty, the remainder, 5, contained fragments of Annelida.

Soles (*Solea vulgaris*).

40 stomachs of Soles were examined of which 27 were

empty, and 6 contained matter unrecognisable, so that only 7 out of the 40 contained food.

4 stomachs contained remains of Annelida.

2 stomachs contained remains of Crustacea.

1 stomach contained Mollusca.

Last year's report gave Annelida as being the most useful food supplying agent of this valuable food fish, Crustacea being second, so that it seems clear, that on the whole Annelida form a very important item in the food of the Sole.

It may be stated here that by far the greater number of Soles examined in this district are found to have no food in the stomachs.

Cod (*Gadus morrhua*).

30 stomachs of Cod were examined, of which 13 were empty, the remainder contained recognisable food matter.

Crustacea were found in 12 stomachs, or fully 70 %.

Fish were found in 4 stomachs, nearly 23 %.

Annelida were found in only 1 stomach.

Last year 90 % of the stomachs examined contained Crustacea, Fish being again second with 12 %, and Annelida third.

Whiting (*Gadus merlangus*).

74 stomachs of Whiting were examined, of which 38 were empty, and 5 contained unrecognisable food matter, leaving 31 to be accounted for.

Crustacea were found in 13 stomachs, or nearly 43 %.

Annelids were found in 3 stomachs, or fully 9 %.

Fish were also found in 3 stomachs, or fully 9 %.

Mollusca were found in 2 stomachs, or nearly 7 %.

In last year's report, Crustacea were found to occupy the first place with fully 73 %, Fish second with 24 % and Annelida third with 7 %.

Haddock (*Gadus æglefinus*).

32 stomachs of Haddock were examined of which 9 were empty, and 1 contained unrecognisable food matter, leaving 22 to be accounted for.

Crustacea were found in 12 stomachs, or fully 54 %.

Fish were found in 6 stomachs, or fully 27 %.

Mollusca were found in 3 stomachs, or fully 13 %.

Annelida were found in 2 stomachs, or fully 9 %.

From last year's Report it will be seen that Mollusca occupied the first place with fully 54 %, Echinoderms second with 21 %, Annelida and Crustacea third with fully 18 % each.

Thornback Skate (*Raia clavata*).

17 stomachs were examined of which 4 were empty, and 1 contained unrecognisable animal matter, leaving 12 to be accounted for as having contained recognisable food material.

Crustacea were found in 8 stomachs, or fully 66 %.

Mollusca were found in 3 stomachs, or 25 %.

Fish were also found in 3 stomachs, 25 %.

Last year's report shows that fully 97 % of the stomachs of the Skate contained Crustacea, Mollusca occupying second place with 16 %, and Fish third with 10 %, so that as far as our results go they show that the Thornback Skate in our district feed largely upon Crustacea such as *Crangon*, *Carcinus*, *Galathea*, *Hyas*, *Nephrops*, *Portunus*, *Pagurus* and a species of Amphipoda, probably *Ampelisca spinipes*, Boeck.

We have also examined the stomachs of a number of other more or less important food fishes, such as the "Lemon Sole" (*Pleuronectes microcephalus*), "Long Rough Dab" (*Hippoglossoides limandoides*), "Grey Gurnard" (*Trigla gurnardus*), "Starry Ray" (*Raia radiata*), "Grey Skate" (*Raia batis*), but not in sufficient numbers to make them worth while recording.

A number of the inedible fishes (fishes of no marketable value) such as the "Solenette" (*Solea lutea*), "Megrim" (*Arnoglossus laterna*), "Pogge" (*Agonus cataphractus*) etc., have been examined with the view of obtaining fresh information regarding their habits and food, so that we may have some idea as to what extent they compete with the more valuable food fishes of this district.

In the stomach of one of the Solenettes a young Sole, measuring $\frac{5}{8}$ of an inch, was found, which is the first direct evidence we have from this district of Solenettes feeding upon young Soles. Whether or not this happens to any great extent it is difficult to say.

Conclusion.

If we take into consideration the results of the four years work of examining stomachs and compare one year with another we find, as a rule, that each particular species of fish is fairly consistent in preferring one kind of animal as food.

There are times, however, when unusual animals may form a large proportion of the food, and this may well be due to a temporary scarcity of the usual foods or a temporary abundance of the forms substituted. Such variations in food matters may have considerable influence upon the movements of fishes within our district.

SECTION II.

The Drift Bottles and Surface Currents.

(By Professor Herdman.)

In last year's report the scheme for the distribution of drift bottles over the Irish Sea, for the purpose of helping to determine the set of the chief currents, tidal or otherwise, which might influence the movements of fish food and fish embryos, was fully explained. Since September, 1894, this work has been going on actively, and at the end of about twelve months over one thousand drift bottles in all had been set free. Many of them have been let out at intervals of ten minutes, or quarter of an hour, or twenty minutes (corresponding to distances of from 3 to 6 miles apart) from the Isle of Man boats when crossing between Liverpool and Douglas—a very convenient line of 75 miles across the middle of the widest part of our area, traversing the "head of the tide" or meeting place of the tidal currents entering by St. George's Channel and the North Channel. Others have been let off from Mr. Alfred Holt's steamers, in going round from Liverpool to Holyhead and in coming down from Greenock. Mr. Dawson on the Fisheries steamer "John Fell" has distributed a number along the coast in various parts of the district, and the Fisheries bailiffs have let off some dozens from their small boats. Other series have been set free at stated intervals during the rise and fall of the tide from the Morecambe Bay Light Vessel in the northern part of our area, north of the "head of the tide;" and, through the kindness of Lieutenant M. Sweny, R.N., a similar periodic distribution has taken place from the Liverpool North-West Light Vessel, to the south of the "head of the tide." Others, finally, have been despatched by Mr. Robert Harley, by Mr. R. L. Ascroft, by Mr. Andrew Scott and a few friends in other parts of the area from small boats and on our dredging expeditions, in some cases between the Isle of Man and Ireland. Altogether we have pretty well covered this northern area of the Irish Sea in our distribution of floating bottles.

Mr. Ascroft has also let off fifty larger and heavier bottles, champagne quarts weighted with sand so as to float almost entirely submerged, and with a post card attached to the end of the cork. Nearly 30 % of these have been returned; most were set free in the northern part of the district, and about 10 % have come south—*e.g.*, No. 34, set free off Duddon outer buoy (Cumberland) on 9th May, was found at Wallasey embankment (Cheshire) on the 18th of May—thus differing from our smaller bottles (see below) which have largely gone north. Possibly this difference in result may be due to the weighted champagne bottles having floated lower in the water or having been carried along near the bottom. Some of them are said to have sunk out of sight when set free, and one was trawled up from 12 miles S.E. of the Bahama Light Ship from a depth of 14 fathoms.

The first small bottles used, and the printed paper they contained, were described last year. We afterwards adopted a rather larger size of bottle, 8·5 cm. in length; and, after various postal difficulties and experiments, we hit upon a convenient size and thickness of private post card, which, ready stamped and addressed, and marked with a distinguishing letter or number, is rolled up in its bottle, and has printed on its back the following:—

For scientific enquiry into the currents of the Sea.

Whoever finds this is earnestly requested to write distinctly the DATE and LOCALITY, with full particulars, in the space below, and to put the card in the nearest post office.

[No. here]

LOCALITY, where found..................................

....

....

DATE, when found..

Name and address of sender...........................

....

[No. here]

The number is marked with blue and black pencils in duplicate on opposite corners of the card, in case of one edge of the card getting worn by moisture; and the card is so rolled in the bottle that one of these numbers can be read through the glass, in order that a record may be kept of when and where each bottle is set free. Mr. Andrew Scott has collated these records with the particulars of finding of those bottles which have been recovered, and I am indebted to him for the details upon which the following statement of results is based.

Altogether out of the 1045 bottles distributed, over 440 or 42 per cent., more than two in five, have been subsequently picked up on the shore, and the paper, or post card, has been duly filled up and returned. We beg to thank the various finders of the bottles for their kindness in filling and posting the cards. They come from various parts of the coast of the Irish Sea—Scotland, England, Wales, Isle of Man, and Ireland. Some of the bottles have gone quite a short distance, having evidently been taken straight ashore by the rising tide; while others have been blown ashore by the wind, *e.g.*, two (post cards 211 and 214) let off near New Brighton stage on 9th October, 1895, the tide ebbing and the wind N.N.W., were found next day near the Red Noses, 1 mile to the west. Others have been carried an unexpected length, *e.g.*, one (No. 35), set free near the Crosby Light Vessel, off Liverpool, at 12.30 p.m., on October 1st, was picked up at Saltcoats, in Ayrshire, on November 7th, having travelled a distance of at least 180 miles* in thirty-seven days; another (H. 20) was set free near the Skerries, Anglesey, on October 6th, and was picked up one mile north of Ardrossan, on November 7th, having travelled

* More probably, very much further, as during that time it would certainly be carried backwards and forwards by the tide,

150 miles in thirty-one days; and bottle No. 1, set free at the Liverpool Bar on September 30th, was picked up at Shiskin, Arran, about 165 miles off, on November 12th. On the other hand, a bottle (J. F. 34) set free on November 7th, in the Ribble Estuary, was picked up on November 12th at St. Anne's, having only gone 4 miles.

We have not considered it necessary to give the particulars of every bottle that has been set free and afterwards recovered, but we have divided up our district into eight convenient areas in each of which a sufficiently large number of bottles has been set free, and the following table shows our results for these areas:—

Area.	No. set free.	No. recovered.	Apparent Direction of Drift.
West of I. of Man	84	33	West and North, mostly to Ireland.
East of I. of Man	115	29	Northward, mostly to Wigtonshire.
Central area -	104	26	North-east, Cumbd., & N. Lanc.
North Wales -	71	28	Mostly North-east.
Mersey area -	173	95	24 N., 16 W., rest washed ashore.
N.W. Lt. Vessel	96	41	26 to North, 15 to West.
Ribble area -	137	72	Half N. & N.E., rest ashore.
Morecambe B. & North	107	40	Mostly N.E. and E. (ashore).

It may be doubted whether our numbers are sufficiently large to enable us to draw very definite conclusions. It is only by the evidence of large numbers that the vitiating effect of exceptional circumstances, such as an unusual gale, can be eliminated. Prevailing winds, on the other hand, such as would usually affect the drift of surface organisms, are amongst the normally acting causes which we are trying to ascertain. Mr. W. E. Plummer of the Bidston Observatory has kindly given us access to his records of weather for the last twelve months, and we have noted opposite the bottles, from whose travels we are drawing any conclusions, an approximate estimate of the wind influences during the period when the bottle may have been at sea. There have been a few rather extraordinary journeys, *e.g.*, one let off in the middle of Port Erin Bay on April 23rd was found at Fleetwood on July 6th; another let off at Bradda Head on June 3rd was found on Pilling Sands (near Fleetwood) on July 24th.

It is important to notice that the bottles may support one another's evidence, those set free about the same spot often being found in the same locality, *e.g.*, out of a batch of 6 set free off New Brighton, on Oct. 9th, 1895, 5 have come back and all were found at about the same place.

Dr. Fulton, who has been conducting a similar inquiry by means of drift bottles, in the North Sea, for the Scottish Fishery Board, wrote to me some months ago that he was then having large numbers of his bottles returned to him from the Continent, chiefly Schleswig and Jutland. And he draws the conclusion, "There is no doubt that the current goes across, down as far as Norfolk—none of the bottles have been found south of Lincoln and none in Holland—and this will explain the presence of banks and shallows in the south and east, and the immense nurseries of immature fish there." Since then a detailed account* of these experiments on the Scottish coast has appeared, and it is interesting to compare our results with them.

Their experiments commenced on Sept. 21st, and ours on Sept. 30th, 1894. They report upon 729 bottles of which 159, or nearly 22 % have been returned, while we have distributed 1045 of which over 42 % have been found and recorded. The general result of the Scottish investigations is to show that most of the bottles are carried southwards in the North Sea along the east coasts of

* Thirteenth Ann. Report of Fishery Board for Scotland, Part III., p. 153.

Scotland and England as far as the Wash, and then eastward to the Continent; so that the fish supply of a given area of the territorial waters may be derived not from the offshore spawning areas opposite, but from those situated further north—for example: the inshore waters of the Firth of Forth and St. Andrews Bay derive their main supplies not from the waters lying contiguous to them to the eastward, but from areas further north, such as the spawning grounds in the neighbourhood of the Bell Rock and those off the Forfarshire coast. In the case of our district, the drift is chiefly to the north and north-east (see below).

What is already well-known* in regard to the tidal streams or currents in the Irish Sea is that for nearly six hours after low-water at, say, Liverpool, two tidal streams pour into the Irish Sea, the one from the north of Ireland, through the North Channel, and the other from the southward, through St. George's Channel. Parts of the two streams meet and neutralise each other to the west of the Isle of Man, causing the large elliptical area, about 20 miles in diameter and reaching from off Port Erin to Carlingford, where no tidal streams exist, the level of the water merely rising and falling with the tide. The remaining portions of the two tidal streams pass to the east of the Isle of Man and eventually meet along a line extending from Maughold Head into Morecambe Bay. This line is the "head of the tide." During the ebb the above currents are practically reversed, but in running out the southern current is found to bear more over towards the Irish coast.

* All the accounts I have had access to seem based upon Admiral Beechey's observations published in the Philosophical Trans. for 1848 and 1851. Admiral Wharton, F.R.S., the present Hydrographer to the Navy, has kindly informed me that Admiral Beechey took his observations by the direct method of anchoring his ship in various places and then observing the direction and force of the tide.

There is some reason to believe that, as a result of the general drift of the surface waters of the Atlantic and the shape and direction of the openings to the Irish Sea, more water passes out by the North Channel than enters that way, and more water enters by the South (St. George's) Channel than passes back, and that consequently there is, irrespective of the tides, a slow current passing from south to north through our district. The fact that so many of our drift bottles have crossed the "head of the tide" from S. to N., and that of those which have gone out of our district nearly all have gone north to the Clyde sea-area supports this view, which I learn from Admiral Wharton is *a priori* probable, and which is believed in by Mr. Ascroft and other nautical men in the district from their experience of the drift of wreckage.

It may be objected to our observations by means of drift bottles that they are largely influenced by the wind and waves, and are not carried entirely by tidal streams. Well, that is an advantage rather than any objection to the method. For our object is to determine not the tidal currents alone but the resulting effect upon small surface organisms such as floating fish eggs, embryos and fish food, of *all* the factors which can influence their movements, including prevalent winds. The only factors which can vitiate our conclusions are unusual gales or any other quite exceptional occurrences, and the only way to eliminate such influences is (1) to allow for them so far as they are known from the weather reports, and (2) to employ a large number of drift bottles and continue the observations over a considerable time. We have carefully considered the bearing of the weather records, and we think that the large number of bottles we have made use of, during the year, ought to enable us to come to some definite results. Our conclusions so far (January, 1896) then are:—

(1) A large number (over 42 %) have been stranded and found and returned,

(2) of these returned, only a small proportion (13 %) have been carried out of our part of the Irish Sea,

(3) nearly 12 % have crossed the "head of the tide," showing either the influence of wind in carrying floating bodies over from one tidal system into another, or the effect of that slow drift of water to the north referred to above,

(4) most of the bottles set free to the west of the Isle of Man have been carried across to Ireland, only a small number (3·8 %) of them have got round to the eastern side of the Island and been carried ashore on the English coasts,

(5) the majority of the bottles set free off Dalby have gone to the Co. Down coast,

(6) a considerable number of bottles have been set free over the deep water to the east of the Isle of Man, where our more valuable flat fish spawn, and of those that have been returned the majority had been carried to the Lancashire, Cheshire and Cumberland coasts.

So we may reasonably conclude that *the embryos of fish spawning off Dalby would tend to be carried across to the Irish Coast, while those of fish spawning in the deep water on this eastern side of the Isle of Man would go to supply the nurseries in the shallow Lancashire and Cheshire bays, and very few would be carried altogether out of the district.*

The bearing of this conclusion upon the site of a Sea-Fish Hatchery for our district is obvious. It would not do to set the newly hatched larvæ free anywhere near the Lancashire or Cheshire coasts. Besides the muddiness and varying specific gravity of the water to which they would there be exposed, they would run too much risk of being carried straight ashore or stranded on sandbanks by wind and tide. They must be set free as nearly as possible where they would be found under natural conditions, and that is somewhere in the open deep water where the parent fish spawn. It is most satisfactory and re-assuring, then, to find, by these "drift bottle" experiments, that small objects set free in the surface layers of water to the east and south-east of the Isle of Man (where we can obtain the purest and most constant water for the purposes of a hatchery) are gradually carried over to the eastward; so that young flat fish hatched there, or set free there from a hatchery, by the time they have passed through their larval stages and are ready to take to the bottom in shallow water in order to search for Copepoda and other food matters, would find themselves in the Lancashire and Cheshire bays and estuaries which constitute our fish "nurseries."

SECTION III.

Mussels and Mussel Beds.

(By Mr. Andrew Scott.)

We have continued the examination of samples of the various kinds of shell-fish caught for sale in the Lancashire Sea-Fisheries district, but have nothing new to record beyond the fact that the results as to feeding and spawning confirm what has already been published in the former Reports.

With a view of securing further information, however, regarding the food, habits, life-histories, etc., of the shell-fish, we have begun to make periodic examinations of the various beds of the district. In connection with this investigation a visit was made to the Mussel beds at Piel, Duddon and Morecambe, about the middle of September last, the condition of the shell-fish was noted, and samples of material were collected for microscopic inspection at the University College Laboratory, with the following results. A short description of the beds is given first with remarks upon the Mussels, then come lists of the various animals observed either on the beds themselves or in the material collected from them.

Roosebeck Scars.

The Roosebeck Mussel Scars are situated about one and a half miles S.E. from Piel and are practically continuous with the shore, at low-water spring tides only a very narrow and shallow channel separates the inner scar from the outer, at high-water the beds are covered to a depth of several feet. The outer scar, which is evidently the most suitable for the production of this valuable shell-fish, is fully half a mile long and from one hundred to one hundred and fifty yards wide, and lies parallel to the shore, the whole area of this scar at the time the examination was made was covered with fine mud, reaching in some places to a depth of nearly two feet, but this mud, from the information supplied by Mr. Wright the head fishery officer of the Northern District, appears to have only settled down after the Mussels attached themselves to the hard ground, for until the Mussels appeared on the bed the ground was quite hard and free from mud. This experience is the same elsewhere, that Mussels tend to accumulate mud and so raise the level of the bed.

The outer scar is clearly a much better rearing place for Mussels than the inner one as the present condition of the shell-fish show, for while the Mussels on the outer scar which only settled down in April, 1895, had reached in the majority of cases to nearly three-quarters of an inch in about a period of five months, those on the inner scar deposited at the same time had scarcely attained to one-quarter of an inch in length when the examination was made. The Mussels on the outer scar are very numerous being so closely packed together in some places that there appears to be scarcely any space left for further growth of the shell-fish, but as they have now no firm attachment owing to their having to keep moving as the mud accumulates, they are liable to be washed off by any heavy sea from the southward, and carried off into the deeper water outside the scar from whence they can only be obtained by raking. The shells are quite clean and free from barnacles.

It is difficult to explain why the Mussels on the outer scar should grow so much faster than those on the inner scar as the conditions of the bottom must have been much alike in structure and wealth of food supply before the spat settled down. Possibly the rapid growth of the Mussels on this scar may be due to the large quantities of fresh water that pass over it when the tide is out, little or none of which appears to reach the Mussels on the inner scar. This water will bring down diatomaceous and other material collected on its passage across the shore, which will be deposited when it comes into contact with the sea and will accumulate in considerable quantities just at low-water mark, forming a splendid rearing ground for the microfauna that forms the principle source of food of the Mussel. Whether this be the true explanation or not, the rapid growth of the Mussels on the outer scar is without doubt due to some important cause which does not affect the inner scar, and which can only be found out by further investigation.

Fauna of the Scar.

Besides Mussels, the usual animals that live in association with them are found here, the chief enemies being the boring Mollusca, which perforate the Mussel shells and extract the juices and flesh of the animal, such as the "Dogwhelk," *Purpura lapillus*, L. The "Whelk," *Buccinum undatum*, L., the common "Edible periwinkle," *Littorina litorea*, L., and a few common shore crabs, *Carcinus moenas*, were also present, but none of them in any great quantity. The examination of the mud yielded seventeen species of Foraminifera representing ten genera, ten species of Ostracoda representing six genera, and eleven species of Copepoda representing ten genera. The mud also contained fragments of shells, spines of *Spatangus*, sponge spicules, a few diatoms and a considerable quantity of vegetable debris. The following list gives the names of the species of Ostracoda, Foraminifera and Copepoda. The Ostracoda and Foraminifera from the Mussel beds at Piel, Duddon and Morecambe have been identified by Mr. Thomas Scott, F.L.S., and Dr. G. W. Chaster.

Foraminifera.

Lagena clavata, d'Orb.
,, *lævis*, Mont.
,, *striata*, d'Orb.
,, *williamsoni*, Alcock.
,, *squamosa*, Mont.
,, *sulcata*, W. and J.
Polystomella striato-punctata, F. and M.
Polymorphina lactea, W. and J.
Planorbulina mediterranensis, d'Orb.
Nonionina depressula, W. and J.
Rotalia beccarii, L.

Cornuspira involvens, Reuss.
Biloculina depressa, d'Orb.
Bulimina aculeata, d'Orb.
Miliolina oblonga, Mont.
,, *seminulum*, d'Orb (juv.).
,, *subrotunda*, Mont.

OSTRACODA.

Cythere pellucida, Baird.
Cytherura angulata, Brady.
,, *nigrescens* (Baird).
,, *sella*, G. O. Sars.
Cytherideis subulata, Brady.
Loxoconcha impressa, Baird.
,, *tamarindus* (Jones).
Sclerochilus contortus, Norman.
Paradoxostoma abbreviatum, G. O. Sars.
,, *flexuosum*, Brady.

COPEPODA.

Temora longicornis (Müller).
Paracalanus parvus (Claus).
Canuella perplexa, T. and A. Scott.
Ectinosoma curticorne, Boeck.
Euterpe acutifrons, Dana.
Ameira exigua, T. Scott.
Laophonte serrata (Claus).
,, *lamellifera* (Claus).
Cletodes propinqua, Brady and Robertson.
Harpacticus chelifer (Müller).
Idya furcata (Baird).

SCARFHOLE SCAR, NEAR DUDDON.

This Mussel bed is fully four miles from Barrow-in-Furness and is situated nearly opposite the north end of

Walney Island. Like the Roosebeck Scars it is almost continuous with the shore and at low-water of spring tides is nearly dry, but is covered to a depth of several feet at high-water. The bottom is hard and consists of sand, stones and Mussel shells, quite different from that at Roosebeck, consequently the Mussels have a much firmer hold of the bottom and are not so easily washed off.

The Mussels on this bed are numerous, large and in good condition, but are covered with barnacles.

Fauna of the Scar.

Besides the Mussels, *Buccinum*, *Purpura*, *Littorina* and *Carcinus* were also found on the bed. An examination of the mud yielded thirteen species of Foraminifera representing eight genera, five species of Ostracoda representing four genera, and eight species of Copepoda representing seven genera. The mud also contained fragments of shells, spines of *Spatangus*, sponge spicules and a few diatoms. The following is a list of the Ostracoda, Foraminifera and Copepoda :—

Foraminifera.

Lagena lævis, Mont.
,, *striata*, d'Orb.
,, *sulcata*, W. and J.
,, *williamsoni*, Alcock.
Polystomella striato-punctata, F. and M.
Planorbulina mediterranensis, d'Orb.
Nonionina depressula, W. and J.
Bulimina elegans, d'Orb.
,, *pupoides*, d'Orb.
Miliolina seminulum, L.
,, *subrotunda*, Mont.
Nodosaria communis, d'Orb.
Haplophragmium canariense, d'Orb.

Ostracoda.

Cythere confusa, Brady and Norman.
,, *lutea* (O. F. Müller).
Loxoconcha tamarindus (Jones).
Sclerochilus contortus, Norman.
Paradoxostoma variabile, Baird.

Copepoda.

Canuella perplexa, T. and A. Scott.
Tachidius brevicornis, Müller.
Delavalia palustris, Brady.
Laophonte curticauda, Boeck.
,, *intermedia*, T. Scott.
Nannopus palustris, Brady.
Platychelipus littoralis, Brady.
Thalestris harpactoides, Claus.

Morecambe Mussel Beds.

These beds by far the most valuable and extensive of the northern district, if not of the whole area under the control of the Lancashire Sea-Fisheries Committee, extend from a little way south-east of the town of Morecambe, to a considerable distance beyond the village of Heysham and are partly continuous with the shore. In front of Heysham, they are separated at low water into three separate banks, the outer one tailing off into the deep-water at the entrance to Heysham Lake. The Mussel scar separates the deep-water into two distinct channels, the outer being Morecambe Channel, the fairway to Morecambe, while the inner is known as Heysham Lake, which at low-water is open only at the south-west end. At high-water the beds are completely submerged and consequently can only be worked upon at low-water or at half tide by means of long mussel rakes. At the time the examination was made no "musselling" was going on. Hedge balks were erected on the tops of the various banks in which a number of codling, plaice, and flounder were being taken.

The area of the bed is composed almost entirely of the deserted sand tubes of *Sabella* which afford a firm hold to the growing Mussels and no doubt also a good food supply from the diatoms and other microscopic animals which feed on the decaying matter about the tubes. Scattered over the beds are numerous large boulders all more or less covered with deserted sand tubes.

The Mussels here are healthy and in good condition showing evidence of an abundant food supply and of conditions favourable to a rapid growth of the shell-fish. They are quite free from barnacles.

Fauna of the Scar.

Along with the Mussels, there were also a few *Buccinum*, *Purpura*, *Littorina* and *Carcinus*. On microscopic examination the mud was found to contain nineteen species of Foraminifera representing eleven genera, eight species of Ostracoda representing five genera, and nine species of Copepoda (one of which appears to be new) representing eight genera. The mud also contained a few fragments of shells, spines of *Spatangus*, diatoms and a quantity of vegetable debris. The following is a list of the Ostracoda, Foraminifera and Copepoda :—

Foraminifera.

Lagena striata, d'Orb.
,, *williamsoni*, Alcock.
,, *clavata*, d'Orb.
,, *semistriata*, Will.
,, *sulcata*, W. and J.
,, *hexagona*, Will.

,, *globosa*, Mont.
Polystomella striato-punctata, F. and M.
Planorbulina mediterranensis, d' Orb.
Nonionina depressula, W. and J.
,, *stelligera*, d'Orb.
Rotalia beccarii, L.
Biloculina depressa, d'Orb.
Miliolina subrotunda, Mont.
,, *trigonula*, Lamarck.
Haplophragmium canariense, d'Orb.
Truncatulina lobatula, W. and J.
Bolivina plicata, d'Orb.
Virgulina schreibersiana, Cz.

Ostracoda.

Cythere confusa, Brady and Norman.
,, *robertsoni*, Brady.
Cytherura cellulosa, Norman.
,, *striata*, G. O. Sars.
,, *sella*, G. O. Sars.
Cytheridea elongata, Brady.
Loxoconcha guttata, Norman.
Sclerochilus contortus, Norman.

Copepoda.

Longipedia minor, T. and A. Scott.
Canuella perplexa, T. and A. Scott.
Ectinosoma curticorne, Boeck.
Bradya minor, T. and A. Scott.
Laophonte intermedia, T. Scott.
Cletodes propinqua, Brady and Robertson.
Platychelipus littoralis, Brady.
Idya furcata (Baird).
,, *elongata*, n.sp.

Conclusion.

The whole area of Morecambe Bay, with its numerous banks and the estuaries of the Wyre and Lune rivers and Morecambe, Grange, Ulverston, Barrow and Duddon Channels, by a little artificial cultivation might easily be turned into a vast rearing ground for Mussels, as everywhere the conditions seem most favourable for the production and rearing of this valuable shell-fish. All that is necessary is to remove some of the seed Mussels from the beds where they are too crowded to places where they are few in number or entirely absent. Many of the Mussels on the various beds under the present conditions are certain to be lost, through having too little room to grow, when consequently they either get choked off and perish miserably or become so stunted in their growth as to be of little or no marketable value either as bait or food.

Under the present conditions the beds are allowed to seed themselves and consequently it takes much longer for the Mussel to spread over any considerable area, than if the young Mussels were transplanted from places on the present beds where they are too close, to new ground. By this means the Mussels would certainly reach a marketable size much sooner than if left to look after themselves, and a convenient time for moving the seedlings would be when the close season begins, as they would be less liable to be disturbed than if done at any other period, and by the time the close season had expired, they would no doubt have firmly established themselves under their new conditions.

We propose during the coming year to continue this investigation by doing some more work at Piel when the temporary laboratory is fitted up, in examining the Mussel beds of the middle and southern district. The southern beds can easily be examined from the central laboratory at University College, but the examination of the beds at Lytham and Fleetwood would be better done from Piel. An examination will also be made of the Cockle beds of the district as far as time permits.

The question has been raised whether Mussels which are no longer quite young and which have been torn off from their first supports, or which have been detached from larger Mussels, as in separating up bunches, are able to fix themselves anew. It is known to Zoologists that Mussels are able to produce byssus threads at any time and so re-attach themselves to any foreign object, consequently there can be no doubt that the smaller individuals torn off a bunch, will, if thrown back promptly into suitable ground, be able to spin fresh byssus round neighbouring objects and so become anchored. In order to settle the question quite definitely we have made some observations in the laboratory during the last year, and especially quite recently. One of our tanks had a number of young Mussels, varying in size from half an inch to an inch and a half in length, put in last June. These after climbing about the sides of the tank for some time attached themselves by means of byssus threads in various positions. They were occasionally detached, and were usually found re-attached after a few days. That has gone on during the last eight months. The Mussels that now survive in the tank have increased considerably in size one being over 2 inches and another 3 inches in length. The former of these was torn off from the side of the tank lately and was thrown into the middle. In two days it was found re-attached by byssus to the glass. Again, on February 4th the largest Mussel, measuring 3 inches in length, $1\frac{1}{2}$ inches in breadth, and $1\frac{1}{4}$ inches in thickness, and weighing $52\frac{1}{2}$ grammes, was torn off from its attachment to the glass and placed on the sand in the bottom of the tank. In four days it had re-attached itself to the glass by means of byssus threads. This shows, if any further demonstration was really required, that even Mussels which have attained to large size have the power of spinning fresh byssus threads by which they become anchored to surrounding objects.

SECTION IV.

Description of New and Rare Copepoda.

(By Mr. Andrew Scott.)

Family Harpacticidæ.

Sunaristes paguri, Hesse.

This rather peculiar and interesting species was obtained by washing the shells of *Buccinum* inhabited by the hermit crabs *Pagurus bernhardus*, collected in the trawl-net of the steamer while working at the mouth of the Mersey estuary on the 23rd of July, 1895. It seems to be a comparatively rare species and so far as is known this is only the third time it has been found in British waters. From our present knowledge of its distribution it appears to be confined to areas having large volumes of brackish water passing over the bottom, and has not been found in pure sea-water.

Sunaristes paguri is not unlike *Canuella perplexa* in general appearance but is readily distinguished from that species by the structure of the various appendages, especially the antennules and second pair of swimming feet of the male.

Stenhelia herdmani, n. sp. Pl. I., figs. 1—11.

Description of the species.—Female. Length 1·43 millim. ($\frac{1}{17}$th of an inch. Body moderately stout; rostrum prominent and curved. Antennules long and slender, eight-jointed; the first, second, fourth and eighth joints longer than the others, the fifth joint being the smallest of the series; the second, third and fourth joints have each a tuft of setæ on their upper distal margins. The proportional lengths of the various joints are as follows:—

$$\frac{14 \;.\; 14 \;.\; 8 \;.\; 10 \;.\; 5 \;.\; 6 \;.\; 7 \;.\; 11}{1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8}$$

Antennæ moderately stout, secondary branch small and slender, two jointed; basal joint elongate narrow with one seta on its upper distal end, second joint short, about one third of the length of the first and furnished with two terminal setæ. Mandibles large and well developed, the broad biting part armed with a few large teeth and a number of smaller ones; mandible palp comparatively large, consisting of a one-jointed basal part which carries at its lower extremity two branches, one large and one small, the smaller of the two being two-jointed, whilst the larger one is composed of a single joint. Masticatory portion of the maxillæ furnished with a number of strong teeth, palp two branched, the outer one bearing three setiferous lobes. Anterior foot-jaws furnished with one large terminal claw and three digitiform setose tubercles. Posterior foot-jaws stout, of moderate length and furnished with a strong, slightly curved terminal claw at the base of which are two setæ; the basal joint of the foot-jaw has four small ciliated tubercles on its lower side, while the second joint has a row of fine cilia on its upper margin and a row of stronger cilia on its lateral surface a little way down from the upper margin, there are also two plumose setæ on the upper margin of the joint. First pair of swimming feet somewhat similar to those of *Stenhelia ima*, Brady; basal joints of the inner branches nearly as long as the entire outer branches, second joint about half the length of the third which is less than one third the length of the long basal joint. Outer branches of the second, third and fourth pairs elongate, inner branches much shorter, those of the fourth pair only reaching to the end of the second joint of the outer branches. Fifth pair of feet large and well developed, inner branches considerably larger than the outer ones, with a subtriangular apex bearing five plumose setæ, two on the outer angle close together and three arranged at regular intervals along the inner margins; outer branches subovate, bearing six setæ on the external distal margins, the second seta from the inside is considerably longer than any of the others. Caudal stylets about as long as broad and about half the length of the last abdominal segment.

Habitat, 1 mile off Spanish Head, Isle of Man, in neritic material dredged from a depth of 16 fathoms, October 27th, 1895.

Remarks.—This large and well marked species though somewhat like *Stenhelia ima* in general appearance is readily distinguished from it and the other known members of this genus, by the form and armature of the fifth pair of feet, and by the structure and proportional lengths of the antennules.

Stenhelia similis, n. sp. Pl. I., figs. 12—25.

Description of the species.—Female. Length 1 millim. ($\frac{1}{25}$ of an inch). Body elongate, moderately robust; rostrum prominent and curved with a bifid apex. Antennules long and slender, sparingly setiferous, the second joint longer than any of the others and slightly contracted near the middle, but expanding again towards the distal end, third, fifth, sixth and seventh joints small, the others of moderate length as shown by the formula :—

$$\frac{13 \,.\, 24 \,.\, 7 \,.\, 12 \,.\, 5 \,.\, 6 \,.\, 6 \,.\, 10}{1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8}$$

Antennæ well developed, secondary branch three-jointed, second joint very small, terminal joint fully half the length of the basal one and furnished with two setæ on its apex, one large and spiniform and one very small; one seta springs from near the middle of the upper margin of the terminal joint, the basal joint bears one seta on its upper distal angle. Mandibles furnished with several strong and serrated teeth on the biting parts, mandible palp consisting of a basal part carrying two branches, the inner branch which is smaller than the outer is two-jointed, both branches are furnished with a number of setæ on the apex and upper margins, the basal part has three terminal plumose setæ, and a curved row of short spines on its lateral surface. Maxillæ somewhat similar to those of *Stenhelia herdmani.* Posterior foot-jaws slender and furnished with a short curved claw, basal joints short and furnished with three small plumose setæ on the upper distal margin, second joint fully three times longer than broad and bearing a few cilia and one seta on its upper margin, there are also a few spines on its lateral surface. The first four pairs of swimming feet are nearly as in *Stenhelia ima,* the joints of the outer branches of the first pair are subequal, basal joint of the inner branches nearly as long as the entire outer branch, second joint small and about half the length of the third which is about half the length of the basal joint, the apex of the third joint is furnished with one short stout spine and two plumose setæ, one long and one short. Fifth pair of feet large, inner branches broad and triangular, bearing five short plumose setæ from the middle of the inner margin to the apex; outer branches elongate ovate, about two-thirds the length of the inner, proximal half of the outer margin ciliated, inner margin slightly ciliated towards the distal end, apex and distal half of the outer margin furnished with six setæ, the second from the inner part of the apex considerably longer than the others. Caudal stylets rather shorter than broad and about one-third the length of the last abdominal segment.

Male. Antennules ten-jointed, fourth and sixth joints very small. Swimming feet, with the exception of the second pair, similar to those of the female. Inner branches of the second pair two-jointed, second joint bearing at the apex two strong and slightly curved spines, the inner spine which is slightly longer than the outer one, becomes distinctly bifid at the middle. The form of the fifth pair of feet is somewhat similar to those of the female, but smaller and furnished with fewer setæ, the inner branches have only two setæ which are placed on the apex, the outer branches have two setæ on the outer distal margin, the lower one being stout and spiniform, two setæ on the middle of the inner margin and one seta on the apex.

Habitat, 1 mile off Spanish Head, Isle of Man, in neritic material dredged from a depth of 16 fathoms. A considerable number of specimens were obtained.

Remarks.—This species comes near *Dactylopus tenuiremis,* but can easily be distinguished from it by the structure and proportional lengths of the antennules, the length and armature of the inner branches of the first feet, and also by the structure of the fifth feet.

Stenhelia reflexa, T. Scott.

[T. Scott, Thirteenth An. Rep. Fish. Board for Scot., pt. III., p. 166, 1895.]

A few specimens of this *Stenhelia* were obtained from dredged material collected off Port Erin in June, 1895.

Ameira gracile, n. sp. Pl. II., figs. 1—11.

Description of the species.—Female. Length ·5 millim. ($\frac{1}{50}$th of an inch). Body elongate and slender, rostrum small and inconspicuous. Antennules long and very slender, seven-jointed; second and fifth joints longer than any of the others, fourth joint very short, the second, third and fourth joints have each a tuft of long setæ on the upper distal margins, the following formula shows the proportional lengths of the joints:—

$$\frac{9 \ . \ 18 \ . \ 10 \ . \ 4 \ . \ 13 \ . \ 8 \ . \ 9}{1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7}$$

Antennæ slender, three-jointed, secondary branch small, two-jointed, the second joint very small. Mandibles elongate narrow, apex obliquely truncate and armed with a number of teeth, mandible palp with a distinct basal part, narrow at the base but somewhat dilated towards the apex to which is attached a one-jointed elongate narrow branch. Posterior foot-jaws moderately robust and armed with a strong terminal claw, lower margin of the second joint furnished with a row of fine cilia. First pair of swimming feet elongate and slender, basal joint of the inner branches nearly as long as the entire outer branch, second joint about one-fourth the length of the basal joint and fully half the length of the third joint. Outer branches of the second, third and fourth pairs elongate three-jointed, inner branches also three-jointed but shorter than the outer branches. Fifth pair of feet foliaceous, the inner branch produced into a subtriangular lobe which reaches to about the middle of the outer branch and furnished at the apex with a stout setiform spine and a small seta, outer branch oblong ovate in shape, the greatest breadth being very nearly half the length, furnished with three setæ on the outer margin, one on the apex and one on the inner distal margin, both the inner and outer margins are clothed with fine cilia. Caudal stylets long and narrow, being about five times longer than broad and nearly twice the length of the last abdominal segment.

Male. Antennules ten-jointed, fifth and sixth joints very small, hinged between the third and fourth joints and also between the seventh and eighth joints. The form of the fifth pair of feet is somewhat similar to those of the female, but the inner branch is much smaller.

Habitat, 1 mile off Spanish Head, Isle of Man, in neritic material dredged from a depth of 16 fathoms, a number specimens were obtained.

Remarks.—This species in general appearance is not unlike *Ameira longicaudata* but is readily distinguished from it by the shape of the cephalothoracic segment and on dissection by the characters described above. Nearly all the specimens obtained had the last three joints of the antennules broken off.

Ameira reflexa, T. Scott.

[T. Scott, Twelfth An. Rep. Fish. Board for Scot., pt. III., p. 240, 1894.]

One or two specimens of this *Ameira* were obtained from the shelly deposit dredged 1 mile off Spanish Head, Isle of Man, depth 16 fathoms. The species is easily distinguished from the other members of this genus by the structure of the inner branches of the first pair of swimming feet and also by the fifth pair of feet.

Canthocamptus palustris, Brady. Pl. II., figs. 12—23.

[Brady, Monograph Brit. Copep., Vol. II., p. 53, 1880.]

A considerable number of specimens of a copepod apparently belonging to this species were washed from mud adhering to samples of Mussels (*Mytilus edulis*) sent from the St. Annes Mussel beds near Lytham, one of the samples was from that part of the bed which never becomes dry at low-water, and was obtained by means of a "mussel rake," it was from this sample that the first specimens were obtained, other samples sent later on in the year also contained numbers of specimens.

The specimens differ a little from the figures given by Dr. Brady in his "monograph," especially in the length of the basal joint of the first pair of swimming feet and also in the shape of the fifth pair of feet of the female.

Mesochra macintoshi, T. and A. Scott.

[T. & A. Scott, An. & Mag. Nat. Hist., Ser. 6, Vol. XV., p. 53, 1895.]

A number of specimens of this species were obtained from the shelly material dredged 1 mile off Spanish Head, Isle of Man, from a depth of 16 fathoms. The slender appearance of the species along with the structure and armature of its various appendages, enable it to be readily distinguished from the other members of the genus.

Tetragoniceps trispinosus, n. sp. Pl. II., figs. 24 and 25; III., figs. 1—6.

Description of the Species.—Female. Length ·5 millim. ($\frac{1}{50}$th of an inch). Body elongate cylindrical, tapering gently towards the posterior end, rostrum small and triangular in shape. Antennules long and slender, six-jointed and sparingly setiferous, the basal joint is considerably longer than any of the others, fifth joint very small, about half the length of the fourth; the proportional lengths of the joints are as shown by the following formula:—

$$\frac{28 \;.\; 13 \;.\; 14 \;.\; 8 \;.\; 4 \;.\; 16}{1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6}$$

Antennæ of moderate length and three-jointed, secondary branch small and rudimentary, consisting of a single seta attached to the lower margin of the second joint of the primary branch at a distance of about one-third from the base. Posterior foot-jaws small, with a strong curved claw as long as the joint to which it is attached. Both branches of the first pair of swimming feet two-jointed, outer branches small, the joints subequal and reaching to about the middle of the basal joint of the inner branch; inner branches long and slender, basal joint nearly twice the length of the entire outer branch and fully seven times longer than broad, a moderately long seta springs from near the base of the inner margin. Second joint short and narrow, fully one-fourth the length of the basal joint, furnished at its apex with a short curved seta, a seta of considerable length springs from near the middle of the inner margin. Outer branches of the second, third and fourth pairs of feet elongate, three-jointed, inner branches short and narrow, one-jointed, in the fourth pair the inner branches are only about one-third the length of the basal joint of the outer branches and furnished at the apex with three short setæ. Fifth pair of feet small, one branched and divided into two distinct portions, an inner which is produced into an elongate curved spiniform apex devoid of setæ and an outer tubercle-like process which arises from near the base of the elongate portion furnished with two short stout setæ and one long slender hair. Caudal stylets elongate narrow, slightly divergent, tapering to an acute apex and about twice the length of the last abdominal segment; on the inner margin of each stylet at a distance of about one-third from the apex there arises a single seta which is fully two-thirds the length of the animal and having a slighly thickened base. Anal operculum semi-circular in shape and produced into three spines, a median and two lateral.

Habitat, 1 mile off Spanish Head, Isle of Man, in neritic material, dredged from a depth of 16 fathoms. Only two specimens were observed.

Remarks.—This species though placed in the genus

Tetragoniceps differs somewhat from the generic description given in the Monograph of the British Copepoda, especially in the number of joints in the outer branches of the first pair of feet and in the inner branches of the second, third and fourth feet, but as the mouth organs have not been satisfactorily worked out, it is perhaps better meanwhile to place it under the genus *Tetragoniceps* its nearest ally rather than institute a new genus for its reception.

Tetragoniceps consimilis, T. Scott.

[T. Scott, Twelfth An. Rep. Fish. Board for Scot., pt. III., p. 244, 1894.]

A few specimens of this species were obtained from the material dredged 1 mile off Spanish Head, Isle of Man, from a depth of 16 fathoms, it closely resembles *Tetragoniceps bradyi* in general appearance as well as in a few structural details, but differs from it in the absence of the strong hook on the second joint of the antennules, in the inner branches of the first pair of feet being three-jointed and in the fifth pair being composed of two distinct branches.

Laophonte propinqua, T. and A. Scott.

[T. & A. Scott, An. & Mag. Nat. Hist., Ser. 6, Vol. XV., p. 460, 1895.]

A few specimens of this species were obtained from material washed from sponges collected by Dr. Hanitsch at Port Erin, Isle of Man, in August, 1894; it is not unlike *Laophonte denticornis* at first sight but on closer examination is found to differ very markedly, not only from that species, but from any of the other known members of the genus.

Laophonte intermedia, T. Scott.

[T. Scott, Thirteenth An. Rep. Fish. Board for Scot., pt. III., p. 168, 1895.]

This species was obtained from the same material as the last, and also from the mussel beds at Duddon and Morecambe, it appears to be intermediate between *Laophonte lamellata* and *Laophonte hispida* but is quite distinct from either of them, the sub-conical form of the stylets alone enable it to be easily recognised when mixed up in a collection of Copepoda along with *L. lamellata* and *L. hispida.*

Pseudolaophonte, n. gen.

Description of the genus.—Pseudolaophonte resembles *Laophonte*, Philippi, in the structure of the antennules and antennæ; the mandibles, maxillæ and foot-jaws, and the first pair of swimming feet, but differs from that genus in the structure of the second and third pairs; the second pair of swimming feet consist of a single one-jointed branch, and the outer and inner branches of the third pair are each composed of two joints. The fourth and fifth pairs of feet are somewhat similar to those of *Laophonte.*

Pseudolaophonte aculeata, n. sp. Pl. III., figs. 7—23.

Description of the species.—Female. Length 1 millim. ($\frac{1}{25}$th of an inch). Body seen from above elongate narrow, of nearly equal breadth throughout, all the segments are more or less angular in shape and furnished with a row of short teeth on their posterior margins; surface of all the segments clothed with minute cilia; rostrum small and inconspicuous, with a small hair on each side of the base. Antennules moderately stout, four-jointed, first and third joints longer than the other two, the fourth joint being the smallest, the basal joint has a row of blunt pointed teeth on its upper margin and three rows on its lateral aspect, the middle row being the longest; a stout tubercle with a quadri-dentate apex arises from near the middle of the lower margin; second joint furnished on its lower margin with a strong slightly curved tooth which reaches to near the middle of the basal joint, and forms with the dentate tubercle of that joint, a powerful grasping apparatus; the third joint is covered with minute spines for about three-fourths of its length, the remaining fourth being covered with fine cilia, the fourth joint is also covered with cilia and has the lower distal part produced into a strong spine, the following formula shows the proportional lengths of the joints :—

$$\frac{17 \;.\; 11 \;.\; 16 \;.\; 6}{1 \quad 2 \quad 3 \quad 4}$$

Antennæ two-jointed and of moderate size, with a small one-jointed secondary branch arising from near the middle of the lower margin of the basal joint and furnished with four setæ. Mandibles small, with a few serrated teeth on the truncate apex, mandible palp very small, with ciliated margins and bearing three setæ on the apex. Maxillæ and foot-jaws somewhat similar to those of a typical *Laophonte*, the second joint of the posterior foot-jaw long and slender, being about four times longer than broad, the terminal claw is also long and slender and is considerably longer than the second-joint. First pair of swimming feet similar to those of a typical *Laophonte*, outer branch composed of two joints. Second pair of swimming feet rudimentary, consisting of a single one-jointed branch, bearing three setæ at the apex, the innermost being longer than the other two. Both branches of the third pair of feet two-jointed, the inner branch being slightly shorter than the outer. The fourth pair of feet has the outer branch three-jointed and the inner two, the basal joint of the outer branch is nearly as long as broad and is equal to the combined lengths of the second and third joints, the first and second joints have each one stout ciliated spine on the outer distal angle, the second joint which is very narrow, is produced on the inner margin into a hook-like process furnished with a short seta, the third joint has three strong spines on the outer margin and apex, inner branches short, reaching to about the middle of the outer branch, the second joint is furnished with three short setæ on its apex. Fifth pair of feet large and foliaceous, inner branch triangular in shape, ciliated on the inner margin and covered with a number of more or less curved rows of cilia, the branch is also furnished with five moderately stout plumose setæ on its inner margin and apex; outer branch broadly ovate, and fully half the size of the inner branch, it is also covered with rows of cilia and bears five short stout plumose setæ on its apex. Caudal stylets elongate narrow, of moderate length, about three times longer than broad and slightly longer than the last abdominal segment; bearing on the inner angles of the apex, a short stout curved spine and near the middle the dorsal surface, a slightly shorter spine and a seta, the outer margins are furnished with two short setæ, the apex also bears two setæ, one of which is very long. Anal operculum produced into a short stout spine.

Male. Antennules six-jointed, first and second joints like those of the female, third and sixth joints very small, fourth joint considerably dilated. Mouth organs similar to those of the female. The first and second feet are also similar to to those of the female. The basal joint of the outer branches of the third pair of feet has a strong curved spine on its outer distal angle which is nearly twice the length of the joint itself and extends considerably beyond the end of the second joint, second joint of the inner branches produced into a curved spine which reaches to beyond the end of the outer branch, both branches of the third pair two-jointed. The fourth pair of feet has the outer branch three-jointed and the inner two; the basal joint of the outer branches is longer than the combined lengths of the second and third joints and bears a strong spine on its outer distal angle, second and third joints of the outer branch of about equal length; inner branches very short reaching to about the middle of the basal joint of the outer branch, basal joint of the inner branch very small and only about one-fourth the length of the second joint. Fifth pair small, inner branch not produced, furnished with two plumose setæ on its apex, the inner one being three times longer than the outer; outer branch elongate narrow, bearing at its apex three stout setæ.

Habitat, 1 mile off Spanish Head, Isle of Man, in neritic material dredged from a depth of 16 fathoms; a number of specimens were obtained.

Remarks.—This species comes very near *Laophonte spinosa*, I. C. Thompson, especially in the structure of the antennules and mouth organs, but differs considerably in the structure of the second, third and fourth pairs of swimming feet; the outer branches of the second, third and fourth feet in *Laophonte spinosa* are two jointed and the inner three, whilst in *Pseudolaophonte aculeata* the second pair of feet consists of a single one-jointed branch, in the third pair each branch is composed of two joints and in the fourth pair the outer branch consists of three joints and the inner of two, the fifth feet also differ somewhat. The appendages of the male differ also from those of the male *Laophonte spinosa.*

Laophontodes bicornis, n. sp. Pl. III., figs. 24—25; IV., figs. 1—7.

Description of the species.—Female. Length ·5 millim. ($\frac{1}{25}$th of an inch). Body seen from above elongate narrow, the breadth gradually decreasing towards the posterior end; all the segments are more or less angular in shape and with the exception of the cephalic segment, bear each a row of short teeth on the distal margin. Cephalothoracic segment broadly triangular in outline, the frontal portion being produced into a small rostrum, and the lateral margins near the distal end into strong curved spines directed backwards and extending slightly beyond the middle of the second segment. Antennules short, five-jointed, all the joints are of moderate length except the fourth which is very short; the proportional lengths of the joints are as shown in the following formula:—

$$\begin{array}{ccccccccc} 13 & . & 17 & . & 22 & . & 3 & . & 13 \\ \hline 1 & & 2 & & 3 & & 4 & & 5 \end{array}$$

Antennæ small, two-jointed without any secondary appendage. Mandibles and other mouth organs nearly as in *Laophonte*. The first pair of swimming feet are similar to those of *Laophontodes typicus*, and the second, third and fourth pairs are also similar to the corresponding feet of that species. The fifth pair are large and prominent and project outwards from the sides of the fifth segment; each foot consists of a single narrow elongate branch, composed of two-joints, furnished with one seta on the inner distal angle of the first joint and two on the outer angle, the second joint has two setæ on the inner margin, two on the apex and one on the outer margin, the basal joint has also a row of cilia on its inner margin. Caudal stylets long and narrow, about equal to the combined lengths of the last two abdominal segments.

Habitat, Off Port Erin, from dredged material collected June, 1895; only one specimen has been observed.

Remarks.—This species is easily distinguished from *Laophontodes typicus* the only other member of the genus, by the lateral projections of the cephalothoracic segment, the proportional lengths of the joints of the antennules and the length of the caudal stylets; the fifth feet also differ, in this species they are two-jointed whilst in *Laophontodes typicus* they are composed of a single joint only.

Normanella attenuata, n. sp. Pl. IV., figs. 8—20.

Description of the species.—Female. Length 1 millim. ($\frac{1}{25}$th of an inch). Body elongate cyclindrical, slender. Antennules nine-jointed; the second much longer than the others, seventh and eighth joints very small, the others are of moderate length as shown by the formula:—

9 .	15 .	10 .	7 .	4 .	5 .	1 .	1 .	5
1	2	3	4	5	6	7	8	9

Antennæ three-jointed, stout and of moderate length, a small one-jointed secondary branch arises from the lower distal end of the basal joint of the primary branch and is furnished with two setæ; the lower one of which appears to be articulated to the apex of the joint. Mandibles slender with a serrated apex, basal portion of the mandible palp considerably dilated and bearing two one-jointed branches, the outer branch being much longer than the inner. Maxillæ and foot-jaws nearly as in *Normanella dubia.* Inner branches of the first pair of swimming feet long and slender, two-jointed, basal joint longer than the entire outer branch, second joint about one-third the length of the basal joint, bearing one curved spine and two setæ on the apex, outer branches three-jointed, shorter than the basal joint of inner branches. In the second and third pairs of feet, the inner branches are short, and two-jointed; the outer branches are considerably longer than the inner and three-jointed. Inner branches of the fourth pair of feet three-jointed and very short, only reaching to about the middle of the second joint of the outer branches. Fifth pair of feet foliaceous, two branched, inner branch large and subtriangular bearing two setæ on the inner distal margin and two on the apex, outer branch pyriform, arising from the middle of the outer margin and extending considerably beyond the apex of the inner branch, bearing four setæ on its outer distal margin and two on the apex. Caudal stylets of moderate length, about twice as long as broad and fully half the length of the last abdominal segment.

Male. Antennules nine-jointed, sixth joint very short, the others of moderate length, hinged between the fourth and fifth joints and also between the seventh and eighth, all the other appendages with the exception of the fifth pair of feet are similar to the corresponding appendages of the female. The inner branch of the fifth pair sub-triangular in form bearing one stout plumose spine and two plumose setæ on its apex, the outer branch pyriform, bearing three setæ on its outer distal margin, and two on the apex, with a strong plumose spine between the two apical setæ.

Habitat, 1 mile off Spanish Head, Isle of Man, in neritic material dredged from a depth of 16 fathoms; very few specimens were obtained.

Remarks.—This species differs considerably in shape from *Normanella dubia* but the structural details are almost similar to those on which the genus was founded, the only differences being that the antennules have nine joints instead of seven, and the inner branches of the fourth pair of feet have three joints instead of two. These differences are not considered to be of sufficient importance to warrant the establishment of a new genus for its reception.

Cletodes similis, T. Scott.

[T. Scott, Thirteenth An. Rep. Fish. Board for Scot. Pt. III., p. 168, 1895.]

A few specimens were obtained from material washed from sponges collected by Dr. Hanitsch at Port Erin, Isle of Man, in August, 1894. This species is very like *Cletodes lata* in general appearance but is easily distinguished from it on dissection by the structure of the antennules, the proportional lengths and armature of the outer and inner branches of the first pair of swimming feet, and also by the form of the fifth pair of feet.

Nannopus palustris, Brady.

Several specimens of this species were obtained in the mud collected from the Mussel beds near Duddon and from mud sent to the laboratory from the Fleetwood Oyster beds. It seems to be a brackish water species and in general appearance is very like *Platychelipus littoralis* another brackish water copepod, it can be distinguished from that species however, even without dissecting, by making an examination of the fifth pair of feet and also of the inner branches of the third and fourth pairs of feet. *Nannopus palustris* has two ovisacs and *Platychelipus littoralis* one only.

Idya elongata, n. sp. Pl. IV., figs. 21—24; Pl. V., figs. 1—5.

Description of the species.—Female. Length ·74 millim. ($\frac{1}{35}$th of an inch). Body seen from above elongate narrow, tapering rapidly towards the posterior end, the length being nearly equal to four times the greatest breadth; rostrum prominent with a bluntly rounded apex. Antennules short and comparatively stout; shorter than the cephalothoracic segment, eight-jointed; second and third joints longer than any of the others, as shown in the following formula:—

$$\frac{11 \,.\, 16 \,.\, 17 \,.\, 13 \,.\, 6 \,.\, 8 \,.\, 5 \,.\, 12}{1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8}$$

Antennæ, mandibles and maxillæ nearly as in *Idya gracilis*, T. Scott. Foot-jaws also similar to those of that species but shorter and stouter. Inner branches of the first pair of swimming feet slender and of moderate length, basal joint nearly as long as the entire outer branch, and furnished with a plumose seta arising from the lower half of the inner margin and extending to slightly beyond the end of the branch, second joint fully two-thirds the length of the basal joint also furnished with a plumose seta arising from near the middle of its inner margin, third joint very small, bearing on its apex two stout spines and one short plumose seta; outer margins and proximal halves of the inner margins of the first and second joints fringed with short hairs, the joints of the outer branches are short and broad, the second joint is slightly shorter than the first and the third joint a little shorter than the second, the armature of the joints is somewhat similar to that of the first pair in *Idya furcata*; the spines are furnished with a row of moderately long cilia on the upper margins. Second, third and fourth pairs of swimming feet similar to those of *Idya furcata.* Fifth pair of feet very short being little more than half the length of the joint to which they are attached and extending only a little way beyond the base of the first segment of the abdomen, the length of each foot is about equal to twice the breadth, the secondary joint is furnished with three setæ on the apex, the innermost one being longer than either of the other two, outer very short; a short seta is attached to the outer margin a little way from the apex. Caudal stylets narrow and slightly divergent, length equal to about twice the breadth and nearly as long as the last segment of the abdomen.

Male. Antennules nine-jointed, hinged between the third and fourth joints and also between the seventh and eighth joints, fourth joint very small; the other appendages are similar to those of the female, fifth feet also similar to the fifth feet of the female but smaller.

Habitat, obtained from the mud collected on the Mussel beds between Morecambe and Heysham; only a few specimens were obtained.

Remarks.—This species is very distinct from *Idya furcata* and also from two other species recently described—*Idya longicornis,* T. and A. Scott, and *Idya gracilis,* T. Scott—and can easily be recognised from either of them by the elongate form of the animal, the short antennules and the small fifth feet.

Idya gracilis, T. Scott.

[T. Scott, Thirteenth An. Rep. Fish. Board for Scot., pt. III., p. 171, 1895.]

A number of specimens of this species were obtained from the shelly material dredged 1 mile off Spanish Head, Isle of Man, from a depth of 16 fathoms; it is easily recognised by the long and slender inner branches of the first pair of swimming feet and also by the shape and arrangement of the setæ on the fifth pair of feet.

Family Sapphirinidæ, Thorell.

Modiolicola insignis, Aurivillius.

Living as a messmate within the mantle of the "horse mussel," *Mytilus modiolus.* A number of specimens were found in the examples of this Mollusc which were brought up in the trawl-net of the steamer, while working in the vicinity of the north end of "the Hole" on March 23rd, 1895. This appears to be a widely distributed species of Copepod, its range being probably co-extensive with that of the Mollusc. It has been recorded from the Firth of Forth, the Moray Firth, and from the vicinity of Mull. It has also been obtained in specimens of the same species of Mollusc dredged by Dr. Norman in 1893, off Trondhjem in Norway.

Family Ascomyzontidæ, Thorell (1859).

Dermatomyzon gibberum, T. and A. Scott.

[T. & A. Scott, An. & Mag. Nat. Hist., Ser. 6, Vol. XIII., p. 144, 1894.]

A considerable number of specimens of this species were obtained by washing the common starfish (*Asterias rubens*) in weak methylated spirit and afterwards examining the sediment. It was taken from starfish collected at Hilbre Island and afterwards from the same species of starfish taken in other parts of the district; both males and females were found, many of the latter with ovisacs attached.

Collocheres elegans, n. sp. Pl. V., figs. 6—15.

Description of the species.—Female. Length 1 millim. ($\frac{1}{25}$th of an inch). Body elongate, subpyriform, anterior segment large and somewhat triangular in outline and equal to twice the combined lengths of the second, third and fourth segments, rostrum small and inconspicuous. Antennules moderately long, slender and sparingly setiferous, twenty-jointed; the first, eighteenth and twentieth joints of about equal length and longer than any of the others, the second and tenth joints slightly smaller than the others; a sensory filament springs from the end of the third last joint. The following formula shows the proportional lengths of the joints:—

9	2	3	3	3	3	3	4	4	2	3	6	5	6	6	6	6	9	3	8
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Antennæ three-jointed, basal joint long and narrow, bearing near the middle of the lower margin a small secondary branch, which consists of a single joint, nearly oval in outline and furnished with three small setæ on the apex and one near the middle of the upper margin, second joint of the antennæ about half the length of the first, third joint about two-thirds the length of the second and bearing at the apex a long slender spine having a slightly thickened base, and a small hair; a short seta also springs from near the base of the upper margin. Mandibles elongate narrow, denticulated on the oblique apex, palp rudimentary and consisting of a single moderately long hair. Maxillæ two-lobed, both lobes of about equal length, but one is slightly narrower than the other and is furnished with one seta at the apex, the broad lobe has four setæ on its apex. Foot-jaws somewhat similar to those of *Collocheres gracilicauda* (Brady). First four pairs of swimming feet also similar to those of that species; the outer branches of all the four pairs are armed with short dagger shaped spines and the terminal joint of the inner branch of the fourth pair is furnished with one stout dagger shaped spine on the apex and a smaller one near the middle of the outer margin. Fifth pair of feet somewhat rudimentary, two-jointed, basal joint broadly triangular in shape, the second joint which is attached to near the middle of the outer margin of the basal joint is elongate, curved, and bluntly serrated at its apex, the length being about equal to three and one-half times the breadth; it is furnished with three setæ, one on the apex and two a little lower down on the outer margin and slightly separated from each other. Abdomen slender, four-jointed, genital segment elongate narrow, length nearly equal to twice the breadth, and longer than the combined lengths of the next three segments, second joint about one-third the length of the first, third joint slightly smaller than the second, fourth joint smaller than the third. Caudal stylets about four times as long as broad and nearly equal to the length of the last two segments of the abdomen.

Habitat, off Port Erin, from dredged material collected June, 1895, only one specimen has been observed.

Remarks.—This species is not unlike *Collocheres gracili-*

cauda and may perhaps have been passed over for that species, but it can be readily distinguished from it by the much shorter caudal stylets and also by the shape of the fifth pair of feet.

Ascomyzon thompsoni, n. sp. Pl. V., figs. 16—26.

Description of the species.—Female. Length 1 millim. ($\frac{1}{25}$th of an inch). Body broad, suborbicular in shape, cephalothorax broadly ovate, last segment of thorax and abdomen much narrower, rostrum not prominent. Antennules slender, twenty-one-jointed, the first being the largest and ciliated on its upper margin; second to eighth joints small and of about equal length, ninth joint smaller than any of the others, eighteenth joint furnished with a short sensory filament. The proportional lengths of the joints are shown in the following formula:—

48	7	7	5	6	6	6	7	8	4	7	8	11	8	12	11	14	15	7	8	7
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Antennæ four-jointed, first joint long and bearing near the distal end of the lower margin, a small one-jointed secondary branch, which bears at the apex a moderately long seta, a small hair also springs from near the middle of the upper margin; second joint of the antennæ shorter and narrower than the first and having its lower margin ciliated, third joint very small, fourth joint about as long as broad and bearing at its apex one strong curved spine and two setæ. Mandibles slender, and stylet shaped; palp elongate narrow, two-jointed, second joint about one-third the length of the first and bearing at its apex, one long and one short plumose seta. The maxillæ consist of a short basal joint bearing two lobes of about equal length, but one is considerably narrower than the other, each lobe is furnished with four plumose setæ; one of the setæ on the broad lobe is much stouter and longer than the others, two of the other setæ on the same lobe are also comparatively stout but are only about half the length of the long seta. Anterior foot-jaws simple, bearing a strong curved apical claw. Posterior foot-jaws elongate slender, four-jointed, resembling those of *Dermatomyzon nigripes* (B. and R.). Both branches of the first four pairs of swimming feet short and stout, three-jointed and nearly equal in length. Fifth pair of feet rudimentary, two-jointed, inner joint short and broad, furnished with one plumose seta on its upper distal angle, outer joint elongate, length about equal to twice the breadth and bearing at its apex two moderately long plumose setæ and one small spine, both margins of the joint ciliated. Abdomen three-jointed, genital segment about as long as broad and nearly equal to the combined lengths of the next two segments and caudal stylets, second joint about half the length of the first, third joint about two-thirds the length of the second. Caudal stylets slightly longer than the last abdominal segment, length about equal to twice the breadth.

Habitat, 1 mile off Spanish Head, Isle of Man, in neritic material dredged from a depth of 16 fathoms; a few specimens only were obtained. A number of specimens have since been found in material washed from Ophiuroids (*Ophioglypha* and *Ophiothrix*) taken in the trawl-net off Blackpool, and sent to us by Mr. Ascroft.

Remarks.—This species is readily distinguished from the other members of the *Ascomyzontidæ* by the almost oval outline of the cephalothorax and on dissection by the structure of the mandible palp and maxillæ, the stout setæ on the larger lobe of the maxillæ appears to be a well marked character. Dr. W. Giesbrecht of the Zoological Station Naples, is preparing a monograph on this interesting family and an abstract which appeared in the Ann. and Mag. of Natural History for August, 1895, shows a number of changes in the nomenclature and classification of the genera and species.

SECTION V.

Investigations on Oysters and Disease.

(By Professor Herdman.)

From the earliest times more or less well grounded suspicion has been cast from time to time upon shellfish—chiefly oysters and mussels—as being the cause of outbreaks of disease amongst consumers. These outbreaks fall into two categories:—1st Cases of sudden poisoning due to the presence of putrefactive products, and 2nd Diseases due to a specific micro-organism, where there is a period of incubation and where therefore a considerable interval has elapsed between the infection and the actual illness. In the latter case it is obviously much more difficult to determine with certainty the source from which the disease germ has entered the body; and although many positive assertions have appeared of late years attributing outbreaks of enteric or typhoid fever to the consumption of oysters, still it must be pointed out that the connection between the two has not yet been scientifically proved, and is only at present more or less of a possibility or, at most, probability.

Under these circumstances I suggested to my colleague Professor R. Boyce that the subject was one well worthy of our attention, and during the past year we have been making a number of observations and experiments, both in our Liverpool laboratories and at Port Erin, upon the conditions under which oysters live healthily, and upon the possibility, or even in some cases the probability, of their being the carriers of disease germs. We gave a preliminary account of our work at the meeting of the British Association in Ipswich last September, and we shall prepare a detailed Report upon the matter to be laid before the next meeting of the British Association in Liverpool in September, 1896, but in the meantime so much public interest and apprehension has been raised by several recent outbreaks of typhoid popularly attributed to oysters, and the matter is so closely connected with the shellfish industries of this district, that I consider it advisable to give a summary here of the results of our work up to the present time.

A. The objects we had in view in entering on the investigation were as follows:—

1. To determine the conditions of life and health and growth of the oyster by keeping samples in sea waters of different composition—*e.g.*, it is a matter of discussion amongst practical ostreiculturists as to what specific gravity or salinity of water, and what amount of lime are best for the due proportionate growth of both shell and body.

2. To determine the effect of feeding oysters on various substances—both natural food, such as Diatoms, and artificial food, such as oatmeal. Here, again, there is a want of agreement at present as to the benefit or otherwise of feeding oysters in captivity.

3. To determine the effect of adding various impurities to the water in which the oysters are grown, and especially the effect of sewage in various quantities. It is known that oysters are sometimes grown or laid down for fattening purposes in water which is more or less contaminated by sewage, but it is still an open question as to the resulting effect upon the oyster.

4. To determine whether oysters not infected with a pathogenic organism, but grown under insanitary conditions, have a deleterious effect when used as food by animals.

5. To determine the effect upon the oyster of infection with typhoid, both naturally—*i.e.*, by feeding with sewage water containing typhoid infection, and artificially—*i.e.*, by feeding on a culture in broth of the typhoid organism.

6. To determine the fate of the typhoid bacillus in the oyster—whether it is confined to the alimentary canal, and whether it increases in any special part or gives rise to any diseased conditions; how long it remains in the alimentary canal; whether it remains and grows in the pallial cavity, on the surface of the mantle and branchial folds; and whether it produces any altered condition of these parts that can be recognised by the eye on opening the oyster.

7. To determine whether an oyster can free its alimentary canal and pallial cavity from the typhoid organism when placed in a stream of clean sea water; and, if so, how long would be required, under average conditions, to render infected oysters practically harmless.

B. The methods which we employed in attaining these objects were as follows:—

I. Observations upon oysters laid down in the sea, at Port Erin—

(*a*) Sunk in 5 fathoms in the bay, in pure water.

(*b*) Deposited in shore pool, but in clean water.

(*c*) Laid down in three different spots in more or less close proximity to the main drain pipe, opening into the sea below low-water mark.

These observations were to ascertain differences of fattening, condition, mortality, and the acquisition of deleterious properties as the result of sewage contamination.

II. Observations upon oysters subjected to various abnormal conditions in the laboratory.*

(*a*) A series of oysters placed in sea water and allowed to stagnate, in order to determine the effect of non-aëration.

(*b*) Similar series in water kept periodically aërated.

(*c*) A series placed in sea water to which a quantity of fresh (tap) water was added daily, to determine effect of reduction of salinity.

(*d*) A series of oysters weighed approximately, and fed upon the following substances, viz.:—(1) Oatmeal, (2) Flour, (3) Sugar, (4) Broth, (5) Living Protophyta (Diatoms, Desmids, Algæ), (6) Living Protozoa (Infusoria, etc.), (7) Earth.

In this series of experiments the oysters were fed every morning and the water aërated, but not changed (evaporation was compensated for by the addition of a little tap water as required). The oysters were weighed from time to time, and observations made upon the apparently harmful or beneficial effects of the above methods of treatment.

(*e*) A series of oysters placed in sea water to which was added daily—

(1) Healthy fæcal matter.

(2) Typhoid fæcal matter.

(3) Pure cultivations of the typhoid bacillus.

The oysters were carefully examined to determine their condition, with special reference to condition of branchia, alimentary canal, adductor muscle, and viscera generally. The contents of the rectum, as well as the water in the pallial cavity, were subjected to bacteriological analysis

* The oysters were kept in basins in cool rooms of constant temperature, shaded from the sun, both at the Port Erin Biological Station and also in the Pathological and Zoological Laboratories at University College, Liverpool.

to determine the number of micro-organisms present, as well as the identity of the typhoid or other pathogenic organisms.

C. The following is a summary of the results obtained so far:—

We consider that these results are based upon tentative experiments, and serve only to indicate further and more definite lines of research. They must not be regarded as conclusive. We feel strongly that all the experiments must be repeated and extended in several directions.

Our experiments demonstrate:—

I. The beneficial effects of aëration—

(*a*) By the addition of air only;

(*b*) By change of water;

pointing to the conclusion that the laying down of oysters in localities where there is a good change of water, by tidal current or otherwise, should be beneficial.

II. The diverse results obtained by feeding upon various substances, amongst which the following may be noted. The exceedingly harmful action of sugar, which caused the oysters to decrease in weight and die; whilst the other substances detailed above enabled them to maintain their weight or increase. The oysters thrive best upon the living Protophyta and Protozoa. Those fed upon oatmeal and flour after a time sickened and eventually died.

III. The deleterious effects of stagnation, owing to the collection of excretory products, growth of micro-organisms, and formation of scums upon the surface of the water.

IV. The toleration of sewage, etc. It was found that oysters could, up to a certain point, render sewage-contaminated water clear, and that they could live for a prolonged period in water rendered completely opaque by the addition of fæcal matter; that the fæcal matter obtained from cases of typhoid was more inimical than that obtained from healthy subjects; and that there was considerable toleration to peptonised broth.

V. The infection of the oyster by the micro-organisms. The results of the bacteriological examination of the pallial cavity of the oyster, and of the contents of the rectum, showed that in the cases of those laid down in the open water of the bay the colonies present were especially small in number, whilst in those laid down in proximity to the drain pipe the number was enormous (*e.g.*, 17,000 as against 10 in the former case). It was found that more organisms were present in the pallial cavity than in the rectum. In the case of the oysters grown in water infected with the *Bacillus typhosus*, it was found that there was no apparent increase of the organisms, but that they could still be identified in cultures taken from the water of the pallial cavity and rectum fourteen days after infection.

It is found that the typhoid bacillus will not flourish in clean sea water, and our experiments seem to show so far that it decreases in numbers in its passage along the alimentary canal of the oyster. It would seem possible, therefore, that by methods similar to those employed in the "Bassins de dégorgement" of the French ostreiculturist, where the oysters are carefully subjected to a natural process of cleaning, oysters previously contaminated with sewage could be freed of pathogenic organisms or their products without spoiling the oyster for the market.

It need scarcely be pointed out that if it becomes possible thus to cleanse infected or suspected oysters by a simple mode of treatment which will render them innocuous, a great boon will have been conferred upon both the oyster trade and the oyster-consuming public.

The discovery of a green tinge of more or less intensity which made its appearance on the mantle and other parts of the body of some of the oysters in our experiments started us on a series of investigations into the minute structure of the green parts, and the nature and causes of the greenness in general in oysters. We soon found that the greenness of our experimental oysters,* which is very different in appearance from the greenness of the cultivated French oyster—the "huitre de Marennes"—was present also in some American oysters freshly imported, and was liable to make its appearance in oysters laid down in certain parts of our own coast. We found that this pale green inflammation, as it may be called, was known to the local oyster importers and oyster merchants, by whom the suggestion was made that the colour was due to copper poisoning in the oyster.

This led us to a chemical examination of the matter which showed (as had been shown in the case of other green oysters before) that copper had nothing to do with the disease. There was very little copper present in the green parts—practically no more than in the corresponding parts of colourless (yellow) oysters. Moreover we have kept oysters in old copper vessels and in vessels of sea water containing different amounts of sulphate of copper in solution (0·02 and 0·2 % of the copper, in 10 litres of water), and other salts, and in none of these cases did the animal acquire any green colour except what was deposited on the surface of the shell and other exposed parts until the death of the tissues when a certain amount of post-mortem green staining made its appearance.

Dr. Charles Kohn has kindly analysed the gills of some green (French) and some ordinary colourless oysters, and

* Our thanks are due to Charles Petrie, Esq,, C.C., and to George T. G. Musson, Esq., for the kind help they have given us in procuring various kinds of oysters for investigation and experiment.

finds that in both of them there are traces of copper, and of iron, but that the amount of both metals is actually greater in the colourless than in the green gills.

Cases of sudden poisoning following upon the consumption of oysters have frequently been ascribed to the oysters having a green colour which was supposed, with little or no reason, to be due to impregnation with a copper salt. The river Roach, in Essex, has long been known to produce in winter green oysters which, on account of their colour, are not sold in England but are sent to the French and other continental markets. It has been shown several times that copper has nothing to do with the greening of these oysters. However, that conclusion is constantly doubted, and such cases as the following are quoted:—In 1713 a certain Ambassador gave a great supper at the Hague, and, we are told, as a luxury procured green oysters from England. The guests who eat them are said to have been seized with severe colics and to have been cured with great difficulty. It is also said, however, that the merchant had palmed upon the Ambassador some common oysters tinted with copper instead of the true greens. Another historic case is that of the trial which took place at Rochefort in 1862 of a merchant who had sold green oysters imported from England and which were said to contain copper.

Other cases are on record of green oysters which are supposed to have taken up copper from old mines under the sea, as at Falmouth, or from the copper bottoms of ships, and so have become poisonous. Mr. G. C. Bourne of Oxford who has investigated the Falmouth oysters tells me that their greenness is in his opinion due to a green Desmid upon which the oysters feed in quantity. It is said that these oysters lose their colour on being transplanted to the mouth of the Thames.

It has been conclusively shown by various investigators, since Dumas in 1841 and Berthelot in 1855, that the green colour is not due to Chlorophyll and that although every oyster contains a very small amount of copper in its blood there is no reason to believe this becomes increased to a poisonous extent in any oyster, and that the green colour of the French cultivated oysters ("huitres de Marennes") is not due to copper.

Gaillon in 1820 came to the conclusion that the green colour is due to the microscopic food which the oyster gets from the water of the "claire" or oyster park. He called the organism in question *Vibrio ostrearius*; it is now known to be a Diatom—*Navicula fusiformis*, var. *ostrearia*, Grunow. Since then other French investigators, and notably Valenciennes in 1841, have corroborated Gaillon's conclusion and have shown that in addition to the branchiæ, the inner surfaces of the labial palps, the alimentary canal beyond the stomach, and to some extent the liver, become coloured green.

It has been proved experimentally by Puységur,* Bornet, Decaisne and others that white oysters can be greened rapidly—in 26 hours—by keeping them in clean soup plates and feeding them with water containing the *Navicula*. These interesting experiments were carried out at Le Croisic in Brittany, and were afterwards repeated in Paris; and the result seems entirely opposed to the old suggestion that iron salts in the soil at the bottom of the "claire" are the cause of the greening, which was alluded to twenty years ago by Bouchon-Brandely and has quite recently been revived by Carazzi at Spezia.

Ryder,† in America, was also in 1880 investigating the greening of oysters, with much the same results as those of Puységur. He went a step further, however, and

* Revue Maritime et Coloniale, 1880.

† U. S. Fish Comm. Report for 1882 (published 1884).

showed that the colouring matter was taken up by the amœboid blood cells, and that these wandering cells containing the pigment were to be found in the heart, in some of the blood-vessels and in aggregations in "cysts" under the surface epithelium of the body. He describes the colour (in the ventricle) as a "delicate pea-green," and states that it is not chlorophyll nor diatomine: he suggests that it may be phycocyanine or some allied substance.

In 1886, Ray Lankester* gave a useful summary of some of the earlier papers, and discussed the main questions concerned. Moreover he investigated the gills of the green oyster histologically, and described cells laden with green granules which occur in the epithelium of the gills and labial palps. He showed that such cells are also present in the common oyster, where, however, they are not green, and that these cells may be found also wandering over the surface of the gills. He considered them as "secretion" cells, but they are clearly the same structures which Ryder a few years before had found in the blood. Lankester found the Navicula in the intestine of the green oyster, and re-asserted that there was no copper and no iron in the refractory blue pigment—which he described under the name "marennin."

Quite recently, Chatin, de Bruyne, and others have re-investigated the structure of the oyster's gill and the process of greening in more detail, with the general result that the large cells (macroblasts) containing the green granules are now regarded as "phagocytes" conveying some substance to the surface of the body. One author, however, Carazzi, considers that the macroblasts are surface cells, which are taking up substances from without for purposes of nutrition, and he attributes the green

* Quart. Journ. Micr. Sci., Vol. XXVI., p. 71.

colour to sesquioxide of iron in the mud of the "claire." This revival of an old view I have alluded to above.

At present then there are several distinct views as to the exact cause and the meaning of the greenness of the French cultivated oyster which is fattened, flavoured and greened in the oyster parks or "claires" of La Tremblade, Marennes, Sable d'Olonne, Le Croisic and other places on the west coast of France. One view is that it is due to the microscopic food of the oyster, another that it is caused by the nature of the bottom of the "claire." One view is that it is a process of excretion or the removal of certain coloured matters from the body, another that it is a process of absorption of nutriment. The whole subject is at present under investigation both by ourselves and by others, and we hope to report upon our conclusions more fully in a few months. It cannot, however, be questioned that the normal green oyster of the French markets is in a thoroughly healthy condition and that its green colour is not due to copper nor to any other poisonous substance.

There are, however, other green oysters—or rather there is a greenness which may appear in any oyster under certain conditions—which have nothing to do with cultivation in "claires" and where the colour is not due to feeding upon diatoms. This is the pale greenness mentioned above which we have met with in some American oysters. We find that it is an inflammatory condition or "leucocytosis" in which enormous numbers of wandering leucocytes filled with large green granules come out on the surface of the body and especially on the mantle. For further details of this green condition of the oyster, with figures, I must refer to our full report to the British Association to be published later. We have tried growing oysters under various unusual conditions, including the addition to the sea water of fluid from alkali works, such as may enter our estuaries, in the hope of getting some clue to the cause of the green inflammation, but have so far failed to reproduce exactly in the laboratory the changes which seem to take place when the oyster is left in its natural (?) surroundings.

Our present opinion, however, is that oysters exhibiting this pale green leucocytosis are in an unhealthy state, and we may add that we find the liver in these specimens is histologically in an abnormal, shrunken and degenerate condition. Whether actually "unfit for food" or not, they are at any rate in very "poor" condition, and have lost the aroma and flavour of the normal healthy oyster.

It is clear that, so far as our present knowledge goes, oysters only share along with many other food matters—such as tinned foods, meat pies, fish under certain conditions, and diseased or infected meat—the responsibility of occasionally being capable of conveying poison, parasites, or disease germs into the human body; and that is, taken by itself, no sufficient reason why an important and highly esteemed food matter should be avoided. What is evidently necessary is that the precise conditions under which the oyster may become dangerous as human food should be investigated, and that when these are determined precautions should be taken to insure that the unhealthly conditions can never arise in our oyster beds.

It is all important that perfectly healthy grounds should be chosen for fattening the oysters upon. The water in which they are kept should be above suspicion. Oysters have to be fattened in water that is to some extent estuarine, and unfortunately estuaries are the places where a certain amount of sewage must find its way into the sea. When sewage is present in water the number of micro-organisms, pathogenic and otherwise, becomes very largely increased. The water of the Seine above Paris contains 300 organisms to the cubic centimetre, while below Paris the number has increased to 200,000 per cubic centimetre. We have also shown from our experiments at Port Erin that in oysters purposely placed near the outlet of the drain the number of organisms increased enormously. All estuaries, however, are not polluted, and the deleterious effects of sewage do not extend far, consequently there should be no great difficulty in finding perfectly suitable localities for oyster culture if a careful study is made of the matter. Tides and other currents, depth, specific gravity and temperature of the water all affect the distribution of the sewage in an estuary, and their influence should be carefully enquired into in connection with the site of any proposed shellfish cultivation.

Some of our experiments have shown that the oyster can purify polluted water in a most remarkable degree, but that property may have a bad as well as a good result. The good side of the matter is that the oyster in obtaining its nutriment from the water is able to convert useless and deleterious products of decomposition into excellent human food. The bad side of the matter is that if there happen to be any disease germs in the water the oyster may possibly strain out and store them up in its own body. And it even seems probable that other microbes associated with disease germs may play some part in causing or modifying disease.

It is re-assuring, however, to find as we do from our own investigations as well as from the consideration of the work of others that the typhoid organism (*Bacillus typhosus*) dies off very rapidly in ordinary sea water as one passes either in distance or time from the source of supply.

Professor Boyce has supplied me with the following facts in regard to the presence and behaviour of the typhoid Bacillus in sea water.

We showed at the British Association Meeting in 1895 that, as was to be expected, the number of micro-organisms in oysters grown in the vicinity of sewage was enormously increased. The organisms present were non-pathogenic for man, and it became necessary therefore for us to investigate the growth of the typhoid bacillus in sea water. The first point of importance is the relative proportion of typhoid sewage to ordinary sewage. The proportion of typhoid fæcal matter which may find its way into the sewers has been investigated by Laws and Andrewes, and in one instance in London they gave the proportion as $\frac{1}{250,000}$, pointing out, however, that in the case of the fever hospitals every endeavour was made to disinfect the typhoid materials. The same authors were only able to demonstrate the presence of the *Bacillus typhosus* in the drains in the immediate vicinity of the Typhoid Hospital. Further, from their experiments there seems every reason to suppose that sewage is an unfavourable medium for the propagation of the typhoid Bacillus, and that although when *incubated* and grown in *sterile* sewage the organism may show a slight multiplication in the first 24 hours, it soon tends to become extinct.

Since 1886 a very large number of investigators have shown that drinking and river water may become infected with typhoid sewage, and here again numbers of experiments have been made to ascertain whether the *Bacillus typhosus* propagates in fresh water. Kraus showed that a very rapid decline of the Bacillus and a very rapid increase of the ordinary water bacteria took place when the water was incubated. The most recent observations are those by Frankland and Ward, and they showed that the Bacillus disappeared at the end of 34 days in unsterilised Thames water and that there was no multiplication in potable water. Observations thus tend to show that neither sewage nor fresh water are favourable media and that the former is the least favourable.

A further very important point is the action of salt water upon the typhoid bacillus. In 1889 Giaxa made observations upon the vitality of the *B. typhosus* in sterilised and unsterilised sea water and showed that it was present in the latter up to the 9th day, and in the former to the 25th. Frankland and Ward showed that a 3 % salt solution most prejudicially influences the growth of the Bacillus, the latter disappearing by the 18th day.

Our own experiments have been made so far with sterilised sea water incubated at 35°C., and in one case at 8°—10°C. A culture of the *B. typhosus* on agar was emulsified with sterilised water and a definite quantity of this in each instance was added to the sterilised sea water.

Experiment I.	No. of bacilli at time of mixing	29,250.
	After 21 hours	20,475.
	,, 45 ,,	9,945.
	,, 71 ,,	9,360.
	,, 95 ,,	5,850.
	,, 271 ,,	260.
	,, 340 ,,	11.
Experiment II.	At time of mixing	1,300.
	After 21 hours	1,105.
	,, 45 ,,	780.
	,, 71 ,,	650.
	,, 95 ,,	325.
	,, 271 ,,	2.
	,, 340 ,,	0.
Experiment III.	At time of mixing	22,750.
	After 5 hours	17,550.

	After 23 hours	11,700.
	„ 48 „	3,250.
	„ 72 „	3,250.
	„ 247 „	455.
	„ 316 „	325.
Experiment IV.	At time of mixing	130.
	After 5 hours	41.
	„ 23 „	31.
	„ 48 „	38.
	„ 72 „	negative.
	„ 247 „	1.
	„ 316 „	0.
Experiment V.	At time of mixing	31,200.
	After 172 hours	9,360.
	„ 244 „	325.
Experiment VI.	At time of mixing	325.
	After 172 hours	2.
Experiment VII.	At time of mixing	32,500.
	After 504 hours (water kept at 8°C. to 10°C.).	79.
Experiment VIII.	At time of mixing	325.
	After 504 hours	0.

These results are fairly uniform. When a large number of Bacilli are added to the water their presence may be demonstrated longer than in cases where smaller quantities are used. Fourteen days would appear to be the average duration in sea water incubated at 35°C., whilst when kept in the cold their presence was demonstrated on the twenty-first day. There appears to be no initial or subsequent multiplication of the Bacilli. Between 40 and 70 hours after infection there is less decrease than at other periods; but there is no evidence of increase in numbers of the Bacilli when grown in sea waters either when incubated or at ordinary temperatures.

On the whole the investigations which are summarized above—and which it must be remembered are not yet finished—give results of a re-assuring nature, and demand from the public at the very least a suspension of judgment, while they also indicate the advantage of adopting some simple sanitary measures which, if properly carried into effect, would go far to remove suspicion from the oyster in our markets. These measures are, 1° a strict examination of all grounds upon which oysters are grown or bedded so as to ensure their freedom from sewage, and 2°, if practicable, the use of "dégorgeoirs" or disgorging tanks in which the oysters should be placed for a short time before they are sent to the consumer.

Explanation of the Plates.

Plate I.

Stenhelia herdmani, n. sp. (A. Scott).

Fig. 1. Female seen from the side, × 27. 2. Antennule, × 63. 3. Antenna, × 85. 4. Mandible, × 85. 5. Maxilla, × 85. 6. Anterior foot-jaw, × 127. 7. Posterior foot-jaw, × 90. 8. Foot of first pair of swimming feet, × 85. 9. Foot of fourth pair, × 85. 10. Foot of fifth pair, × 127. 11. Abdomen and caudal stylets, × 170.

Stenhelia similis, n. sp.

Fig. 12. Female seen from the side, × 40. 13. Antennule, × 127. 14. Antennule of male, × 127. 15. Antenna, × 125. 16. Mandible, × 253. 17. Maxilla, × 253. 18. Posterior foot-jaw, × 253. 19. Rostrum, × 253. 20. Foot of first pair of swimming feet, × 127. 21. Foot of

fourth pair, × 127. 22. Foot of second pair, male, × 127. 23. Foot of fifth pair, × 125. 24. Foot of fifth pair, male, × 125. 25. Abdomen and caudal stylets, × 53.

Plate II.

Ameira gracile, n. sp.

Fig. 1. Female seen from the side, × 64. 2. Antennule, × 152. 3. Antennule, male, × 152. 4. Antenna, × 253. 5. Mandible, × 380. 6. Posterior foot-jaw, × 380. 7. Foot of first pair of swimming feet, × 170. 8. Foot of fourth pair, × 170. 9. Foot of fifth pair, × 380. 10. Foot of fifth pair, male, × 380. 11. Abdomen and caudal stylets, × 80.

Canthocamptus palustris, Brady.

Fig. 12. Female seen from the side, × 50. 13. Antennule, × 200. 14. Antennule, male, × 152. 15. Antenna, × 253. 16. Mandible, × 300. 17. Posterior foot-jaw, × 380. 18. Foot of first pair of swimming feet, × 170. 19. Foot of fourth pair, × 170. 20. Foot of fifth pair, × 253. 21. Foot of fifth pair, male, × 253. 22. Appendage to the first abdominal segment, male, × 253. 23. Abdomen and caudal stylets, × 80.

Tetragoniceps trispinosus, n. sp.

Fig. 24. Posterior foot-jaw, × 300. 25. Foot of fifth pair, × 380.

Plate III.

Tetragoniceps trispinosus, n. sp.

Fig. 1. Female seen from above, × 80. 2. Antennule, × 170. 3. Antenna, × 253. 4. Foot of first

pair of swimming feet, × 253. 5. Foot of fourth pair, × 253. 6. Abdomen and caudal stylets, × 253.

Pseudolaophonte aculeata, n. gen. and n. sp.

Fig. 7. Female seen from above, × 106. 8. Antennule, × 170. 9. Antennule, male, × 170. 10. Antenna, × 125. 11. Mandible, × 253. 12. Maxilla, × 253. 13. Anterior foot-jaw, × 253. 14. Posterior foot-jaw, × 253. 15. Foot of first pair of swimming feet, × 253. 16. Foot of second pair, × 253. 17. Foot of third pair, × 253. 18. Foot of fourth pair, × 253. 19. Foot of fifth pair, × 170. 20. Foot of third pair, male, × 253. 21. Foot of fourth pair, male, × 253. 22. Foot of fifth pair, male, × 380. 23. Abdomen and caudal stylets, × 80.

Laophontodes bicornis, n. sp.

Fig. 24. Mandible, × 500. 25. Anterior foot-jaw, × 500.

Plate IV.

Laophontodes bicornis, n. sp.

Fig. 1. Female seen from above, × 120. 2. Antennule, × 253. 3. Antenna, × 253. 4. Posterior foot-jaw, × 380. 5. Foot of first pair of swimming feet, × 253. 6. Foot of fourth pair, × 253. 7. Foot of fifth pair, × 253.

Normanella attenuata, n. sp.

Fig. 8. Female seen from the side, × 50. 9. Antennule, × 127. 10. Antennule, Male, × 127. 11. Antenna, × 150. 12. Mandible, × 253. 13. Maxilla, × 253. 14. Posterior foot-jaw, × 253. 15. Foot of first pair of swimming feet, × 150. 16. Foot of second pair, × 150. 17. Foot of fourth pair, × 150. 18. Foot of fifth pair, ×

300. 19. Foot of fifth pair, male, × 300. 20. Abdomen and caudal stylets, × 90.

Idya elongata, n. sp.

Fig. 21. Posterior foot-jaw, × 380. 22. Foot of fifth pair, female, × 115. 23. Foot of fifth pair, male, × 115. 24. Appendage to the first abdominal segment, × 115.

Plate V.

Idya elongata, n. sp.

Fig. 1. Female seen from above, × 64. 2. Antennule, × 253. 3. Antennule, male, × 253. 4. Foot first pair of swimming feet, × 190. 5. Foot fourth pair, × 190.

Collocheres elegans, n. sp.

Fig. 6. Female seen from above, × 52. 7. Antennule, × 133. 8. Antenna, × 170. 9. Mandible, × 253. 10. Maxilla, × 170. 11. Anterior foot-jaw, × 170. 12. Posterior foot-jaw, × 170. 13. Foot of first pair of swimming feet, × 125. 14. Foot of fourth pair, × 125. 15. Foot of fifth pair, × 190.

Ascomyzon thompsoni, n. sp.

Fig. 16. Female seen from above, × 50. 17. Antennule, × 133. 18. Antenna, × 190. 19. Mandible, × 190. 20. Maxilla, × 125. 21. Anterior foot-jaw, × 127. 22. Posterior foot-jaw, × 127. 23. Foot of first pair of swimming feet, × 127. 24. Foot of fourth pair, × 127. 25. Foot of fifth pair, × 200. 26. Abdomen and caudal stylets, × 85.

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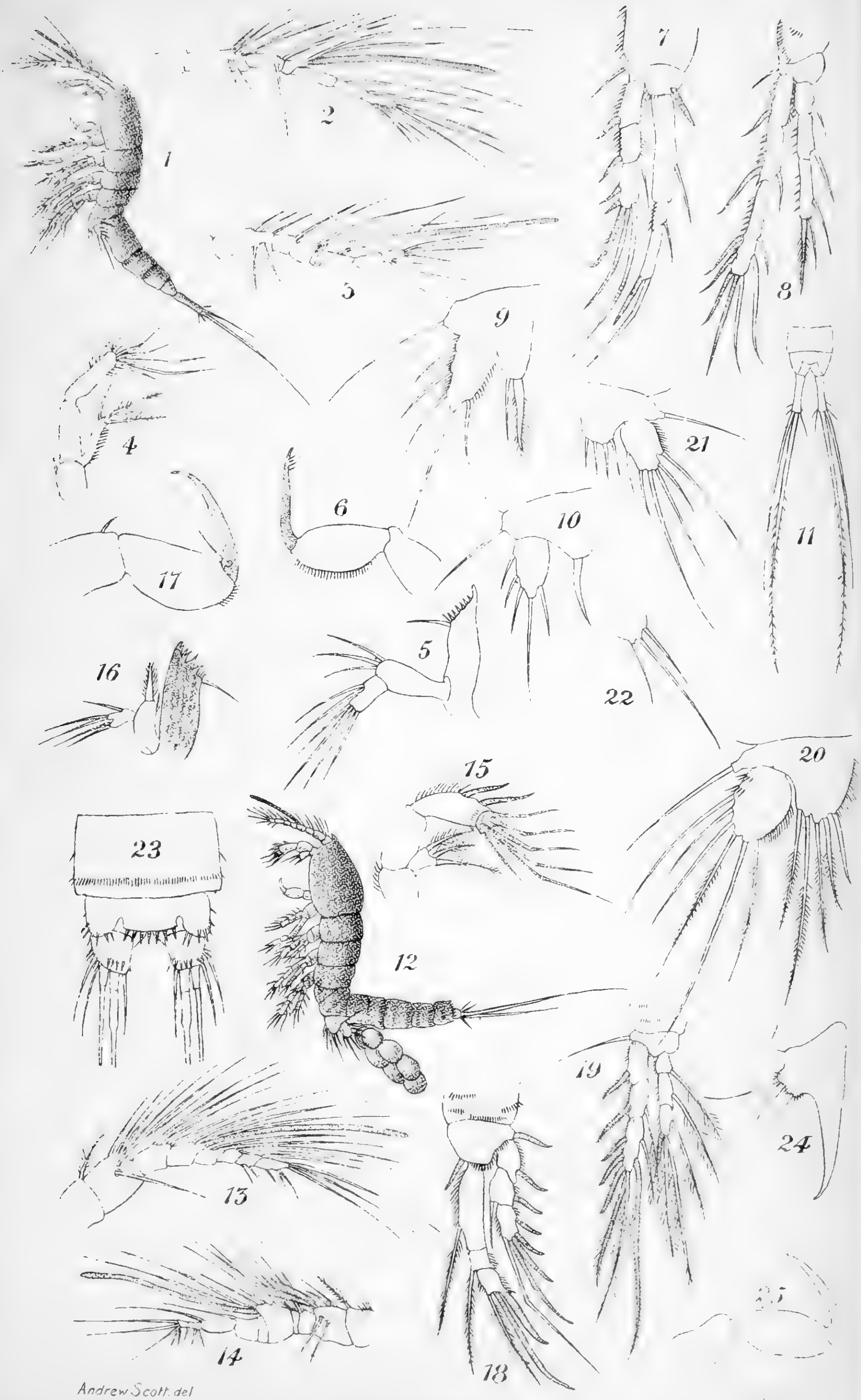

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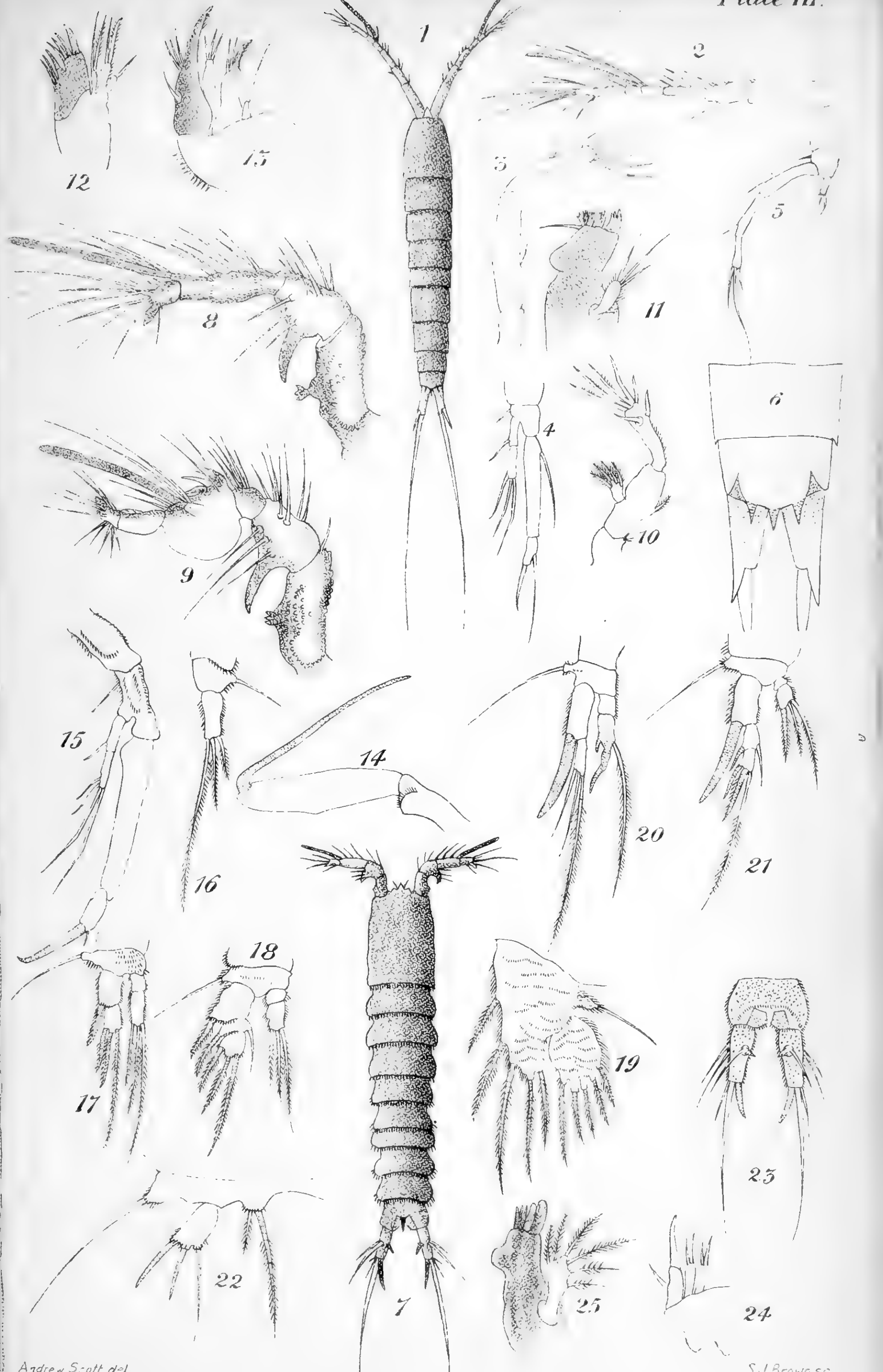
Plate III.



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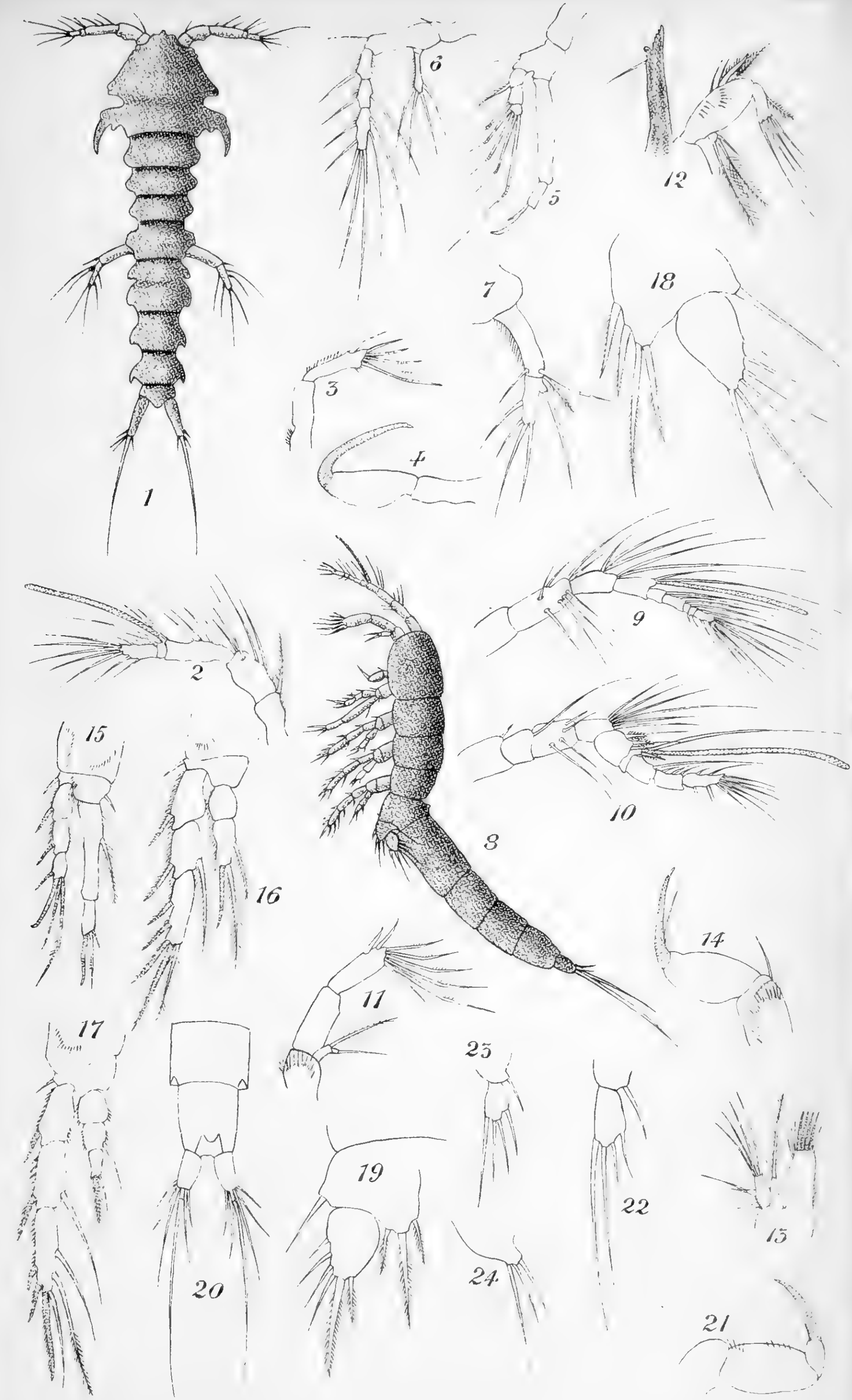

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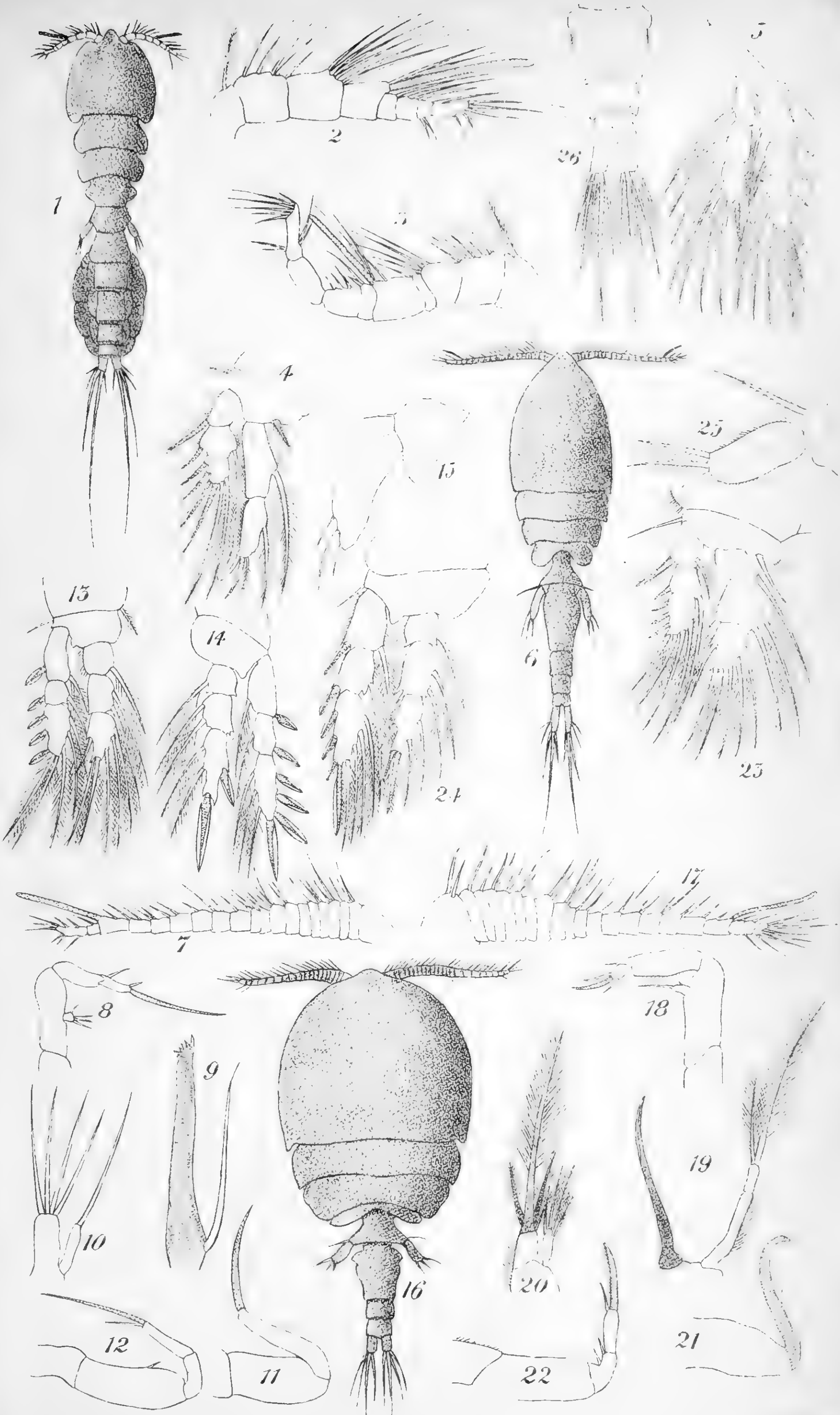

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